ECO-URBAN NEXUS

Designed solutions for urban climate change adaptation through increased human-nature connections.

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A 120 point thesis submitted to the School of Architecture and Design, Victoria University of Wellington, in partial fulfilment of the requirements for the degree, Master of Architecture (Professional).

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Sarah Burns

How might urban environments adapt to and mitigate climate change impacts affecting ecosystems and human wellbeing in a way which preserves social and cultural identities?

ABSTRACT

Urban environments in Aotearoa, New Zealand, face a series of challenges regarding the effects of climate change and urbanisation on ecosystems and human wellbeing. As a result of expansive urbanisation during the mid-19th century, the reshaping of natural landscapes saw the destruction of critical indigenous ecologies, causing ecological degradation and biodiversity loss and severely impacting people's wellbeing; physically, mentally, and spiritually. The way we continue to live in and build cities is causing further ecological degradation through overconsumption and pollution, which contributes to the current climate crisis, and leads to storm surge events and sea-level rise, among other direct negative impacts.

Porirua, New Zealand is no exemption to this condition. Its existing urban infrastructure and continued urban development to accommodate an expanding population are causing several environmental and social issues relating to ecosystem degradation. Regular flood events demonstrate the city's inability to cope with stormwater surges, which will only continue as the effects of climate change intensify (Daysh, 2019).

How might urban environments adapt to and mitigate climate change impacts affecting ecosystems and human wellbeing in a way which preserves social and cultural identities?

This thesis argues that a potential solution to address these issues is through increasing human-nature connections in the built environment at a range of scales and across disciplines. This research will test how biophilic design interventions (those related to increasing human/nature connections) could transform a city into a more livable, resilient place of wellbeing for a growing population. Challenging the typical juncture of ocean and land in an urban setting, the research reimagines Porirua as a 'city on a wetland' through a speculative biophilic design experiment, exploring how architecture might respond to dynamic landscape conditions. Theories of biophilia are studied for their related effects on improved human cognitive, psychological and physiological wellbeing, creating a new typology for civic space which marries culture, environment and architecture.

ACKNOWLEDGEMENTS

To my supervisor, Maibritt Pedersen Zari – Thank you for your invaluable knowledge.

To all my friends in the cohort – Thank you for the past five years of fun.

To Raglan Roast – Thank you for supplying my caffeine addiction.

And lastly, to mum and dad - Thank you for your constant support, encouragement and unconditional love. I could not have done this without you.

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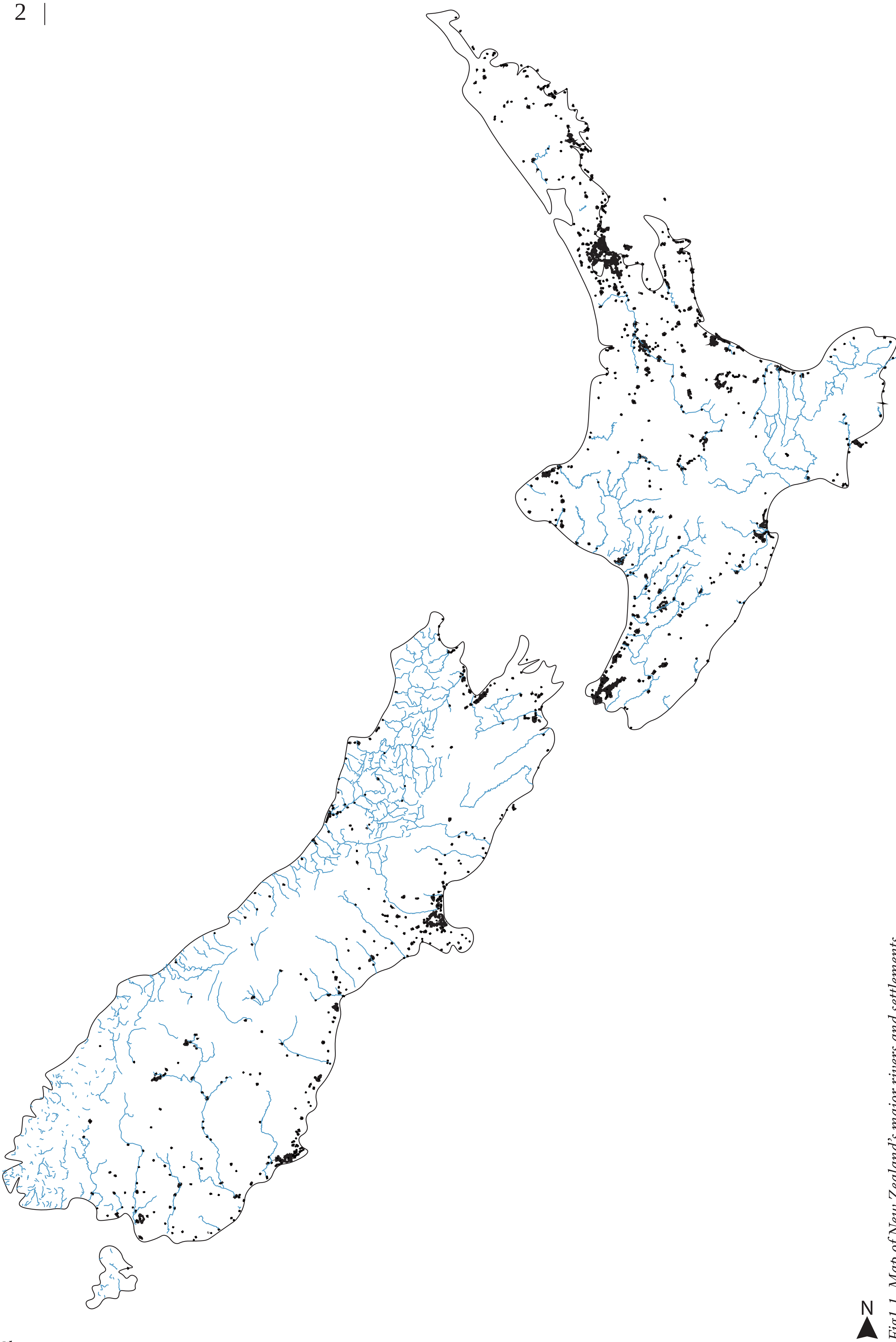


Fig1.1. Map of New Zealand's major rivers and settlements.

1.1

THE ISSUES

The global issue of climate change is caused by human activity, predominantly through releasing greenhouse gasses (GHG) into the earth's atmosphere (NASA, 2021). Climate change impacts include rising sea levels and increased magnitude and frequency of extreme weather events. This puts coastal communities at risk (Arblaster et al., 2007). Aotearoa is a country surrounded by water. Many of our major cities lie on coastal edges; therefore, failure to respond to climate change will significantly impact our cultural, social, economic and environmental wellbeing (Porirua City Council, 2020). Built environment professionals must design solutions to both adapt to the inevitable changes and mitigate the causes of climate change through eradicating the GHG emissions produced through existing building use and the creation of new infrastructure.

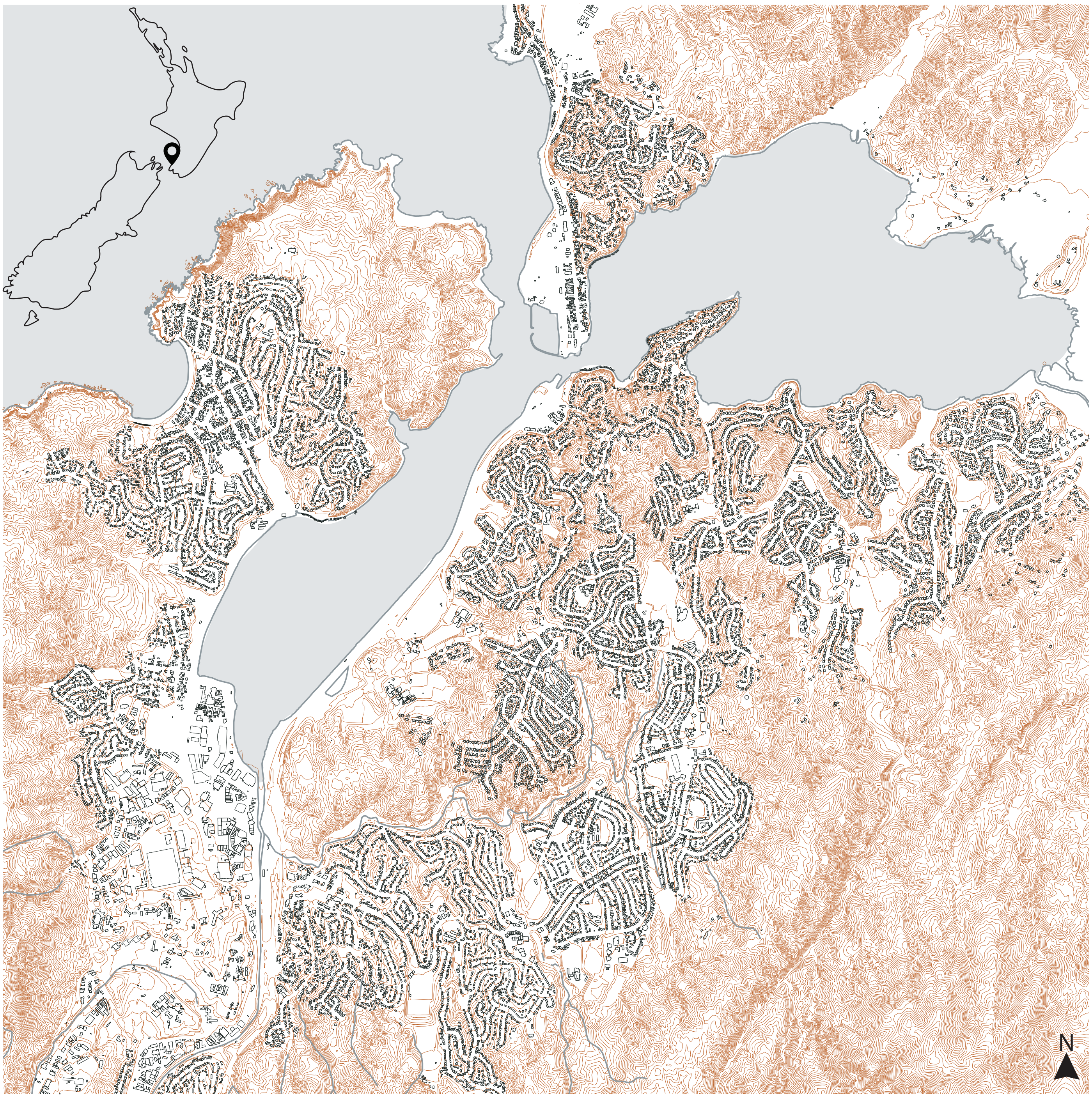


Fig1.2. Map of Porirua Harbour.

The global issue of climate change is caused by human activity, predominantly through releasing greenhouse gasses (GHG) into the earth's atmosphere (NASA, 2021). Climate change impacts include rising sea levels and increased magnitude and frequency of extreme weather events. This puts coastal communities at risk (Arblaster et al., 2007). Aotearoa is a country surrounded by water. Many of our major cities lie on coastal edges; therefore, failure to respond to climate change will significantly impact our cultural, social, economic and environmental wellbeing (Porirua City Council, 2020). Built environment professionals must design solutions to both adapt to the inevitable changes and mitigate the causes of climate change through eradicating the GHG emissions produced through existing building use and the creation of new infrastructure.

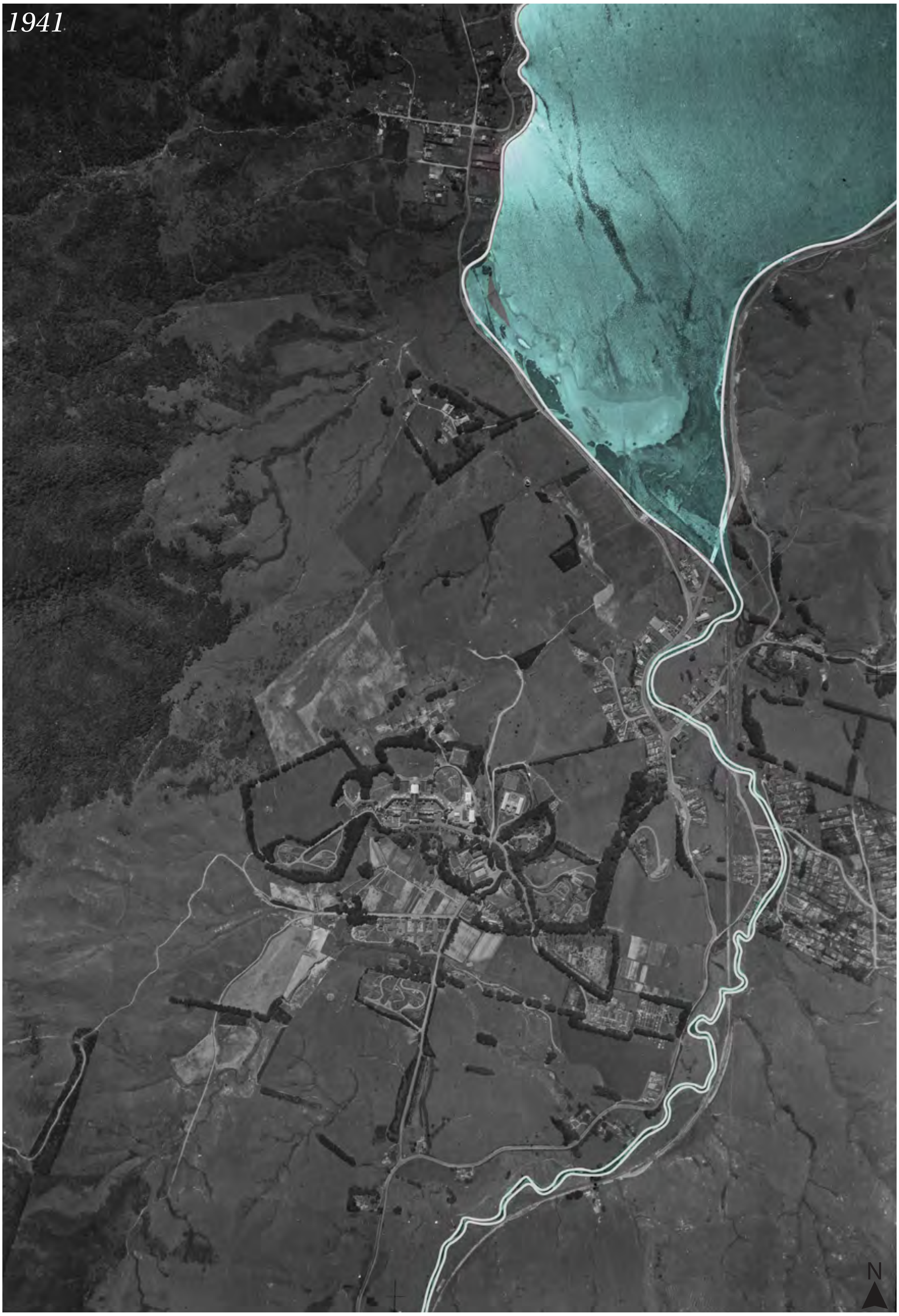
Porirua is a low-lying coastal city in New Zealand under pressure from both the historic and ongoing effects of urban development and climate change (Daysh, 2019). Porirua City Council declared a state of climate emergency in June 2019 and have established a climate change strategy acknowledging the need to minimise the impact of climate change and prepare for unavoidable changes (Porirua City Council, 2020). Predictions for Porirua are that by the mid-21st century, the sea level will rise by 12-24cm, average temperatures will increase by 0.5-1°C, average rainfall will increase, and storm events will become more frequent and extreme (Porirua City Council, 2020).

Occupied by Māori for its fertile soils and abundant food source, Porirua now has a population of 59,100, which is expected to increase to 85,149 by 2043 (Stats NZ, 2020). Rather than growing from the existing settlement, Porirua city exploded onto the landscape, confining the meandering Kenepuru Stream into a linear channel, reclaiming the harbour seabed and dramatically altering the harbour edge (Day, 1991, p. 13). A lack of permeable surfaces within the city fabric causes regular flooding and streambank erosion during high rainfall periods. Flood events pollute the water bodies with excessive sediment, biological and chemical contaminants (Environmental Science Department, 2015, p. 6). The result of this is the destruction of essential habitats for freshwater and marine life, threatened native fauna and flora, and decreased biodiversity (Te Awarua-o-Porirua Whaitua Committee, 2019).

The degrading state of the water bodies causes a physical disconnect between the community and the water, hindering water-related cultural activities, including swimming and fishing (Te Awarua-o-Porirua Whaitua Committee, 2019, p. 8). Local iwi, Ngāti Toa traditionally sourced kaimoana (seafood) from the bountiful harbour; however, despite Ngāti Toa's protests, the land reclamation in the 1940s destroyed most of the seafood bed (Maclean, 2016). Takapūwāhia, located North West of the city centre, is now Ngati Toa's central marae; however, their connection to the harbour is limited due to its degrading state and the related health risk to humans (Te Awarua-o-Porirua Whaitua Committee, 2019, p. 8).

Fig1.3. Top left - A scene in a New Zealand forest near Porirua by G.f. Angas. (1847).
Fig1.4. Top right and bottom - Collection of historic images in Porirua.

Fig1.5. Aerial view of land reclamation process in 1965.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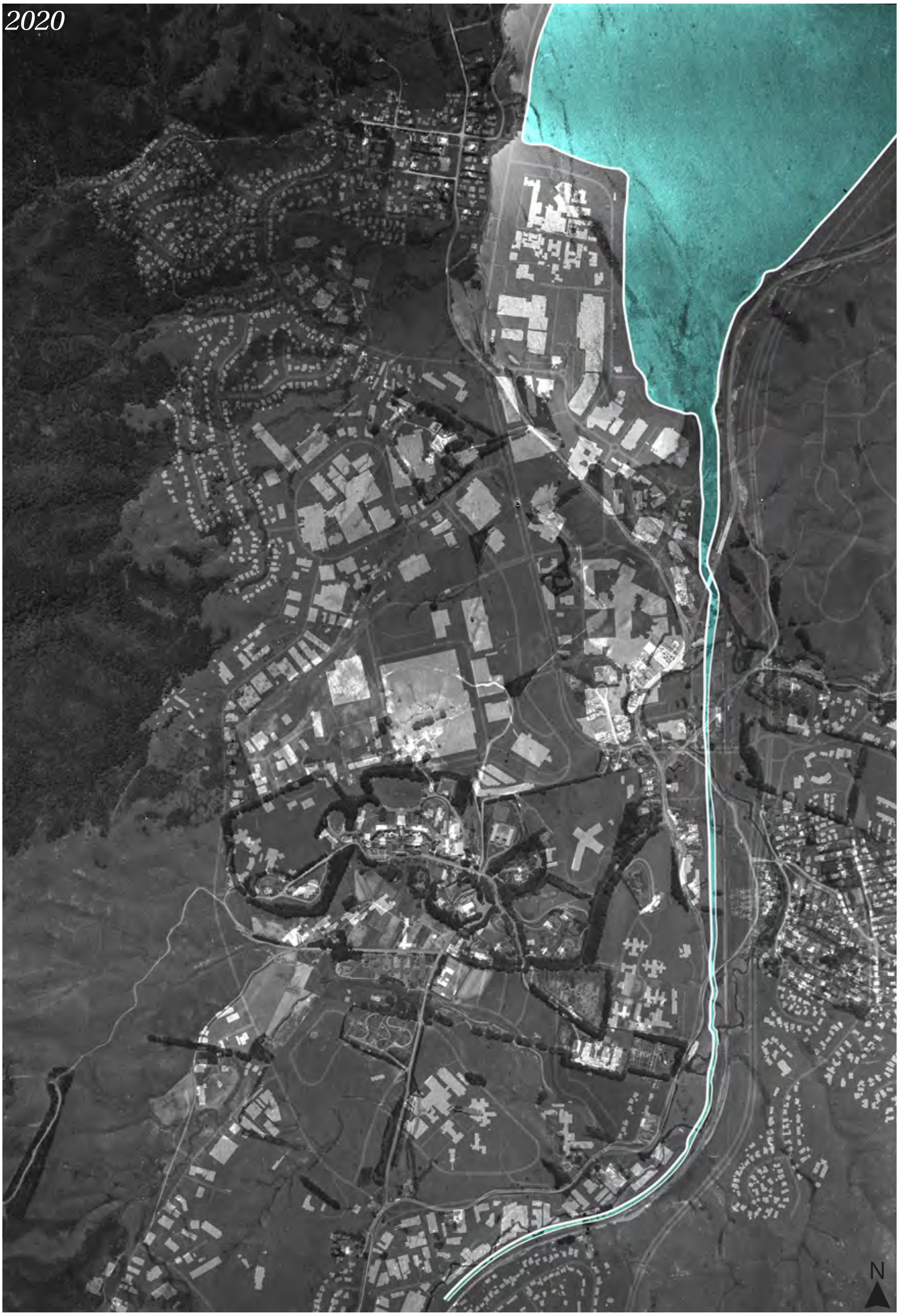
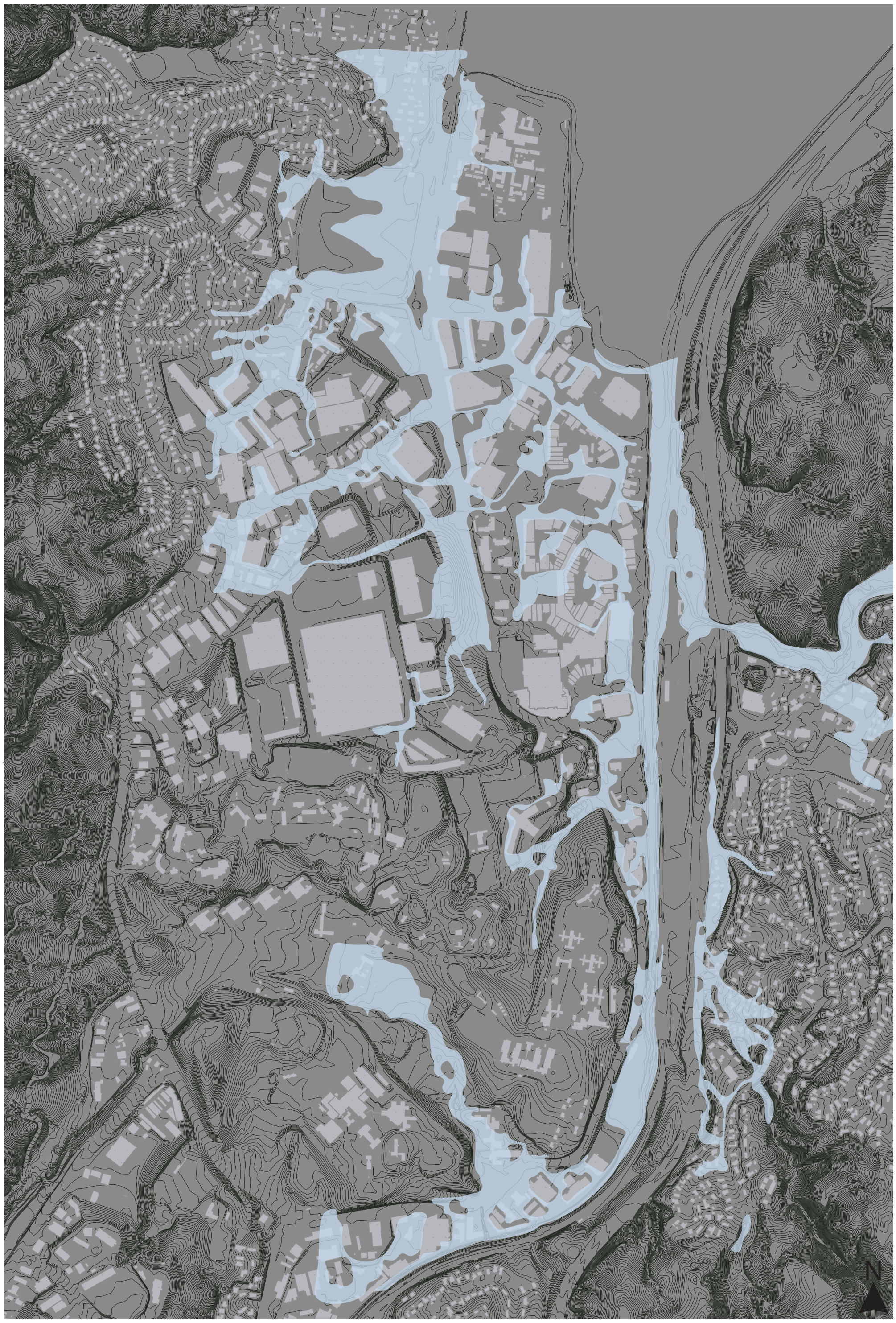


← Fig1.6. Aerial map of Porirua in 1941.
↑ Fig1.7. Aerial map of Porirua in 2020.

←Fig1.8. Flooding in Porirua 1964.
→Fig 1.9. Flooding in Porirua 2015.



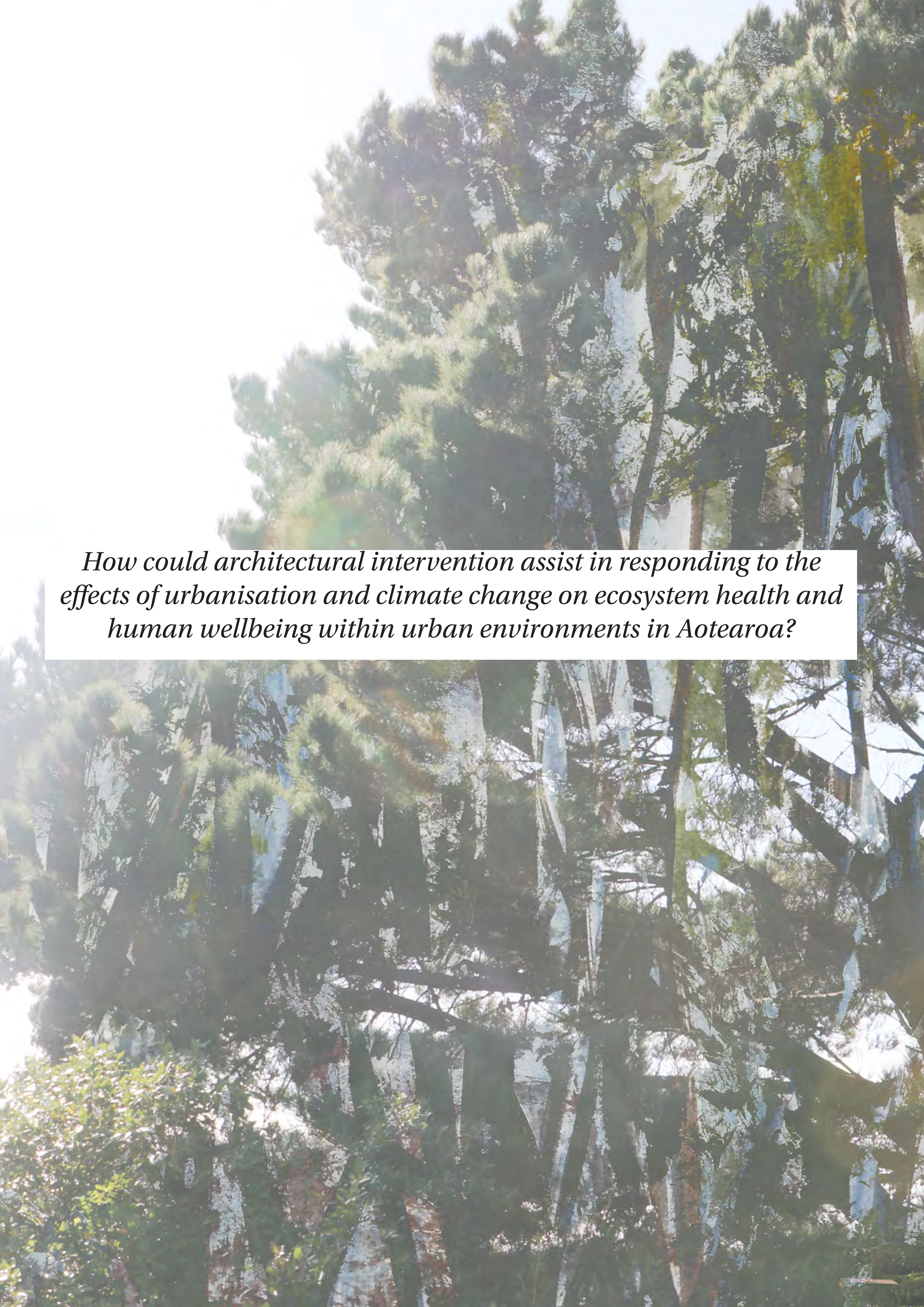
Flood risk zone

Fig1.10. Map of predicted 1 in 100-year flood areas.

Porirua has a culturally diverse population, with 19.6% identify as Maori, 24.6% as Pasifika peoples, 6% Asian, and 60% as Pākeha alongside other smaller groupings (Stats NZ, 2020). With 25% of the population being under 14 years old, Porirua is characterised by a young population (Stats NZ, 2020). Rather than a human-centred city, Porirua has been built at an automotive scale, hosting 'big-box' infrastructure scattered amongst mass car parking, with minimal pedestrian routes and little connection to the harbour or Porirua Stream. The city is difficult to navigate as a pedestrian, which influences a higher use of vehicle transport.

The existing urban fabric leaves the community living in a city with limited opportunity to connect to the dynamic living world which sustains them, adding to the current ecological damage through developed unsustainable human behaviours.

These issues prompt the question…



How could architectural intervention assist in responding to the effects of urbanisation and climate change on ecosystem health and human wellbeing within urban environments in Aotearoa?

1.2

RESEARCH PROPOSITION.

This thesis argues that designing a (re)connection with nature and natural systems could be a solution that simultaneously addresses the issues Porirua faces relating to climate change and urbanisation. Biophilic Design is a concept aiming to increase human-nature connections (Terrapin Bright Green, 2014). The focus of biophilic design is to improve human wellbeing, adopting the evidence and theories from multidisciplinary research which proves a direct or indirect connection to the living world positively affects human cognitive, psychological, and physiological wellbeing (Terrapin Bright Green, 2014). However, additional social, economic and environmental benefits can occur by implementing biophilic design if it carefully integrates local aspects of place. McDonald and Beatley (2020, pg. 106) argue that few solutions will simultaneously and effectively address the severe challenges that cities face in the way that nature can.

Placemaking is an approach to the planning, design and management of meaningful public spaces that promote the health and wellbeing of the community. The concept of placemaking involves the understanding of interconnections between ecological and social processes to create meaningful relationships between humans and the local ecological context for increased human wellbeing (Kellert et al., 2013).

When the local place is understood in-depth and used in the biophilic design application, projects can become ecologically regenerative (Pedersen Zari, 2009). Biophilic Design also addresses the experience of climate change in the built environment by providing a platform for nature-based solutions (Africa et al., 2019). Nature-based solutions address societal challenges such as climate change, disaster risk reduction, food and water security, health and economic development through the protection and restoration of ecosystems (IUCN, 2020). Therefore, through engaging with past, present and future aspects of ecology and culture of the context, biophilic implementation has potential ecological and social benefits as well as increased wellbeing for individuals (Pedersen Zari, 2009). The concept of biophilic design becomes the overarching theme of this research, exploring its most suitable application in Porirua's civic spaces.

Within the context of Aotearoa, the integration of Māori indigeneity and identity into the planning, design, and construction of our built environments, and ultimately our way of being as collective people, is crucial. This body of work acknowledges the more profound significance of this research's overarching themes concerning Māori culture and identity. In this sense, the wellbeing of the human population of Aotearoa cannot be discussed separately from the health of our ecosystems due to the inseverable ties that tangata whenua (Māori people) have with the land (Charles Royal, 2007a). The physical presence of nature implemented in this research provides the opportunity to explore restoring the mana (spiritual power) and mauri (life force) of altered landscapes.

In an ideal situation, the process would involve discussions and collaboration with mana whenua (people indigenous to a particular place); however, this design research is limited to publicly accessible knowledge and analysis and is based on the author's best understanding. Sources of information include The Te Aranga Māori Design Principles, which are referred to throughout the design process to ensure a representation of mana whenua values.

Kellert (2005), 'When this relationship among culture, environment, and architecture is pronounced, these places become alive for us, a part of our collective consciousness and identity' (Kellert, 2005, p. 165).

Fig1.11. Panorama of Porirua Harbour.

1.3

AIMS AND OBJECTIVES

The principle aim of this design-led research is to explore the potential role of biophilic design in addressing issues relating to climate change-induced flooding, ecological degradation and human wellbeing within the urban setting of Aotearoa, using Porirua as the primary test case location.

The objectives of this investigation are:

1. Implement a physical, ephemeral, and virtual presence of nature into urban conditions and infrastructure.

2. Design opportunities for humans to interact with and learn about nature within the urban setting.

3. Create biophilic civic spaces and buildings which respond to the local climate, ecosystem, and culture.

1.4

SCOPE

The issue of climate change-induced storm surge and sea-level rise is not limited to Aotearoa; it is a global issue. The heavy influence of the concept of placemaking will produce outcomes limited to the local ecological, social and cultural context; however, with adaptation, it could be applied to other cities globally tackling similar issues.

This work is inherently interdisciplinary, tackling issues in architecture, landscape architecture, urban design, human psychology, and ecology. Although an architectural thesis, the work is not limited to the boundaries of the architectural profession, exploring the intersections of architecture and landscape architecture. The investigation is limited to accessible public knowledge and technical understanding within reach of an architecture student's comprehension. In a real-world scenario, a project of this magnitude would involve the collaboration of experts from diverse fields and external consultancy.

Beyond this investigation are all aspects of cost, funding, and detailed engineering design. Although outside the scope of this research, it would perhaps be possible to justify the socio-ecological-economic value of this research's implementations through various ecosystem services evaluation methods if deemed appropriate (Clarkson et al., 2014).

1.5

METHODOLOGY

This thesis employs a design-led research methodology, facilitating reflective discussions through an iterative design process. Designs are formed through various mediums (analogue and digital techniques, physical modelling etc.), while literature-based focused research continues parallel to this and supplements and informs the design results. Relevant precedents are critically analysed throughout the design process as it evolves and shifts between scales. Design phases move between macro and micro scales to acknowledge the requirement for a whole-systems approach to nature-based design solutions to positively affect the broader issues relating to climate change and community wellbeing (Yeang, 2020).

Biophilic design principles are explored for their related effects on improved human cognitive, psychological, and physiological wellbeing and their role in creating more resilient and livable cities through nature-based solutions . The explored adaptation methods will respond to the local ecological, social and cultural context to ensure the population's wellbeing is considered through issues relating to identity, belonging and place. Indigenous knowledge offers inciteful solutions specific to the local context by acknowledging the interconnectedness and interrelationship of all living & non-living things (McAleer, 2021).

To ensure the aims and objectives of this research are met, a biophilic design framework was established from the outset to enable critical reflection of design outcomes. The framework was formed by combining several existing biophilic frameworks, placing contact with nature at the forefront of design decision making across all scales.

Specific research techniques were employed at different phases of the research, as discussed in the following section.

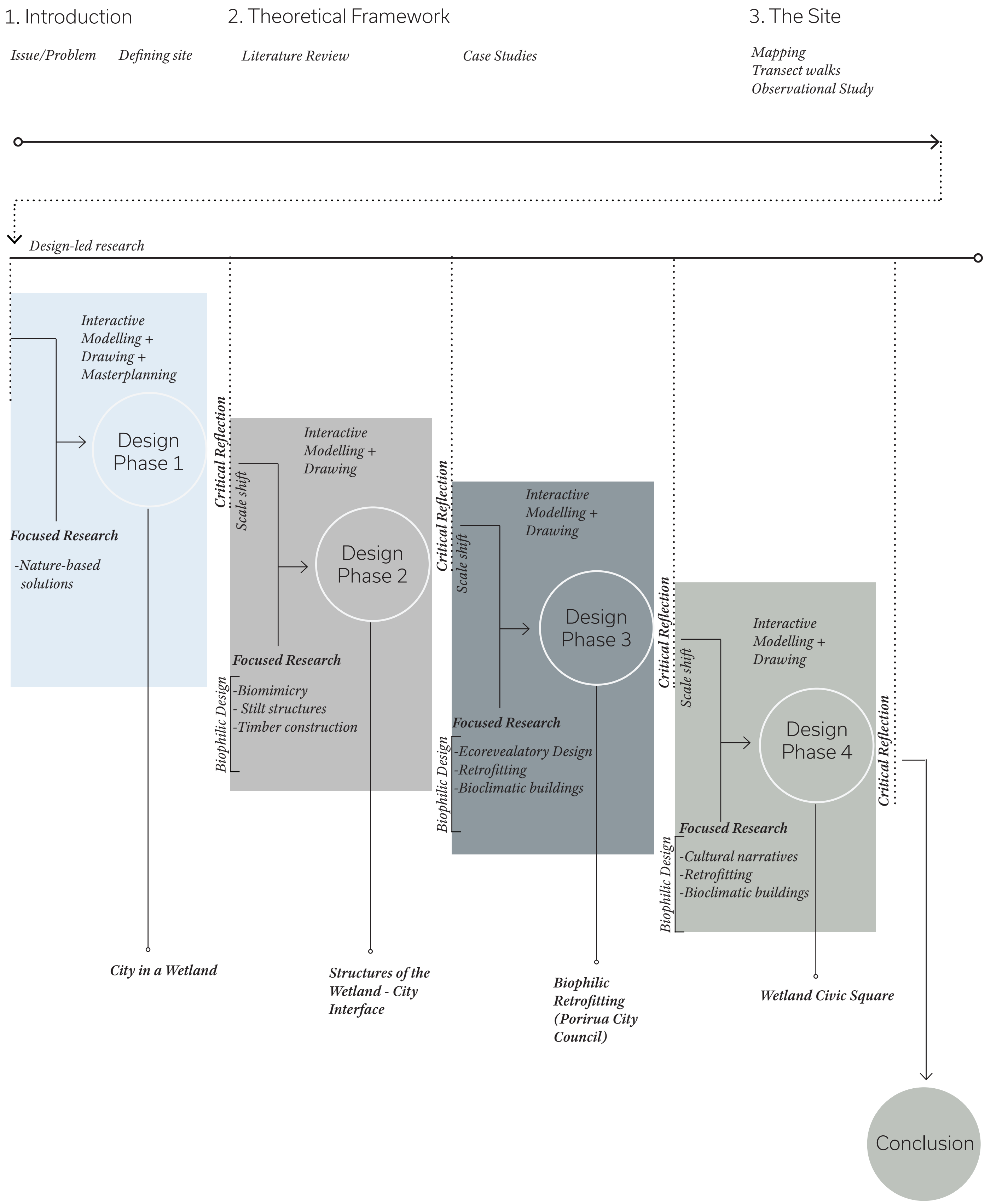


Fig1.12. Methodology Diagram. Introduction

1.6

THESIS STRUCTURE.

Chapter 1 : Introduction

This chapter introduces the problem which drives the research question. It presents a research proposition, summarising the investigation's principal theories, followed by the aims, objectives and scope of the study.

Chapter 2: Theoretic Framework

This chapter contains literature and precedent reviews relating to the aims and objectives of this research, forming a foundational body of knowledge for the design research. A biophilic framework was established to refer to throughout the design phases as assessment criteria.

Chapter 3: Site Analysis

The first stage of the research involved extensive site analysis of Porirua, engaging with past, present and future aspects of ecology and culture. This understanding of 'the local' was an essential step in establishing the appropriate biophilic implementation strategies to use in Porirua. Transect-walks along the river, waterfront and through the CBD enabled insight into the user experience of place and helped to establish suitable sites for biophilic intervention. Transect walks are a participatory method involving walking between two points and mapping observations of characteristics, risks and solutions (parcitypatory, 2017). This method allows researchers to experience and observe the site from a user's perspective, discovering a more thorough understanding of the site and how people use it. Findings from the conducted transect walks are discussed in this chapter then used to influence design decisions in design chapter 4.

Chapter 4: City in a Wetland

Design-Led Research

The first design phase explored implementing a physical presence of nature at the urban scale. The initial discovery and examination of the site's ecology through time informed the design moves for the natural systems implemented in this research. Discovering the historical conditions of the land and water bodies surrounding Porirua before the intensive urban modification period informed the design moves for an ecological blue-green belt and wetland restoration approach to the design.

Through the method of analogue and digital master planning, the chapter explores how the city could continue to function and thrive with the applied landscape remediation through urban planning initiatives such as traffic management, pedestrian routes and required additional infrastructure.

Chapter 5: Structures of the Wetland/City Interface

Design-Led Research

The following two phases have a shift in scale, exploring new typologies for civic space and architecture in Porirua. This design phase explores the concepts for the pathways and bridges required at the wetland and city interface to facilitate human engagement with the implemented landscape. This design phase starts with focused research of biomimicry to inform the design concepts. It explores how through mimicking the wetland ecosystem, the surrounding human-built structures can integrate with its natural systems, processes and cycles.

Chapter 6:
Biophilic Retrofit (Porirua City Council)
Design-Led Research

This phase uses biophilic design strategies to retrofit an existing vacant building at the harbour's edge to become the office and facilities for Porirua City Council. It explores how buildings could adapt to work with the local climate to become bioclimatic buildings, which are more energy-efficient through passive techniques. Ecorevealatory design techniques are explored as an opportunity to change perceptions through civic experience.

Chapter 7:
Wetland Civic Square
Design-Led Research

This design phase, brings together the previous design explorations to devise a wetland civic square located at the mouth of the implemented wetland stream as it enters Porirua Harbour. The intention is to create a civic space at the heart of the city, promoting the community's health through designed human connections with nature.

Linking the community to Te Awarua-o-Porirua was a priority because water is the heart of our culture and identity as collective people of Aotearoa (Ministry for the Environment, 2020).

Rather than designing the civic space's architectural elements separately, this phase first explores how they link together at a larger scale and relate to the local context. The initial exploration occurs in plan through sketches, which are then brought to the 3-dimensional realm through physical and digital modelling.

Cultural narratives influence the design concepts for the spatial and formal composition of the civic space, engaging with placemaking theories that instil a sense of identity.

Architectural components of the public plaza are the Porirua City Council building (a retrofit existing vacant waterfront building), the pavilion and the pier. The designed landscape connections between these components were explored to enable people to occupy and interact with the wetland conditions. This section details how this civic space will function through various human activity.

Chapter 8:
Conclusion

This chapter concludes the findings of design-led research. It reflects on the strengths and weaknesses of the design methods, processes and subsequent outcomes concerning the research question. It then discusses the broader significance of the research's findings for the architectural profession and how the body of work could be extended.

Chapter 9:
Bibliography

2

CHAPTER

Theoretical Framework

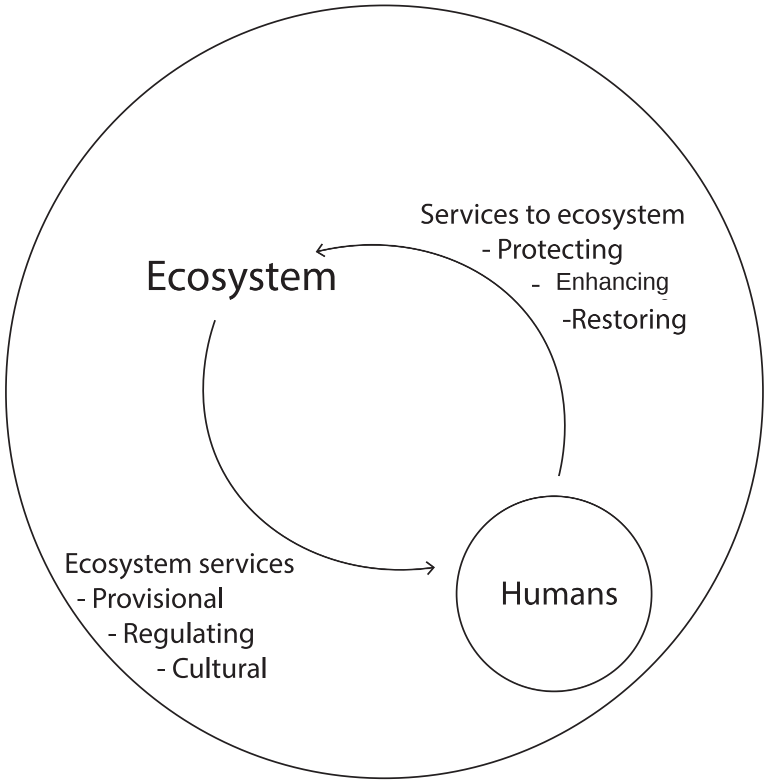
2.1

LITERATURE.

Ecosystems, Human Wellbeing and the Built Environment.

The health of ecosystems links intrinsically to human survival and wellbeing through the provision of ecosystem services (Olaf Bastian et al., 2012). Ecosystem services are the direct and indirect benefits to humans, provided by healthy ecosystems' functions (Clarkson et al., 2014). As well as being the life support system for all forms of life on planet earth, ecosystems affect livelihoods, income, local migration and political conflict (Corvalán et al., 2005).

The built environment has a direct and indirect effect on ecosystems through land-use changes, habitat fragmentation and replacement of natural ground cover with impervious surfaces (Koren & Butler, 2006). These commonly occurring development patterns directly affect biological and human ecological ecologies, leading to more adverse impacts on ecological and human health. A significant contributor to climate change and ecosystem degradation, alongside agricultural-related emissions, is transportation systems based on private vehicle use (Koren & Butler, 2006). Cars release greenhouse gasses causing global climate change, leading to intensified weather events, sea-level rise and decreased air quality. Urban-sprawl is also a significant contributor to the degradation of habitats, altering ecosystems and reducing biodiversity. Often, roads, suburbs and industrial estates require the fragmentation or removal of habitats (Koren & Butler, 2006). These two aspects of transport and land-use are common occurrences in built environments, often influencing vehicle reliance, resulting in diminished social capital and reduced physical activity, amongst other aspects of human wellbeing (Koren & Butler, 2006). Porirua is no exemption to this condition. To truly resolve the issues will require a complete ecocentric reinvention of the human-made world where natural, hydrological, technological, and anthropocentric infrastructures emulate the attributes of ecosystems to become a synergistic bio-integrated whole (Yeang, 2020, p. 44) . The prioritisation of cars in the city centre should be replaced with infrastructure that encourages pedestrian and cycling activity and public transport use. In tandem, rather than continuing to develop residential areas outside the city centre through urban sprawl, development methods should consider densifying the existing city centre with mixed use residential zoning. Most residents of Porirua live in nearby suburbs, such as Elsdon, Titahi Bay, Rānui, Cannon's Creek, Waitangirua which have issues of segregation based on income. Implementing a diverse range of residential accommodation within the CBD could provide homes for a mixed demographic, and activate the city centre.



Service Type	*Detailed Service*
Provisional	Food, fresh water supplies, raw materials, fuel/energy, genetic resources, medicinal resources and ornamental resources.
Regulating	Influence air quality, climate regulation, moderation of extreme events, regulate water flows, waste treatment, erosion prevention, soil fertility maintenance, pollination and biological control.E
Supporting	Habitat Provision, Species maintenance, Nutrient cycling.
Cultural	Aesthetic, recreation/tourism, inspiration for cultural, art and design, spiritual experience and cognitive information, creation of a sense of place.

(Clarkson et al., 2014; Pedersen Zari, 2018).

← *Fig2.1. Table of ecosystem services of wetlands.*
↑ *Fig2.2. Regenerative view world.*

Cultural Response.

Porirua is an example of urban development dominated by European ideologies and structures of colonisation in Aotearoa, resulting in significant ecological and cultural damage, and marked divisions along socioeconomic lines. New Zealand is a bicultural society where Te Tiriti o Waitangi sets up the partnership between hapū and the British Crown, promising mutual benefits. Breach of the Treaty of Waitangi has caused numerous instances of past and ongoing social injustice for Māori. Their indigenous ways of life were forcefully replaced by the Pākehā political and social construct, which continues to dominate the power structures of New Zealand society (Elkington et al., 2020). The built environment provides tangible opportunities to honour Te Tiriti o Waitangi, especially in the urban public setting where tangata whenua's right to autonomy requires better representation and manifestation (Elkington et al., 2020). Construction of the existing urban fabric was the colonisers' vision of 'progress', 'civilisation' and 'development'. For Māori, it meant the plundering of wahi tapu (sacred areas) and the draining of mana felt by the presence of the natural world (Murphy, 2016).

In the context of Aotearoa, the health of ecosystems is a foundation for the individual and collective wellbeing of tangata whenua (Charles Royal, 2007a). Tangata whenua find themselves linked to the natural world through whakapapa (genealogy), explaining their place within Papatūānuku (the earth) through direct relationship to specific mountains, the waterways, and the ancestors associated with self-identity (Charles Royal, 2007b). Te Ao Māori acknowledges interdependent relationships between all living and non-living things (Harmsworth & Awatere, 2013). This valuable indigenous knowledge has the opportunity to shape the physical world into one which better respects Te Tiriti o Waitangi and reflects the entirety of the human and non-human, living and non-living population of Aotearoa (Elkington et al., 2020).

For Māori, water is considered the essence of all life, which each waterway carrying mauri, tangibly represented through the waterbody's health (Mead, 2016). Restoring the mauri and mana of waterways is becoming increasingly crucial in Aotearoa. An example of this is the Whanganui River, which was given legal personhood in 2017 to recognise and respect the inseverable connection that local iwi has with their ancestral river (Warne, 2019). In breaching the Treaty of Waitangi, the New Zealand 'crown' (i.e. government) undermined the local iwi's ability to exercise customary rights and traditional practices concerning the river, significantly impacting physical, cultural, and spiritual wellbeing (Warne, 2019). Caring for the land, waterways and ecosystems and its relation to a sense of belonging not only improves the health and wellbeing of indigenous communities but everyone (Marques et al., 2018, p. 7). In search of meaningful human-nature connections, this research will work with the spatial qualities of Porirua, which could foster healthy interactive environments through biophilic intervention and return the modified streams, rivers, and forests to a natural, healthy state.

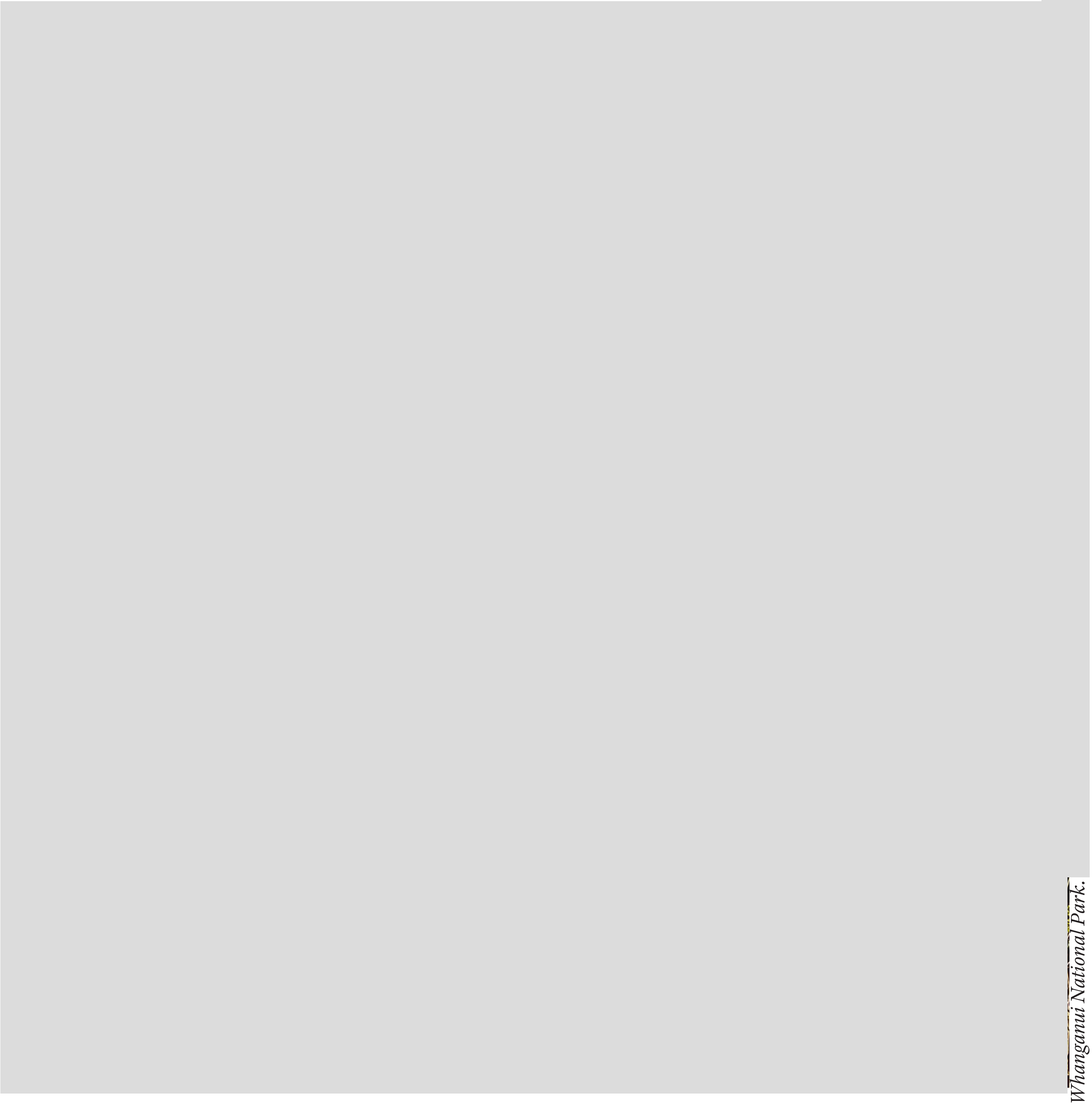


Fig2.3. Whanganui River through the Whanganui National Park.

Mauri
(noun) - life force

Mana
(noun) - prestige, authority, control, power, influence, status, spiritual power

The integration of Māori knowledge into design practice can expand concepts of belonging, identity, quality of life and place. The revival of Māori culture, values, narratives and knowledge transfer (mātauranga Māori) regarding care for the land offers the holistic ideologies of harmony and union between nature and people (Marques et al., 2020). This recognition of the interconnectedness of mind, body, spirit and land is vital for the health of both people and land (Marques et al., 2018, p. 7).

Kellert (2013) defines place-based relationships as "the successful marriage of culture with ecology in a geographical context" (Kellert et al., 2013). Ecological and cultural connection to past, present, and future aspects of place is essential for improved human-nature relationships and improved ecological wellbeing (Ives et al., 2018). An inherent human need is to feel a sense of belonging through connection to a place and is an integral component of individual and collective identity (B. Marques et al., 2020). In Aotearoa, Maori's place identity is established through a strong spiritual connection with the land and water, whereas for the Pākehā / Tauiwi of today, place identity is established mostly through the physical connection to the land they dwell on (Elkington et al., 2020) . How this connection came about is shamefully ignored because the reality is, our Pākehā ancestors took part in an inherently racist and unfair process to get here (Elkington et al., 2020). About European colonisers, Delahunty writes:

"The severing from ancestors from the land has brought [Pākehā] the material advantage and spiritual emptiness. The denial of this condition helps us deny the tangata whenua indigenous reality and justifies our control of resources. But it has required a weird forgetfulness" (Delahunty, 2015, p. 40).

Perhaps a way to replenish this spiritual emptiness could be through exercising the innate connections human possess with the natural world. Architecture acting as the mediator between artificial and natural, creating a human experience that brings awareness to the spiritual weight of nature. Such a phenomenon might help Pākehā better respect Te Ao Māori and achieve collective consciousness about the importance of protecting, enhancing, and restoring the natural world.

Fig2.4. Photograph native tree cover.

Ecorevealatory Design.

The possibility of (re)connecting people with their role in nature comes from an understanding of the natural systems occurring within a specific site (Marques et al., 2020). Understanding these systems involves the ability to observe and experience the natural processes which are often unrecognisable in urban settings. Installing a sense of guardianship and care for the land requires community awareness of the ecological systems and processes that sustain them. The term used to describe a design that seeks to create this awareness is ecorevealatory design. Ecorevealatory design reveals the ecological phenomena, processes and relationships occurring in the built environment, which are usually concealed in conventional design (Achilles & Elzey, 2013). The goal of ecorevealatory design is to change human perceptions, assuming that if the public can visualise and experience environmental phenomena and processes, they are able "to appreciate, evaluate and make wise decisions concerning them" (Helphand & Melnick, 1998, p. x). Revealing ecological phenomena allows humans to observe, understand and experience the ecosystems which sustain them, triggering a sense of guardianship/stewardship as they become aware of how their actions affect the ecosystems they intrinsically belong to. Encouraging active participation in conservation efforts through these techniques promotes activities that make people feel a sense of purpose and increased happiness (Reid & Hunter, 2013). Therefore, reconnecting humans with ecological processes through ecorevealatory design could improve environmental and human wellbeing simultaneously. The concept of ecorevealatory design is being implemented at times in landscape architecture (Achilles & Elzey, 2013). However, with buildings beginning to adopt techniques of ecomimicry to become constructed ecosystems (Pedersen Zari, 2018), there is an opportunity for the architectural field to apply these methods. The highlighting of a building's systems could include water collection and the treatment and transportation of water or 'waste', for example, becoming performative elements rather than a concealed necessity.

Fig2.5. Photograph of wahi tapu site in Aotearoa.

Biophilia.

“The desire for a (re)connection with nature and natural systems” (Terrapin Bright Green, 2014).

Evidence and theories from multidisciplinary psychologies prove a direct or indirect connection to the living world positively affects human cognitive, psychological, and physiological wellbeing. Benefits include reduced stress, improved cognitive function and expedited mental and physical healing (Wilson, 1984 ; Terrapin Bright Green, 2014; Ulrich, 1984). Biophilic design is the concept which seeks to create these human-nature connections for increased human wellbeing. Within the context of Biophilic Design, nature can be defined as “the living organisms and non-living components of an ecosystem” (Terrapin Bright Green, 2014). The biophilic concept is derived from the term ‘biophilia’, originating from E.O. Wilson, describing it as “the innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature” (Wilson, 1984, p. 31). Humans subconsciously seek connections with nature through genetic tendencies, which, throughout evolutionary history, helped with survival (Beatley, 2016). S. Kellert’s research in biophilia describes these genetic tendencies as a weak muscle which needs cultural reinforcement and exercising (Kellert, 2005). Several researchers have identified biophilic design elements; however, the two common expressions are direct experience and indirect experience of nature (Terrapin Bright Green, 2014). Direct experience requires bringing the physical components of nature into the built environment, such as plants, water and light. Indirect experience relates to the mimicking of geometries, forms and structures found in the living world (Beatley, 2016).

Biophilic design implementation can occur at multiple, interconnected scales, forming a complex ecological system full of shared habitat and biodiversity (McDonald & Beatley, 2020, p. 87). Application at the urban scale creates biophilic cities, which are designed to increase opportunities for human-nature relationships within urban environments through designing nature in the city, natures activities and the nature of the city (Pedersen Zari, 2019, p. 3). Biophilic cities are economically vibrant, full of interaction and resilient through nature-based solutions (McDonald & Beatley, 2020, p. 69).

Experiences and Attributes of Biophilic Design

Direct experience of nature	Indirect experience of nature	Experience of space and place
- Light - Air - Water - Plants - Animals - Weather - Natural landscapes and ecosystems	- Images of nature - Natural materials - Natural colours - Simulating natural light and air - Naturalistic shapes and forms - Evoking nature - Information richness - Age, change, and the patina of time - Natural geometries - Biomimicry	- Prospect and refuge - Organized complexity - Integration of parts to wholes - Transitional spaces - Mobility and wayfinding - Cultural and ecological attachment to place

(Calabrese & Kellert, 2015).

14 Patterns of Biophilic Design

Context	14 Patterns
Nature in the Space	1. Visual Connection with Nature
	2. Nonvisual Connection with Nature
	3. Nonrhythmic Sensory Stimuli
	4. Thermal & Airflow Variability
	5. Presence of Water
	6. Dynamic and Diffuse Light
	7. Connection with Natural Systems
Natural Analogues	8. Biomorphic Forms and Patterns
	9. Material Connection with Nature
	10. Complexity and Order
Nature of the Space	11. Prospect
	12. Refuge
	13. Mystery
	14. Risk/Peril

(Terrapin Bright Green, 2014).

↑ *Fig2.6. Table of Experiences and Attributes of Biophilic Design (Calabrese & Kellert, 2015).*
↓ *Fig2.7. Table of 14 Patterns of Biophilic Design (Terrapin Bright Green, 2014).*

Nature-based Solutions.

The International Union for Conservation of Nature defines nature-based solutions (NBS) as the "actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human wellbeing and biodiversity benefits" (Nature-Based Solutions, 2016). The addressed societal challenges include climate change, rapid urbanisation, increased demand for food and water and enhanced disaster risk, all of which can lead to abrupt and sometimes irreversible environmental change that adversely affects human development (Brears, 2020). Traditional approaches to address these issues rely on hard engineered grey infrastructure in urban flood control, stormwater management and pollution remediation. They often use unrecyclable and finite resources and are usually only temporary, needing improvement or replacement as climate change intensifies (Brears, 2020). Their green counterpart (NBS) is an alternative approach that uses ecosystems and the services they provide to address societal challenges sustainably (Brears, 2020). NBS are inspired by, supported by or copied from nature through ecosystem approaches, ecosystem-based approaches or biomimicry (Brears, 2020).

Typically, coastal urban environments use hard engineered grey infrastructure, creating defined lines or barriers between land and water, such as sea wall defence systems. Living shorelines and floating islands, such as mangroves and coral reefs, are a low cost, low maintenance alternative NBS to defend the urban fabric (Al, 2018). Dynamic, flexible, green edge conditions work cooperatively with water and its fluctuating properties rather than fighting against it.

This relates to the context of Porirua because the reclaimed land of the city centre required the removal of a vast area of intertidal saltmarsh - a natural occurring living shoreline defence system. It is, therefore, no wonder that Porirua experiences the flooding it does. Restoring this naturally occurring condition will be an appropriate nature-based solution for Porirua City's interface with the harbour. Careful design of this edge condition will allow an experience that connects humans with this thriving edge condition rather than separating people from, in this case, the ocean. Floating and elevated paths, which allow light to penetrate for photosynthesis, can preserve the natural system better through less human interference (Al, 2018) .

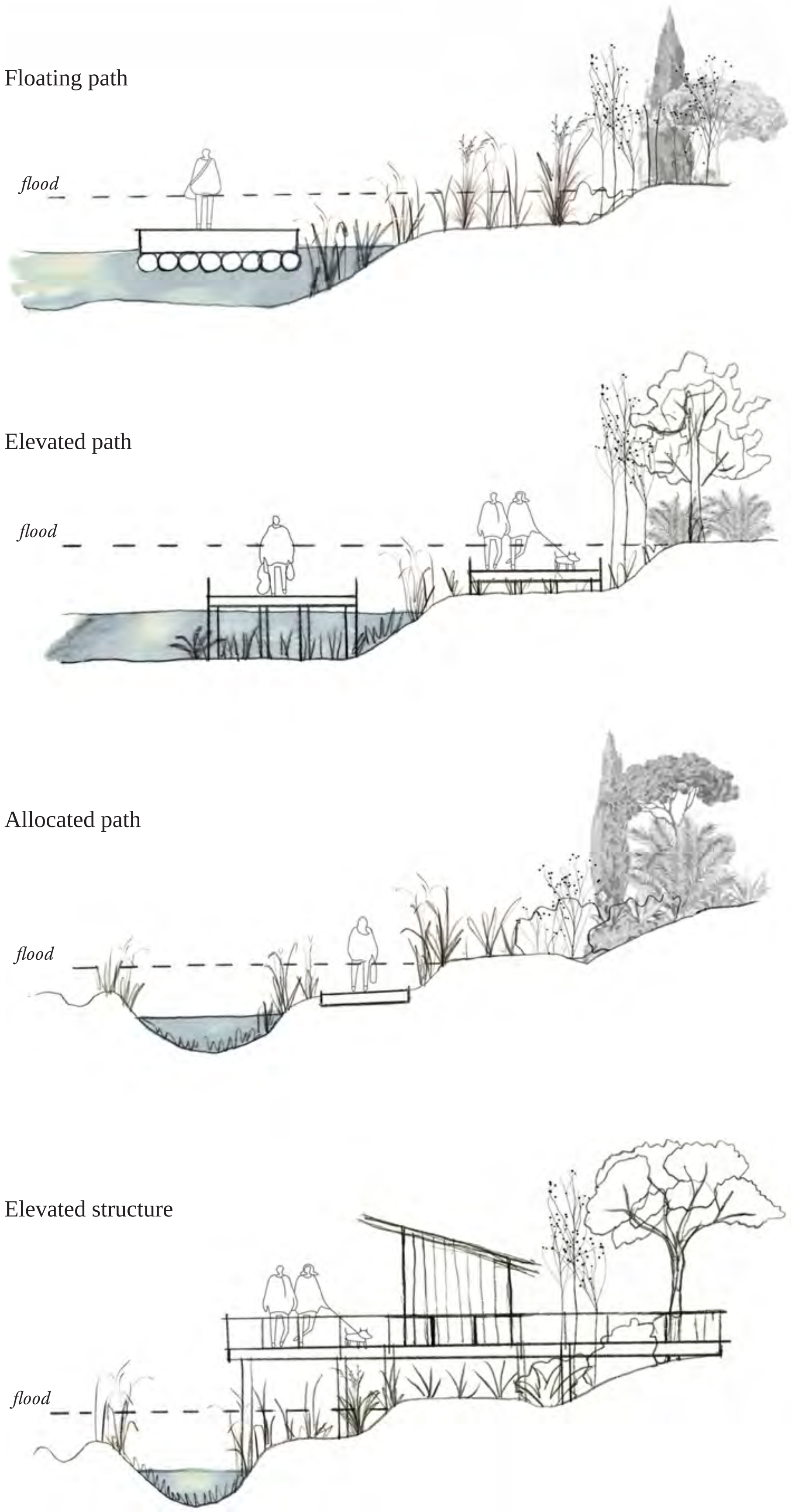
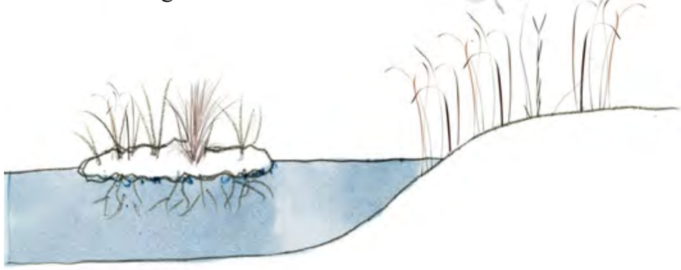


Fig2.8. Living shoreline sections.

Floating Islands

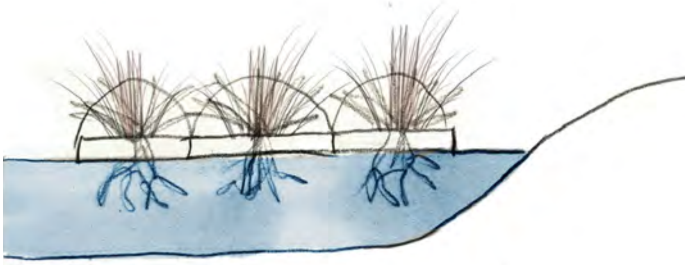
Floating islands are thick floating organic mats that support plant growth and remediate water, mimicking the natural islands that occur in marshes and wetlands (Al, 2018). Clustering biofilters produces a floating wetland, which could help to manage and purify stormwater runoff. The floating structure can be multifunctional by integrating recreational use (Al, 2018). This technique would be a more helpful defence solution on coastal edges which have direct contact with oceans because they can diffuse wave power during storm events. Porirua is located on an inlet; therefore, wave inundation is not a threat. If applied to the context of Porirua, floating islands could serve as natural filters of the water in the harbour and stream for improved water quality. They could also improve the issues regarding high volumes of sediment deposition at Porirua stream's mouth if installed at fast-flowing straightened sections further upstream. Slowing down the streamflow in these areas could produce a more natural and gradual sediment disposition along the river.

Natural floating island



Biofilters

Biofilter cluster



Recreation

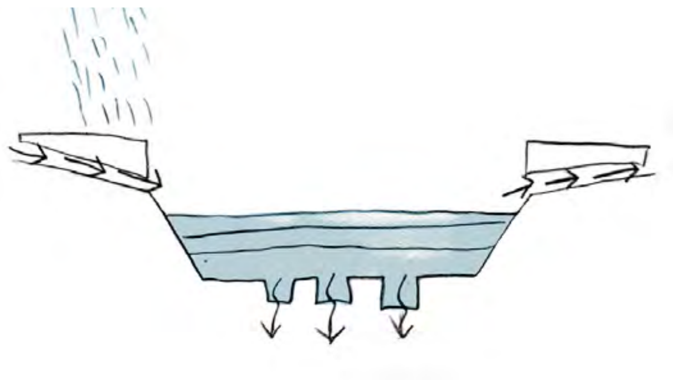
Fig2.9. Floating island sections.

Stormwater Infiltration

Sustainable drainage systems such as rain gardens, green roofs, rainwater harvesting systems and bioswales, are commonly used in many existing urban development frameworks to manage stormwater as well as offering ecosystem services (Zevenbergen et al., 2018). Increased porous surfaces and green infrastructure within the urban setting can relieve pressure on existing stormwater infrastructure. As well as offering flood protection, these strategies provide habitat for increased biodiversity and create opportunities for meaningful human-nature connections, which are critical for human wellbeing. The application of ecosystem services to the economic value of such large-scale implementation justifies the investment of these systems.

Reimaging Porirua City, this research will introduce bioswales, green roofs and walls into both existing and new infrastructure as an NBS to manage stormwater and increase the absorptive capacity within the city

Stormwater retention process



Parkand retention basins

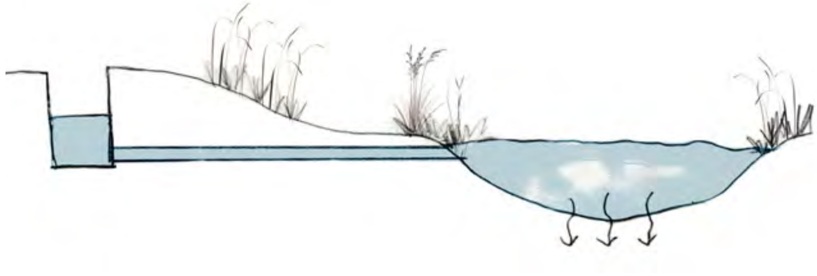


Fig2.10. Stormwater retention diagrams.

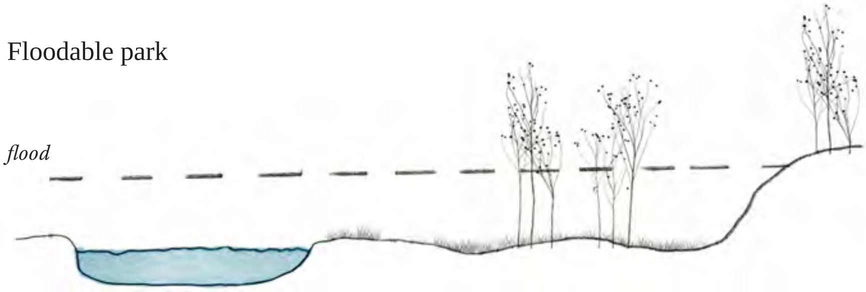
Store Strategies

An alternative to the defensive NBS solutions regarding urban flood control, stormwater management and pollution remediation, is to design floodwater retention areas throughout the city fabric. Storm and floodwater retention areas such as floodable plains, floodable squares, and stormwater infiltration can be integrated into parks, plazas and streets within the urban fabric.

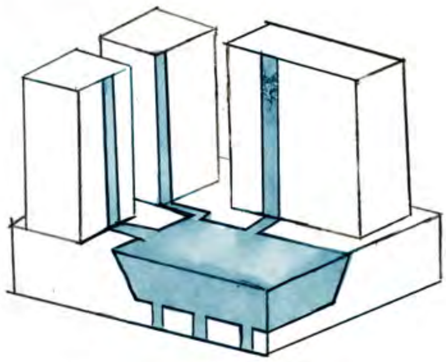
Designing floodable areas within the city fabric reduces the flood risk of essential city infrastructure elsewhere (Al, 2018). In wet conditions, floodable parks store the access water, allowing groundwater recharge and increasing soil fertility. In dryer conditions, the floodable spaces provide recreational use. By lowering certain areas of parks, these areas become the first to flood, therefore depending on the volume of water, they can have continued recreational function during flood events. This could be supplemented with sporadic elevated structures and terraces, creating amphitheatres, platforms, and buildings to activate the parks. Alternatively, through lowering urban areas and creating bioretention ponds, stormwater from surrounding urban infrastructure can be permanently held, creating urban green/blue space, and promoting biodiversity.

The idea of designing floodable areas will be an applied solution in Porirua as a strategy to protect essential existing urban infrastructure. Allowing spaces within the city to fluctuate with the seasons and changing climatic conditions rather than fighting against it will enable a human experience of the natural cycles of ecosystems within the urban fabric.

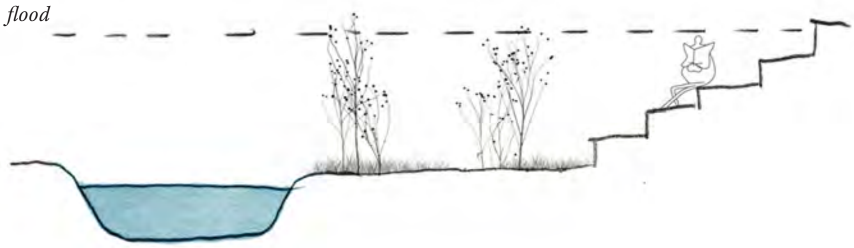
Floodable park



Floodable square



Recreation



Bioretention pond

Elevated Structures

Fig2.11. Store strategy illustrations.

2.2

PRECEDENTS AND CASE STUDY REVIEW.

Introduction.

The following precedent and case study reviews aim to extend the body of knowledge collected in the literature review. The common theme through all the reviewed projects is the application of nature-based solutions to solve various issues relating to climate change. Each case study's relevance to this research is analysed and translated into design progressions in further design chapters.

Fig2.12. Photographed wetland.

Sponge cities - a case study review

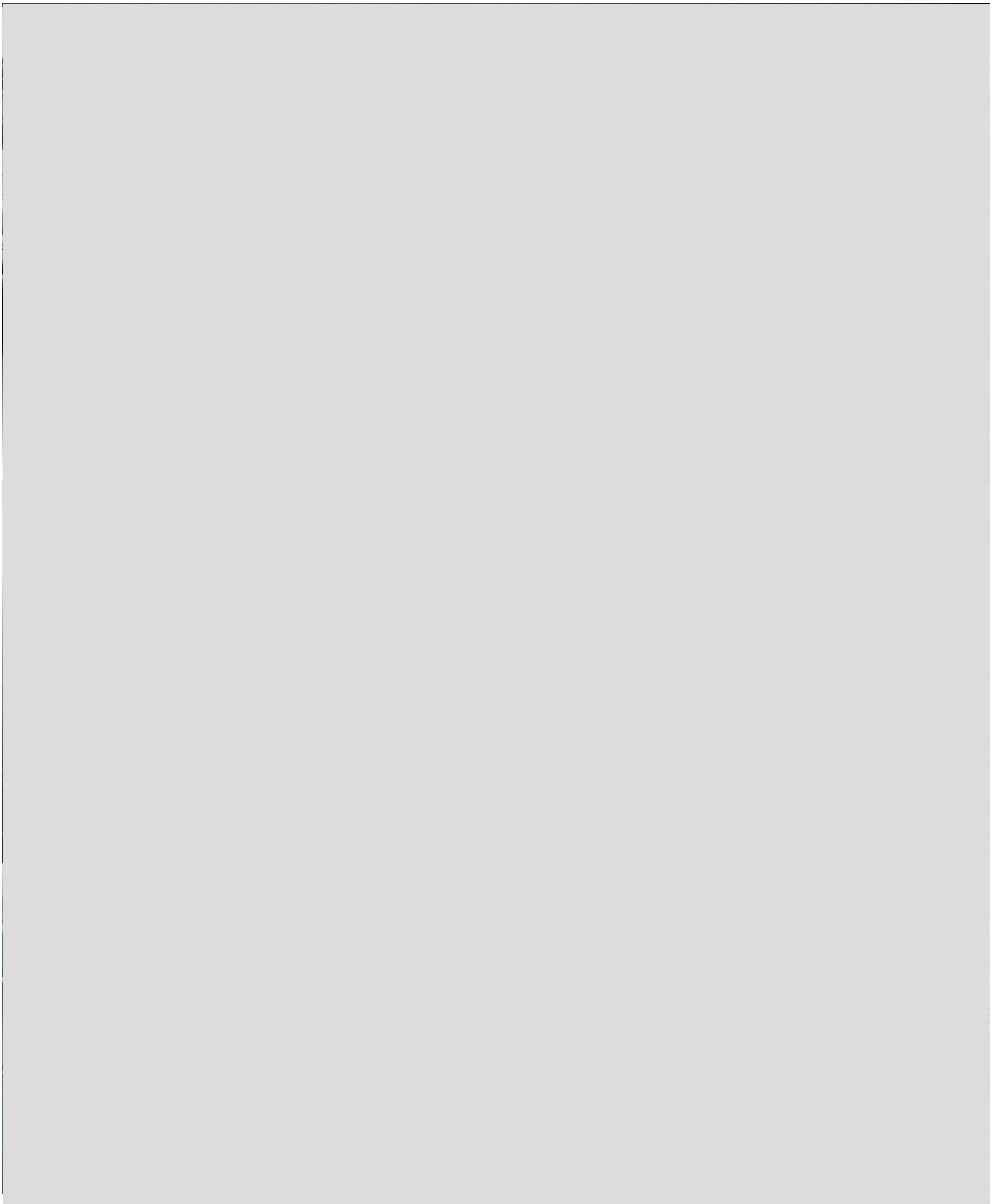
Meishe River Greenway and Fengziang Park
Location : Haikou, China
Turrenscape Landscape Architects

Many cities around the world are under pressure to tackle the water-related risks associated with climate change and urban growth, as well as achieving sustainable goals and addressing environmental concerns. Consequently, sponge cities urban development captures the synergies between sustainability planning and urban water management (Zevenbergen et al., 2018, pg. 1). Sponge cities use nature-based solutions to address urban water problems by mimicking natural hydrological and ecological processes (Zevenbergen et al., 2018, pg 2). These systems collect, store, and treat (excess) rainwater to cope with issues of “too much water”, “too little” and “too dirty” water (Zevenbergen et al., 2018, pg. xi).

Compared to underground sewer systems, sponge city infrastructure uses publicly exposed biological systems. The maintenance of all implemented technologies is vast and requires specialised training, providing jobs for the local community (Koster et al., 2019). Ecological cities can be achieved through wetland restoration using a near-natural method, an approach that embraces the philosophy of harmony between man and nature (Koster et al., 2019).

The Meishe River Greenway and Fengziang Park, located in Haikou, China, is a sponge city project led by Turrenscape Landscape Architects. It transformed a river suffering from pollution through sewage and stormwater runoff into a clean, biodiversity-rich and socially vibrant river. Terraced wetlands act as a sewage treatment system, with the ability to clean 6000 tons of runoff daily and making the river water swimmable (Yu, 2020). This ecological green infrastructure based on terrain, land use and hydrological processes is successfully integrated with a pedestrian and recreational network (Yu, 2020). Replacing grey infrastructure with holistic ecological infrastructures can provide several ecosystem services and resilience against floods. Many successful, symbiotic solutions are inspired by the ancient wisdom of living harmoniously with nature (Yu, 2020, p. 49). In Aotearoa, the idea of living harmoniously with nature is a critical aspect of Te Ao Māori, which could assist in the design of urban spaces that intertwine culture, climate, and ecologically. Urban stormwater systems which use nature-based solutions that mimic natural ecological processes can integrate the non-living built systems with naturally occurring living systems. Rather than controlling and containing water underground in pipes, stormwater solutions should acknowledge that water is a taonga (a treasured resource) that should be connected to the built environment in ways that enhance its Mauri. Key aspects of this case study that will be taken forward into the design investigations are the mimicking of natural hydrological and ecological processes and the exposing of usually hidden urban systems.

Fig2.13. Meishe River Greenway and Fengziang Park.



Rising Currents: Projects for New York's Waterfront Museum of Modern Art Exhibition

The Rising Currents exhibition held at the Museum of Modern Art presented projects for New York's waterfront in the face of the effects of climate change-induced sea-level rise and extreme weather events. Teams of architects, landscape architects, engineers, ecologists, and artists worked together to reinvent urban infrastructure. Challenging the effectiveness of 'hard infrastructure' as flood protection, the teams explored the benefits of soft shorelines - a more gradual transition from land to water. Collectively, the teams embraced the necessity to construct in and on water (Bergdoll, 2011, p.48).

New Urban Ground project by dlandstudio and ARO introduce absorptive wetlands, parklands and green streets acting as a sponge for rainwater and responding to daily tidal flows and occasional storm surges (Bergdoll, 2011, p. 60). The two primary components that form the interconnected system are wetland edges at the water's edge and the city's filtering streets.

New Aqueous city by nArchitects and MLC blurs the boundary between land and sea, extending water into the town through basins, swales and culverts, and extending the city into the water on elevated platforms. The aqueous city can control and absorb rising sea levels and accommodate predicted population growth (Bergdoll, 2011,p.100).

A vital aspect of this case study that will be taken forward into the design investigation is the idea of blurring the boundaries of land and sea. This case study demonstrates the application of living shorelines as an NBS, which mediates the edge of the city and water and creating more dynamic, flexible, and green edge conditions. This case study focuses on transforming the edge; this thesis research will push the blurring of the edge conditions further by introducing wetlands amongst the city centre. The dispersed arrangement of existing buildings in Porirua creates an opportunity to transform the space between buildings whilst maintaining civic function. This idea can be supplemented by extending the city's elements into the harbour through floating and elevated structures. In blurring the boundaries of land and water, this research will explore designing for the occupation of a fluctuating wetland condition.

Fig2.14. Rising Currents exhibition.

A New Zealand Case Study

Brylee Drive Reserve Wetland
Location: Takaniki, New Zealand
Morphum Environmental Ltd

The Brylee Drive Reserve Wetland by Morphum Environmental Ltd is a project in Takaniki, New Zealand, completed in June 2017. The 10,000 square meter wetland treats 30 hectares of the urban catchment before entering the Pahurehure Inlet (Morphum Environmental, 2020). This water sensitive urban design project provides long term improvements to water quality, increases the biodiversity of the existing reserve, and creates a recreational space for human interaction through allocated bridges and pathways. The project demonstrates the performance and function of constructed wetlands on coastal edges, including their potential role in sea level rise adaptation (Morphum Environmental, 2020). The flow of stormwater enters the wetland through a weir with a notch in it. The weir controls the volume of water entering the wetland to produce a continuous low flow of water.

This diversion method is a potential technique that could be used within the context of Porirua through the diversion of a specific volume of water from the Porirua Stream throughout the city wetlands. Where the Brylee Reserve Wetland project differs from the landscape implementation of this research is its focus on improving the quality of the water through wetlands, rather than a focus on human wellbeing. For a wetland to successfully clean a waterway, it must be 2-4% of the catchment size. The area of the city within the scope of this research is approximately 0.09 km2, which is less than the required minimum of 1.12km2 of wetland to clean the water in the 56km2 catchment for Porirua (Blaschke et al., 2009). Although outside the scope of this research, the implementation could contribute to a larger scheme of cleaning the waterways through the addition of wetlands further upstream.

The defining purpose of introducing wetlands within Porirua through the blue-green belt is not to clean the waterway; it is to increase the population's wellbeing, increase biodiversity and provide resilience against floods. Although the wetlands would not clean all of the water entirely, they would likely contribute to purifying some water before entering the harbour.

The wetland at Brylee reserve is heavily controlled, with only one downstream cell subject to saline ingress on king tides (Morphum Environmental, 2020). This research's wetland implementation will be significantly more dynamic, welcoming the tidal fluctuations of the Porirua Harbour. The reasoning for this is to provide a human experience of the low-lying ecosystem's natural cycles within the urban setting.

Fig2.15. Brylee Drive Reserve Wetland.

2.3

A BIOPHILIC URBANISM FRAMEWORK.

After critically analysing and comparing several biophilic design frameworks, a final framework was devised and formed the design outcomes' assessment criteria throughout this research. The chosen framework is Pedersen Zari's biophilic urbanism framework, which contains 30 characteristics of biophilic cities, considering both urban design and architectural aspects of biophilic design (Pedersen Zari, 2019, p. 3) . This framework is most suitable for the shifts in scale required throughout this design-led research to address the aims and objectives.

Design solutions will be applied at various scales engaging with Pedersen Zari's Framework for Biophilic Urbanism (Pedersen Zari, 2019) to transform Porirua into a Biophilic City. The work will explore the opportunities for adaptation of a city currently facing issues relating to urbanisation and climate change, establishing a new typology for civic space and architecture in Porirua.

1. NATURE IN THE SPACE (CITY)
1.1 Parks
1.2 Green belts/connected ecosystems/wild and semi-wild native nature spaces
1.3 Habitat provision
1.4 Rivers/streams/wetland/marine reserves
1.5 Water features
1.6 Street trees and canopies
1.7 Green roofs walls/rooftop gardens
1.8 Community gardens/edible landscaping
1.9 Nonvisual and virtual nature
1.10 Sensory stimuli

2. NATURE ACTIVITIES:
2.1 Nature clubs and ground
2.2 Outdoor activity centres/sports fields/places to swim
2.3 Camping grounds
2.4 Pedestrian zones/bike paths/tramping walkways
2.5 Gathering spaces in nature/playgrounds
2.6 Cafes/restaurants with outdoor spaces
2.7 Natural history museums/botanical gardens/environmental education initiatives
2.8 Natural history markers/celebrations
2.9 Ecosystem restoration/conservation projects
2.10 Local/international sustainability organisations

3. NATURE OF THE SPACE (CITY):
3.1 Bioclimatic buildings
3.2 Biomorphic buildings/spaces
3.3 Dynamic natural light
3.4 Thermal and airflow variability
3.5 Material and colour connections with nature
3.6 Celebration of nature/ climate/bioregion
3.7 Prospect/view
3.8 Refuge/sanctuary
3.9 Mystery, surprise, and curiosity
3.10 Risk and peril

3

CHAPTER

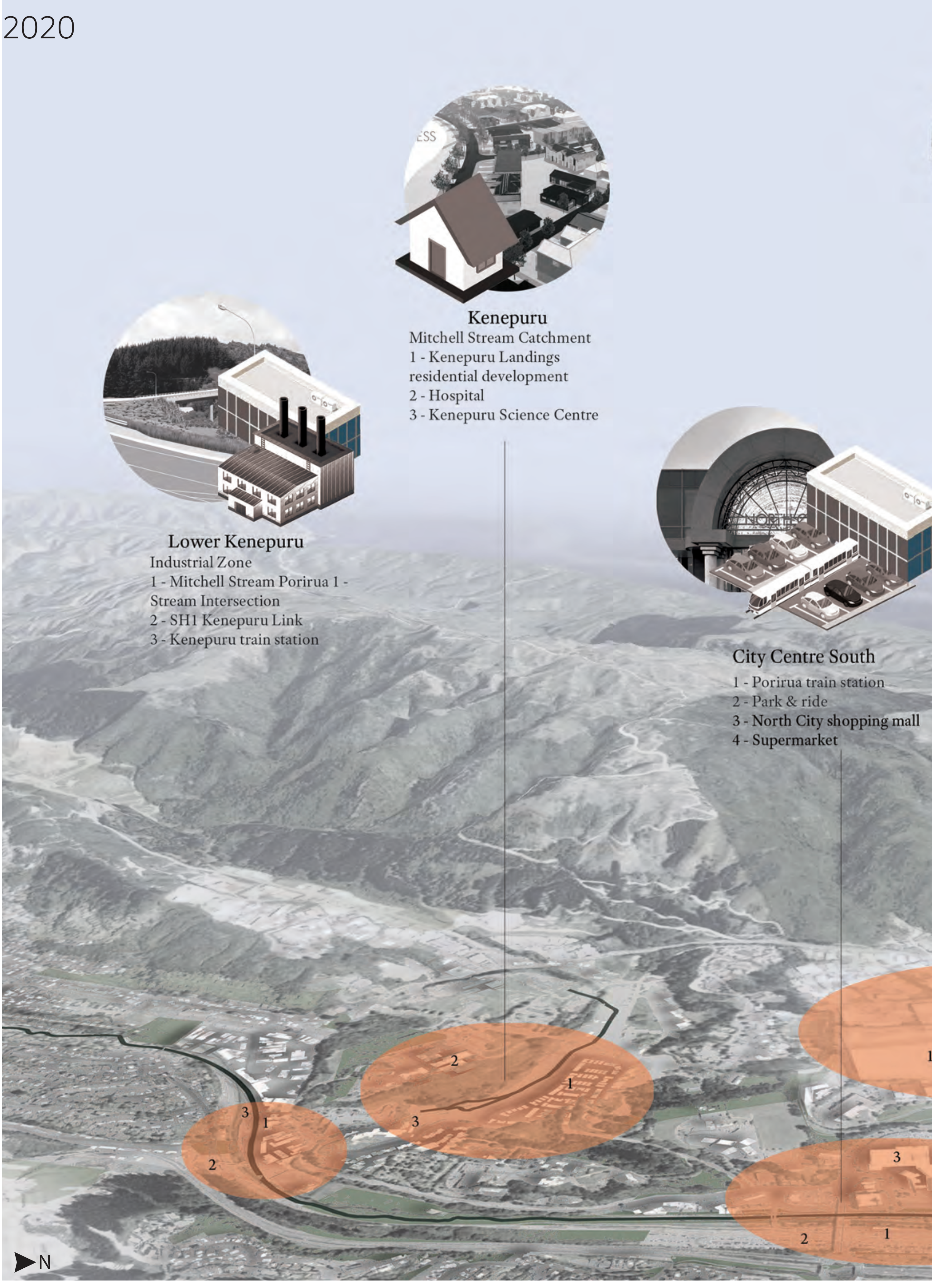
Site Analysis

3.1

INTRODUCTION.

This chapter analyses strengths, weaknesses, opportunities and threats of the existing urban conditions in Porirua as related to the biophilic urbanism framework (see section 2.3). This section begins by analysing the city's existing infrastructure, including the buildings and their typologies across zones, the existing green/blue space in the city, and a sun analysis. The significant natural features and values of the site are identified as well as the main threats leading to ecological degradation. The chapter goes on to critique the Porirua City Council's existing growth strategy and suggest alternative solutions. Transect walks are the method of research used to explore the site from a human user perspective. The visible biophilic features and areas for the potential increase of biophilic features are documented through photographs along the walk.

Fig3.1. Photographed Porirua Stream. →


2020
Kenepuru
Mitchell Stream Catchment
1 - Kenepuru Landings residential development
2 - Hospital
3 - Kenepuru Science Centre
Lower Kenepuru
Industrial Zone
1 - Mitchell Stream Porirua 1 - Stream Intersection
2 - SH1 Kenepuru Link
3 - Kenepuru train station
City Centre South
1 - Porirua train station
2 - Park & ride
3 - North City shopping mall
4 - Supermarket
N

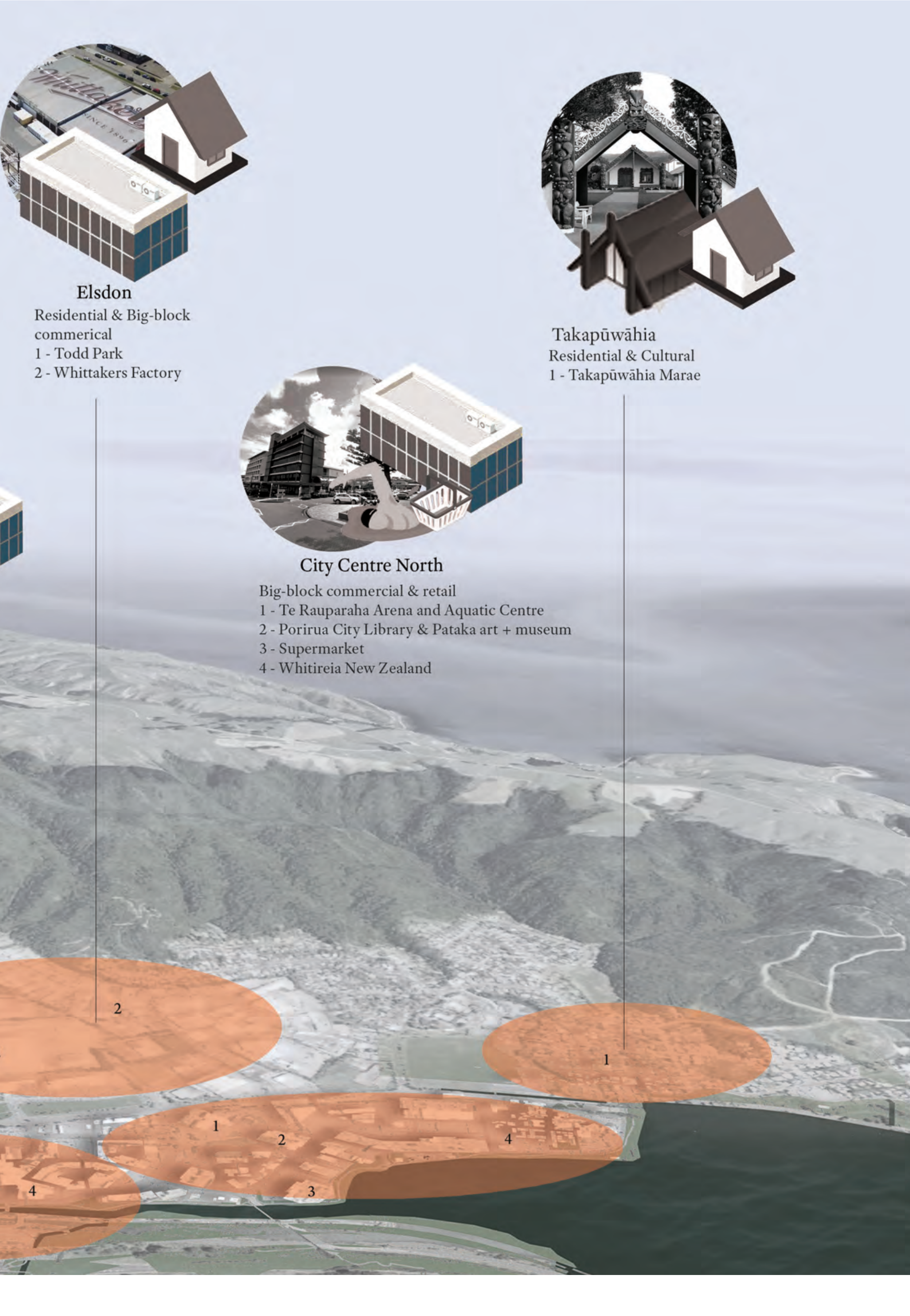


Fig3.2. Porirua zones and significant buildings and their typologies.

Fig3.3. Photographs of riverside parks.

Parks

The city centre contains one recreational sports park (Te Rauparaha Park) and several small grass sections around the river's edge, which are managed.

Green belts/connected ecosystems/wild and semi-wild native nature spaces

Highlighted in orange are the significant natural areas in and around Porirua. These areas contain native fauna and flora, explained in further detail in section 3.2.

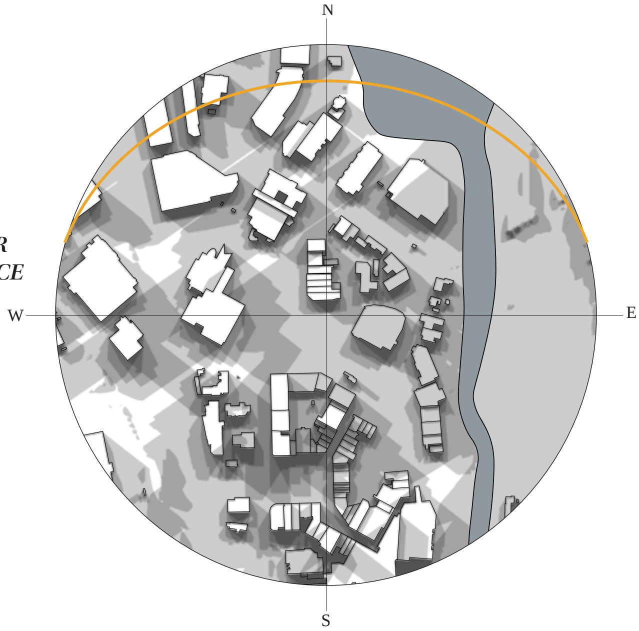
- Green space
- Significant natural area
- Notable tree (cupressus macrocarpa)

1. Takapuwahia Reserve
2. Elsdon Park
3. Porirua School field
4. Porirua Scenic Reserve
5. Te Rauparaha Park
6. Riverside park
7. Rangituhi Colonial Knob Parkland

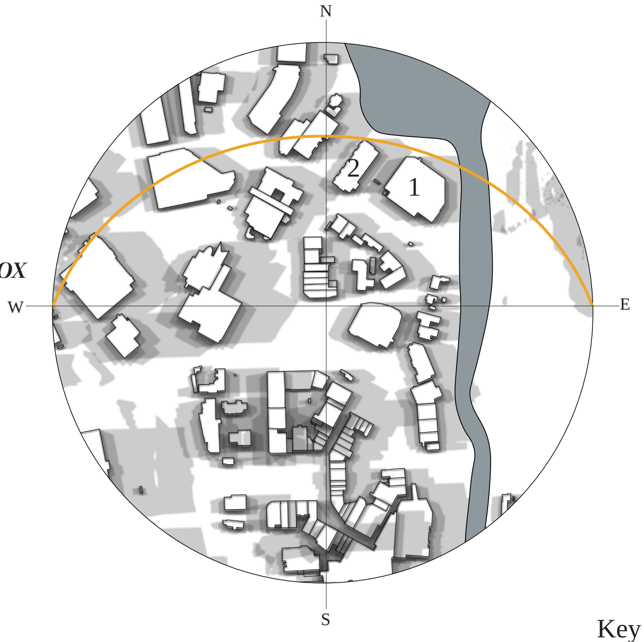
Fig3.4. Map of green space and significant natures areas.

A significant land area in the city is dedicated to car parking, creating a network of undesirable, unoccupied spaces. Buildings are scattered amongst the car parking, creating pockets of sunny spots throughout the city. The strip of land from the stream mouth along the harbour's edge is north facing, therefore, receiving considerable direct sunlight throughout the year. The large building at the corner of the river mouth and waterfront is a Pak'n'Save supermarket made of 8m high concrete block walls and no windows. The buildings along this edge have minimal connection to the waterfront, and the resulting harbour-city interface is mostly undesirable and underutilised.

WINTER SOLSTICE

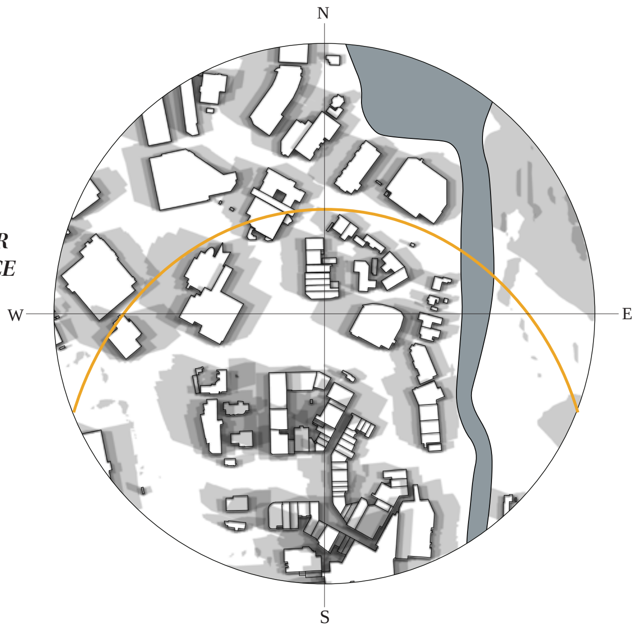


EQUINOX



Key
1. Pak'n'Save supermarket
2. Retail building with unoccupied spaces at waterfront edge

SUMMER SOLSTICE



← *Fig3.5. Map of car parks in the city.*
↑ *Fig3.6. Sun analysis.*

3.2

ECOLOGY OF PLACE.

The aim of defining the ecology of place is to understand which ecologically significant sites exist that must be protected, encourage regeneration, and enhance the community's function and sense of place where projects are built.

Bar Tailed Godwit *Banded Dotterel*

NZ Pied Oystercatcher *Royal Spoonbill*

Banded Kokopu

Fig3.7. Significant fauna and flora.

Porirua harbour hosts the seasonal core habitat for a significant number of migratory shorebird species. Porirua harbour represents 20% of the region's saltmarsh despite its near absence in the Onepoto Arm due to the reclamation of the harbour seabed in the mid-nineteenth century where the city centre lies (MacDiarmid et al., 2012). The seagrass's total area in the harbour is 79% of the regional total for this habitat, making it of exceptionally high value (MacDiarmid et al., 2012). It has a regionally significant number of species and total biomass of cockles (MacDiarmid et al., 2012).

The following lists are obtained from P.Blaschke's report on Ecological Restoration Priorities for the Porirua Stream and its Catchment (Blaschke et al., 2009).

Threats to biodiversity in the catchment:

- Streambank instability
- Insufficient vegetation to provide cover for fish and shade the stream
- Fine sediment inputs
- Pollution from nutrients, toxicants and litter
- Weeds
- Lack of connectivity
- Fish barriers
- Lack of protection for remnant native and riparian vegetation
- Lack of knowledge about natural resources other than vegetation

The human contribution to these threats :

- Permissive rules for stormwater discharge and setbacks from streamside development
- Flood protection measures do not align with ecological objectives
- Increasing levels of land development
- Changing land values (e.g. demand for greenfields development)
- Increasing areas of impervious surfaces
- Piping of first and second-order streams
- Structures in streams block fish access

(P. Blaschke et al., 2009).

Waterbody conditions

Concrete river banks of Porirua Stream

Stormwater outlet into Porirua Harbour

Sediment build up in the harbour

Riverside pedestrian path

Fish barriers and weed-infested banks of Mitchell Stream

The pedestrian path at Porirua River Mouth

Porirua Harbour is one of the most hard-edge estuaries in New Zealand, surrounded by road, rail and cycle/ walkway embankments (Blaschke et al., 2010). The result is a loss of coastal habitat, loss of potential habitat for estuarine species retreating from sea level rise, and pollution from vehicles entering the harbour. Human access to the foreshore is also significantly reduced, especially along the eastern edge.

Several of the identified issues are related to urban development practices. The increasing population of Porirua means the city is continuously growing in ways that continue to add to these threats. The following section discusses the Porirua City Council's existing growth strategy.

Fig3.8. Waterbody conditions.

3.3

PORIRUA GROWTH STRATEGY 2048.

Porirua City Council's growth strategy involves building thousands of new homes in greenfield development to accommodate the predicted increasing population. The most considerable demographic growth type will be in couples without dependents, and one-person households, which have influenced the designed new homes (Porirua City Council, 2019). Two thousand state homes are being developed in Porirua East by Kāinga Ora, providing affordable housing for the community, 53 of which opened in Cannons Creek in 2020. Located South of the city centre is the Kenepuru Landings development, the first significant medium density development in Porirua (Porirua City Council, 2019). Although these developments have many positive economic and social effects, they could increase ecological degradation and vulnerability to flooding locally and downstream. Although the densification of housing is a positive aspect of the Kenepuru Landings development, greenfield development requires the transition of previous green space to impervious surfaces, causing additional pressure on the Mitchell Stream ecosystem. Both housing projects generate increased stormwater volumes to enter the catchment streams, raising flood risk locally and downstream. Kenenpuru Landings is located within the Mitchell Stream catchment, a tributary of the Porirua Stream; therefore, this development could increase the CBD area's flood risk around the Porirua stream. Management of these issues includes water-sensitive strategies such as green infrastructure designs with green roofs, walls and stormwater collection. Rather than sprawling housing outside the CBD on green sites, strategies should consider densifying existing developed land to cause less negative ecological impact.

This research will create an alternative growth strategy focusing on developing the city centre through biophilic design principles. There is an opportunity to densify the existing CBD in areas dedicated to car parking, as well as bringing green space into the city. Creating medium density residential zoning within the CBD reduces the need for greenfield residential developments, which will lessen the outlined issues. Rather than lowering the catchment's absorptive capacity through new infrastructure, this research looks to increase it through nature-based solutions and biophilic design strategies. These strategies maintain the social and economic benefits of the existing growth strategy, with additional ecological services ensuring increased wellbeing and resilience of the community.

Fig3.9. Map of areas of urban development.

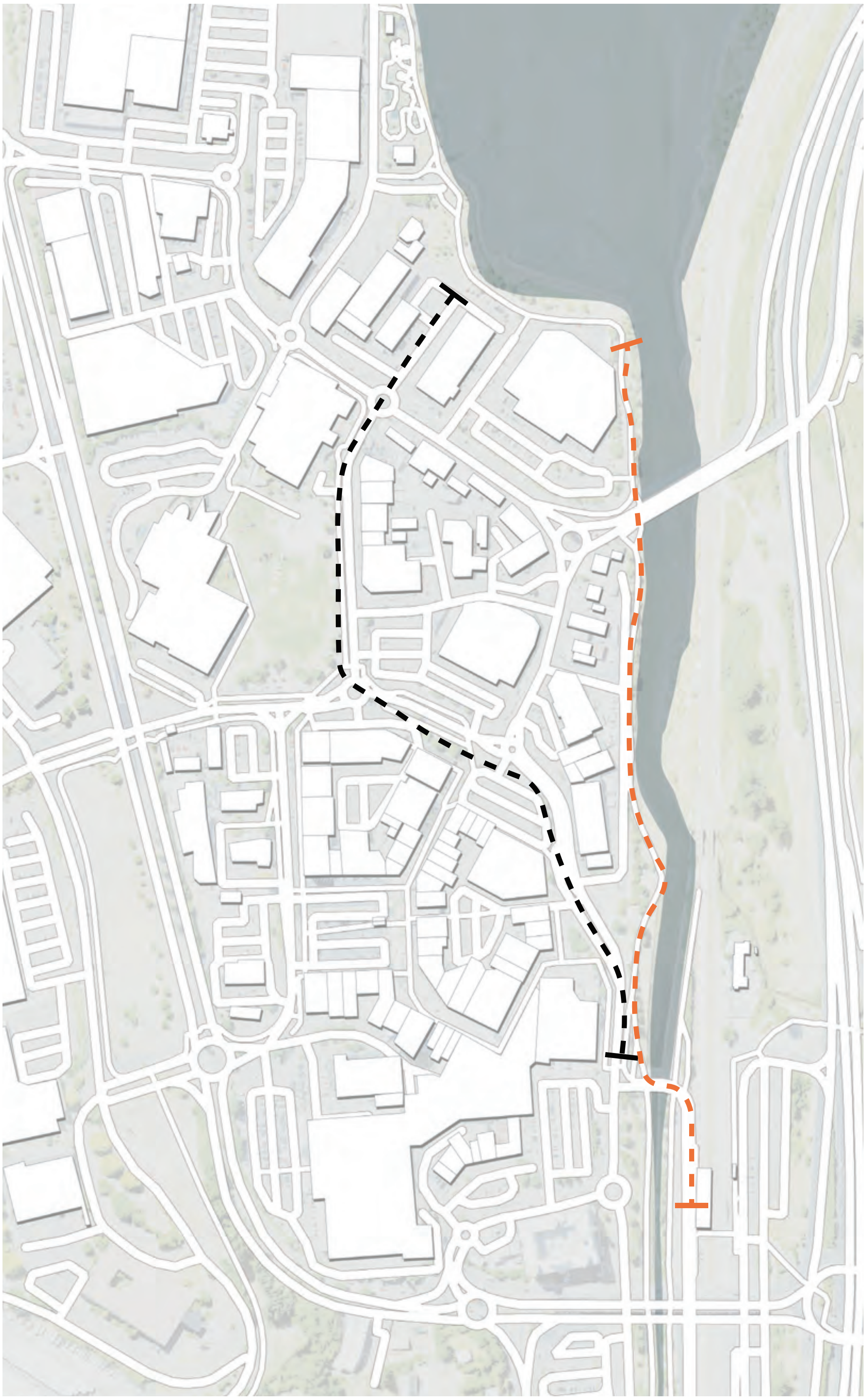
3.4

TRANSECT WALKS.

This section of site analysis shows the findings from two transect walks through the site. The map shows the transect routes and the location of the photographs taken along the way. The identified strengths relate to the existing features of the city that meet the biophilic framework. The elements which are negatively impacting ecological and community wellbeing are identified as threats.

Transect Walk 1 begins at the train station and follows the pedestrian path beside the Porirua Stream, ending at the stream's mouth as it enters the harbour. The walk gives insight into the experiential conditions of the cities interface with the stream.

Transect walk 2 begins at the train station and follows the main arterial road through the CBD, then from the CBD to the harbour, ending at the harbour's main pedestrian access point. It provides insight into the pedestrian movement and uses of space within the CBD. This route was the stream's rough location before its straightening during the urbanisation period in the mid-19th century.



Transect walk 1

Transect walk 2

Fig3.10. Map of transect walk routes.

8

7

9

3

6

1

2

4

5

Transect walk 1

Strengths

Nature in space:

- Parks(1, 2)
- Semi wild native nature spaces(5)
- Wildlife (4)
- Porirua Stream (1)

Nature activities:

- Pedestrian paths (2, 3, 8)
- Natural history markers (9)

Weaknesses

- Rubbish/pollution in the stream (7)
- Threatening paths under highway bridges
- Concrete paved parks (1, 2)
- Hard edges of the river (1)
- Lack of human activity

← *Fig3.11. Transect walk 1 - photograph matrix.*

→ *Fig3.12. Map of transect walk 1.*

6

7

1

8

5

4

2

3

Transect walk 2

Strengths

Nature in space:

- Parks (5)
- Tree canopy (5)

Nature activities:

- Pedestrian Pathways (2, 4, 5)
- Waterfront cafes with outdoor spaces
- Biomorphic sculptures (7)

Weaknesses

- Pedestrian crossing reliance across major roads (1, 2)
- Sprawled car parking (2, 3)
- Imperceptible waterfront connections
- Vacant waterfront buildings (8)

← Fig3.13. Transect walk 2 - photograph matrix.
→ Fig3.14. Map of transect walk 2.

Pedestrian Pathways

1 
Waterfront aggregate paths

2 
Brick pedestrian paths

3 
CBD pedestrianised street

← Fig3.15. Map of existing pedestrian walkways and streets.
→ Fig3.16. Photographed qualities of pedestrian paths.

Key learnings from Transect Walks

- The waterfront and river are dissociated from the city centre.
- The city is difficult to navigate as a pedestrian.
- The waterfront and riverside paths feel unsafe and have minimal human use because they're wedged between the backside of large warehouse-style buildings. This limits the community's opportunity to make meaningful connections to nature existing in the city at present.
- Attempts to activate the harbourside involve temporary cafes with outdoor space; however, access to the harbour entrance is through a car park.
- Green spaces in the city lack wild nature and are mostly manicured grass banks.

Opportunities

- Establish stronger pedestrian connections to the harbour.
- Mass sprawled car parking around the city provides areas for potential new green landscape and building developments.
- Activate the harbour and stream edge by reorientating building frontages to face the waterfront.
- Prioritise pedestrian movement with pedestrianised roads, better traffic management, and pedestrian bridges.

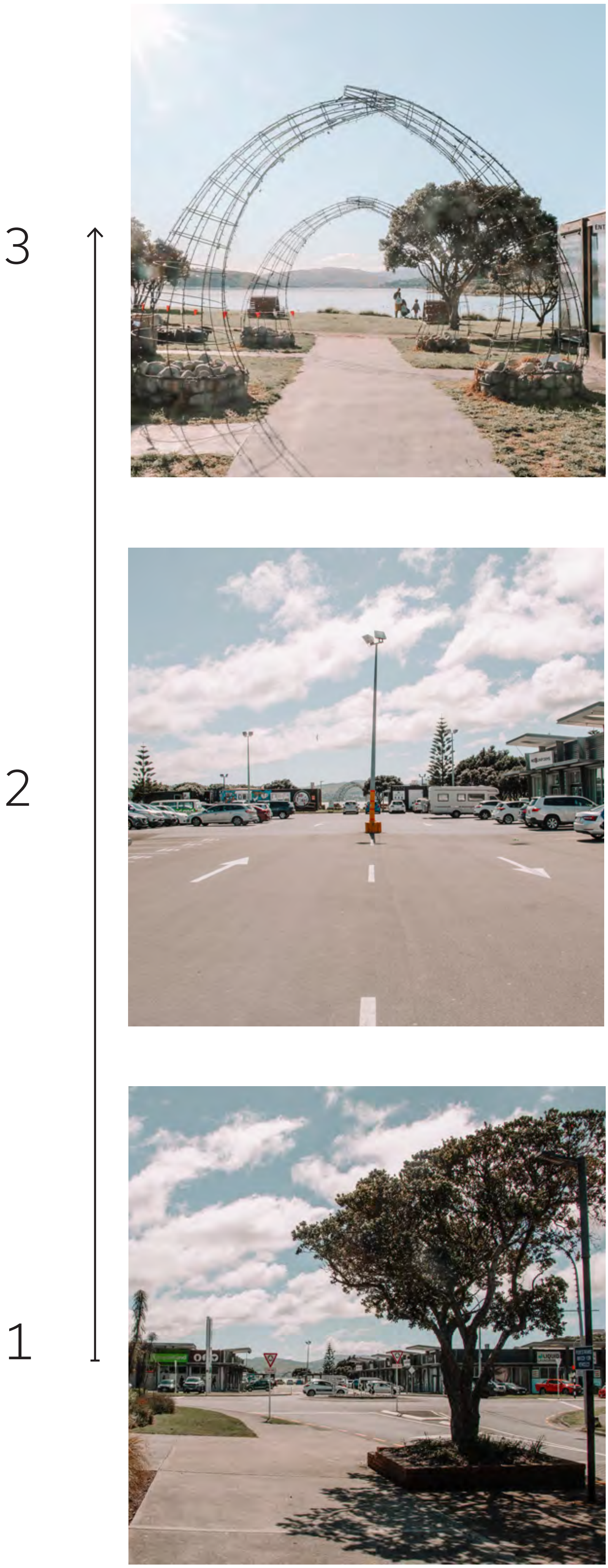


Fig3.17. Primary waterfront connection route from the CBD.

Fig4.1. Path of old stream route overlayed onto the existing city.

4

CHAPTER

City in a Wetland

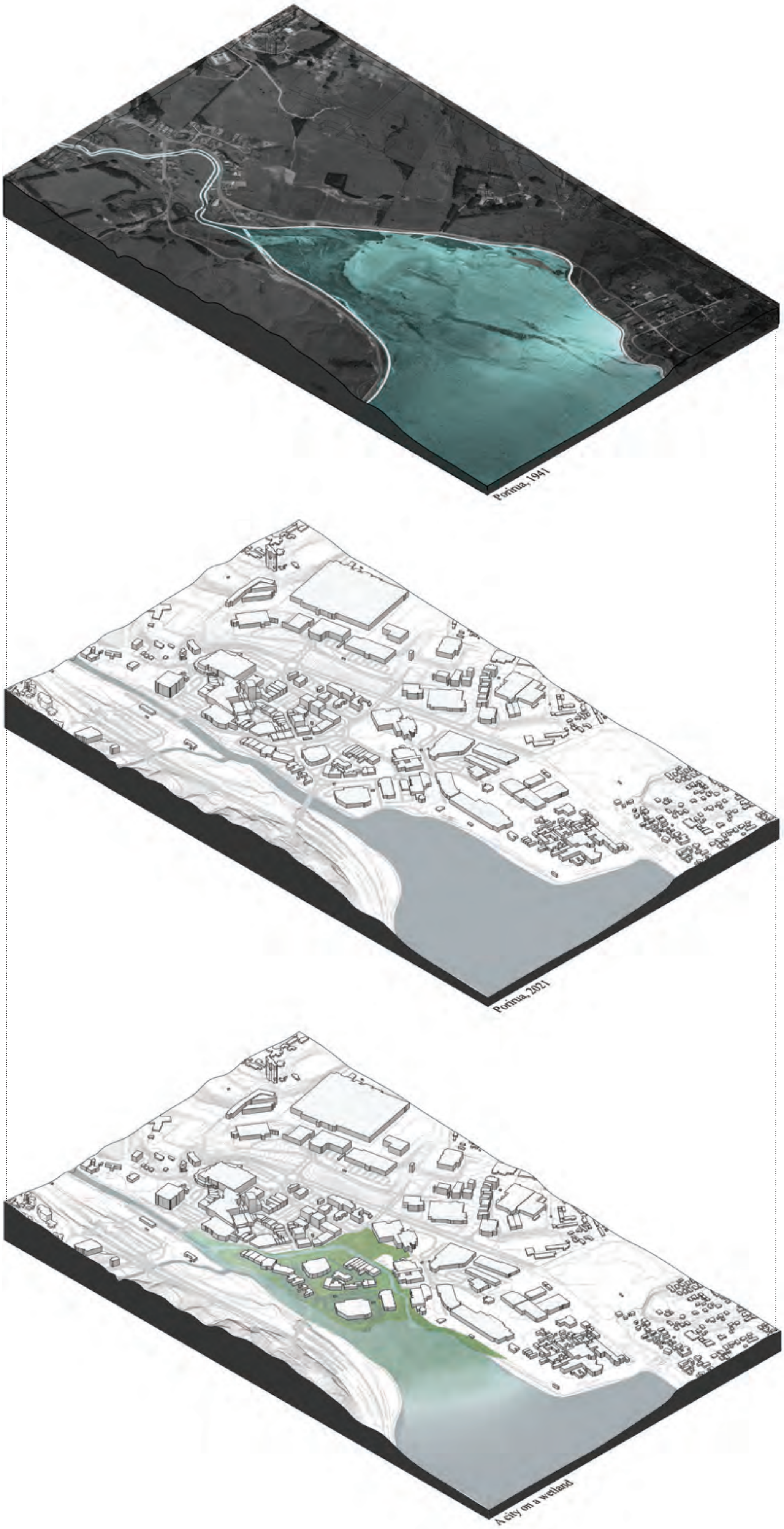


Fig4.2. Graphic representation of the schemes key idea.

4.1

INTRODUCTION.

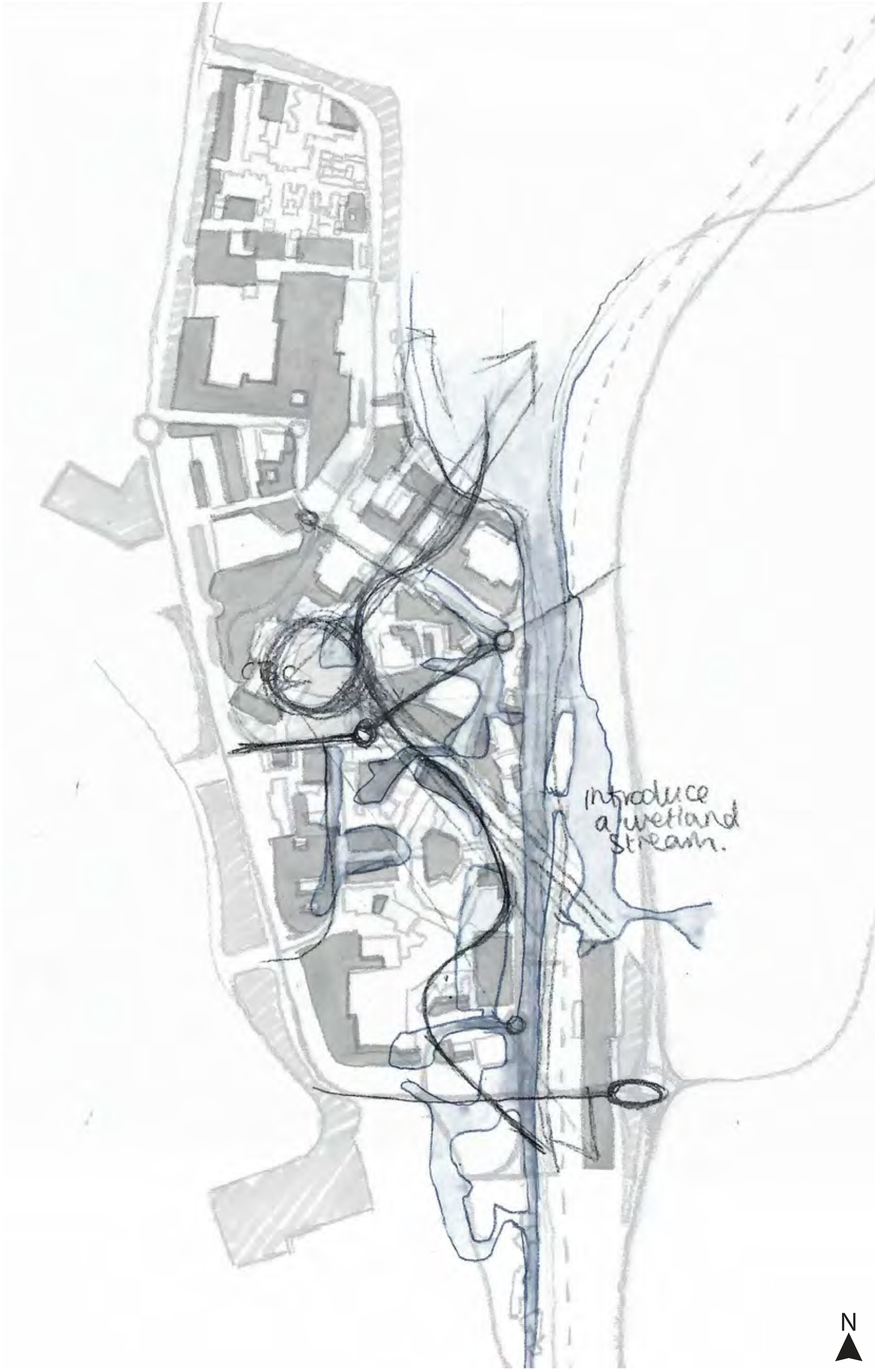
Where the city centre lies, just 60 years ago, was a dynamic, biodiversity-rich intertidal wetland where the meandering Porirua Stream flowed. The historical image of Porirua inspires the rewilding of Porirua to become a 'city in a wetland'. This section investigates retrofitting some built areas of the city to remediate the land back to its pre-development state, namely, a floodable, dynamic wetland. The Porirua stream's original location was overlayed onto the existing city and used as the basis for the placement of an urban biophilic blue-green belt. The stream is returned to its rightful path, restoring its mana and mauri.

Contemporary spatial design tends to create isolated buildings, spaces and landscapes without understanding or integrating with the broader living contexts, which are ever-changing in time and space (Connolly et al., 2020, p. 2). This research challenges this tendency by beginning with an urban holistic vision of Porirua and considering the broader significance of the collective civic components. Urban master planning is the tool used to ensure an effectively functioning city through considering transport, zoning, and open space.

This section takes an iterative approach by exploring several concepts which are both conservative and extreme to reach a final urban vision.

Titiro whakamuri, kōkiri whakamua.
This whakatauki encourages us to look back and reflect before we move ahead.

Revealing the stream, restoring mana. Lines of roads and the Porirua Stream were extracted from the aerial image in 1941 and overlayed onto the 2020 aerial of Porirua City to locate the old stream route in relation to the city today.



← *Fig4.3. Roads, stream and train track of Porirua in 1941 overlayed on Porirua 2021 map.*
→ *Fig 4.4. Layers of information including flood zones, car parking, old stream route, roads.*

Fig4.5. The initial concept for city blue-green belt.

4.2

CONCEPTUAL MASTERPLANNING.

An extreme approach - Relocating buildings

The initial conceptual vision implements a blue-green belt through the city in the exact historic location of Porirua Stream. It becomes the starting point of the next series of iterations of its route through the city. Rather than removing buildings, these two iterations explore the relocation of structures to densify certain areas and make space for wetland implementation.

Fig4.6. Map of building relocation concepts.

Refined Concept 1

The first refined conceptual urban plan seeks to return the stream as close to the original location as possible with the least disruption to the city's existing roads and structures. The stream passes under the existing roads at 3 points, which would require traffic overpasses. Removed buildings include a gas station, a small warehouse building at the harbourfront, and the Work and Income building. Norrie Street becomes a pedestrianised riverside strip. Otherwise, the stream meanders mostly through what was previously land dedicated to car parking.

Reflection:

Although implementing Norrie Street's pedestrianisation, there maintains a sense of a car prioritised city, especially with the pedestrian riverside walk passing under the car overpasses. As evident from an existing case of this in Porirua (Fig3.11 - photograph 8), the human experience created is not desirable . The required overpasses would be highly disruptive; therefore, the subsequent iterations will consider a complete redesign of the roads in this area.

Fig4.7. Existing city map.

Big Moves & Applied Nature-Based Solutions

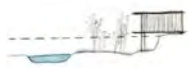
Wetland Civic Square at Harbour edge.
Bioretention Square.
Space to host public events, e.g. Waitangi Day and local markets.

Amphitheatre.

Timber pedestrian bridge over the main road.

Norrie Street buildings frontage to river with additional carparking out the back.

The existing skatepark remains.



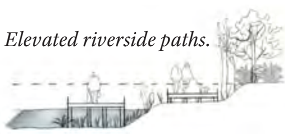
Space for green car park development.

Floodable retention sports ground.

Wetland Park.

CBD connection.
The primary connection to the existing CBD

Elevated riverside paths.

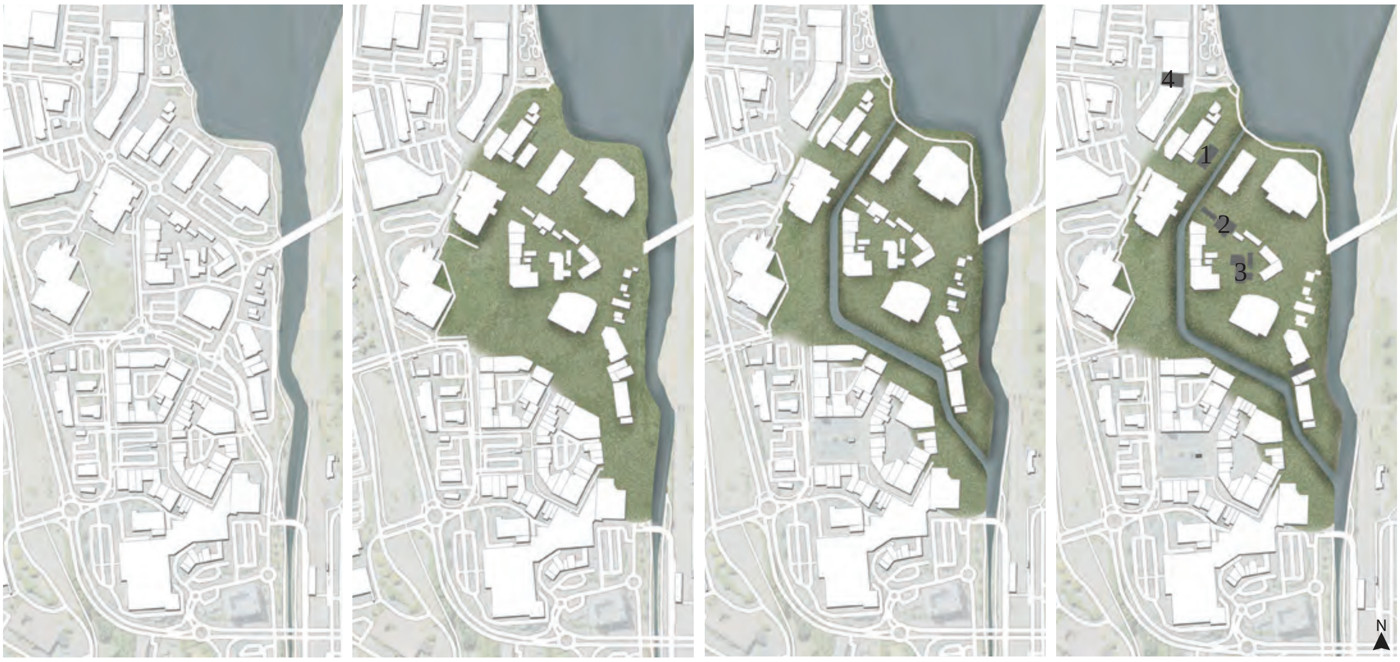


Bioswales beside roads.

River bifurcation.
Located after the straightest section of the channelled Porirua stream.

Fig4.8. Urban concept 1 and applied NBS.

To address these issues, the next series of design iterations explore traffic management, pedestrian routes and the potential location of additional buildings required to activate the blue-green belt. High-density green car park buildings replace all car parking lost through the wetland restoration.



Existing city | *Car parks and roads removed* | *Possible stream route* | *Buildings Removed*

1-Small waterfront warehouse.
2-BP petrol station.
3-Tyre centre warehouse
4- Cash converters pawn shop

Fig4.9. City transformation breakdown.

These buildings were removed to make room for the wetland stream. The BP petrol station causes vehicle congestion in the city, and its removal allows space for a wetland park for stream overflow. The small waterfront warehouse's removal creates a larger opening at the waterfront for entrance to the waterfront from the city. The removal of building 4 opens up another direct physical and visual connection to the harbour from a main arterial route running east-west.

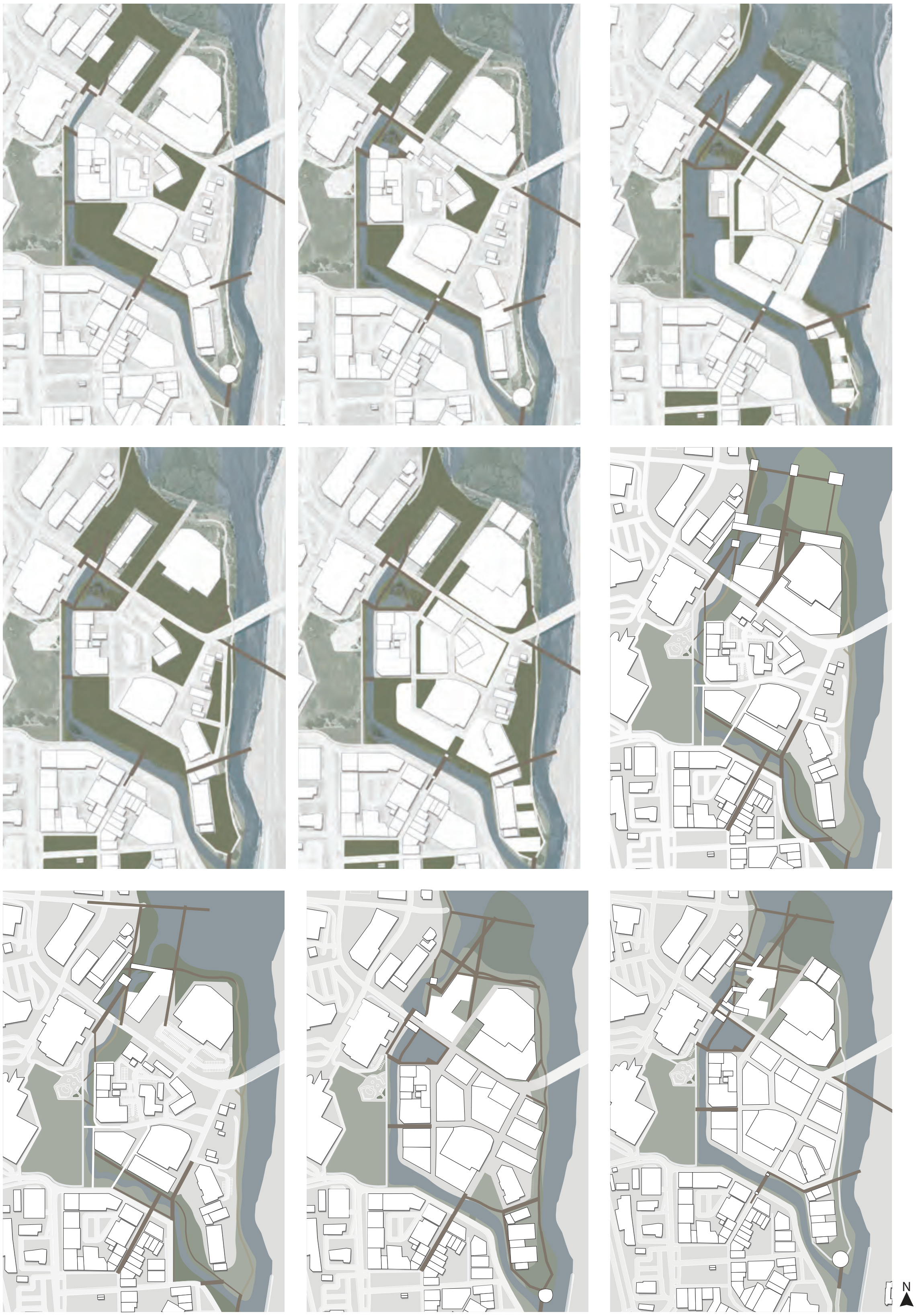


Fig4.10. Design iterations exploring a balance of blue, green, existing and new infrastructure.

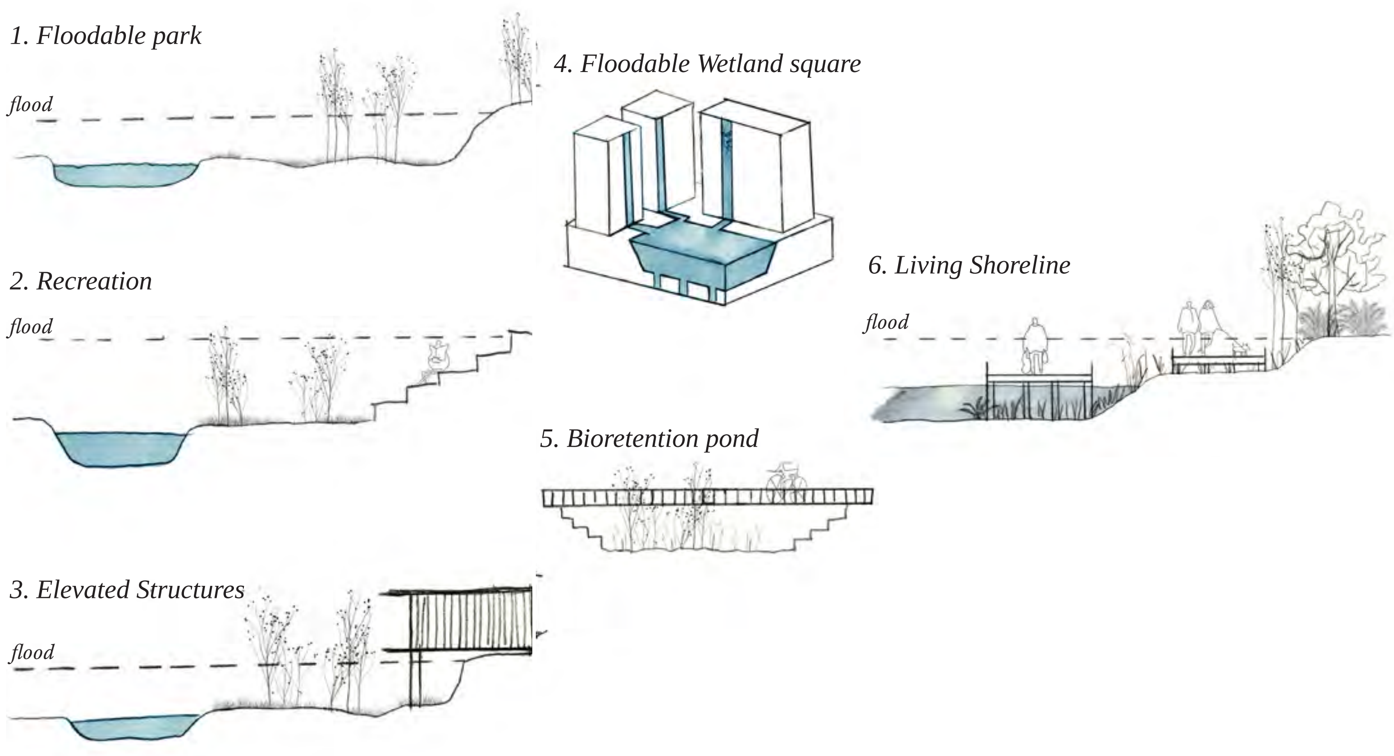
4.3

FINAL URBAN HOLISTIC VISION.

Existing city for comparison

Fig4.11. Final conceptual masterplan.

Applied Nature-Based Solutions

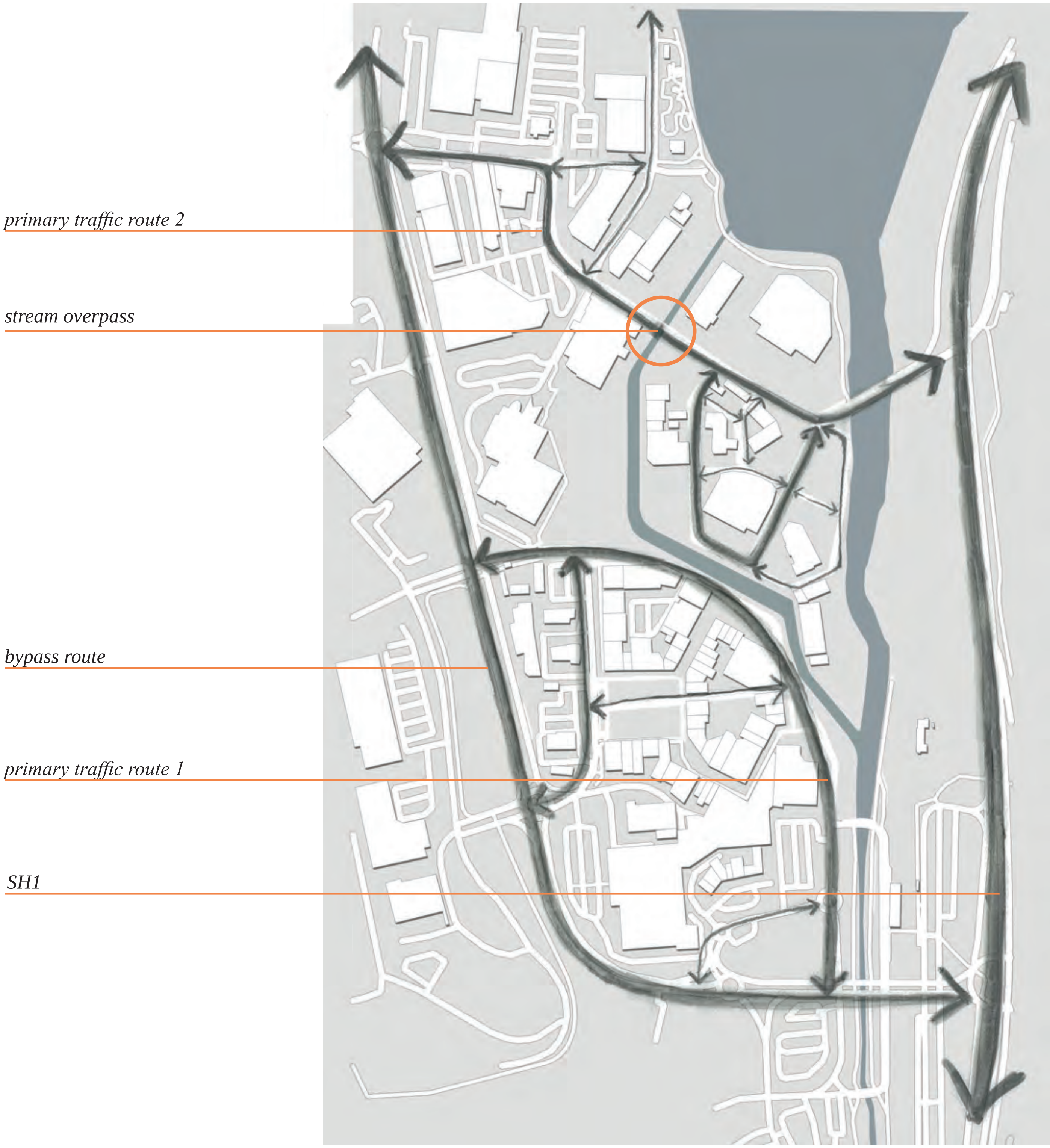


Big Moves

- Reconfiguring roads – removing three major roundabout intersection.
- One vehicle overpass
- Pedestrainising Norrie Street.
- New high-rise car park buildings to free land currently used for parking (see fig4.14).
- New traffic flow routes (see fig4.12).
- Medium density CBD residential zoning (see fig4.14).
- Removing outdated buildings which obstruct the stream route (see fig4.8).
- Narrowing roads adjacent to the stream by removing on-street parking to make room for a more considerable stream riparian zone.

Fig4.12. Applied NBS.

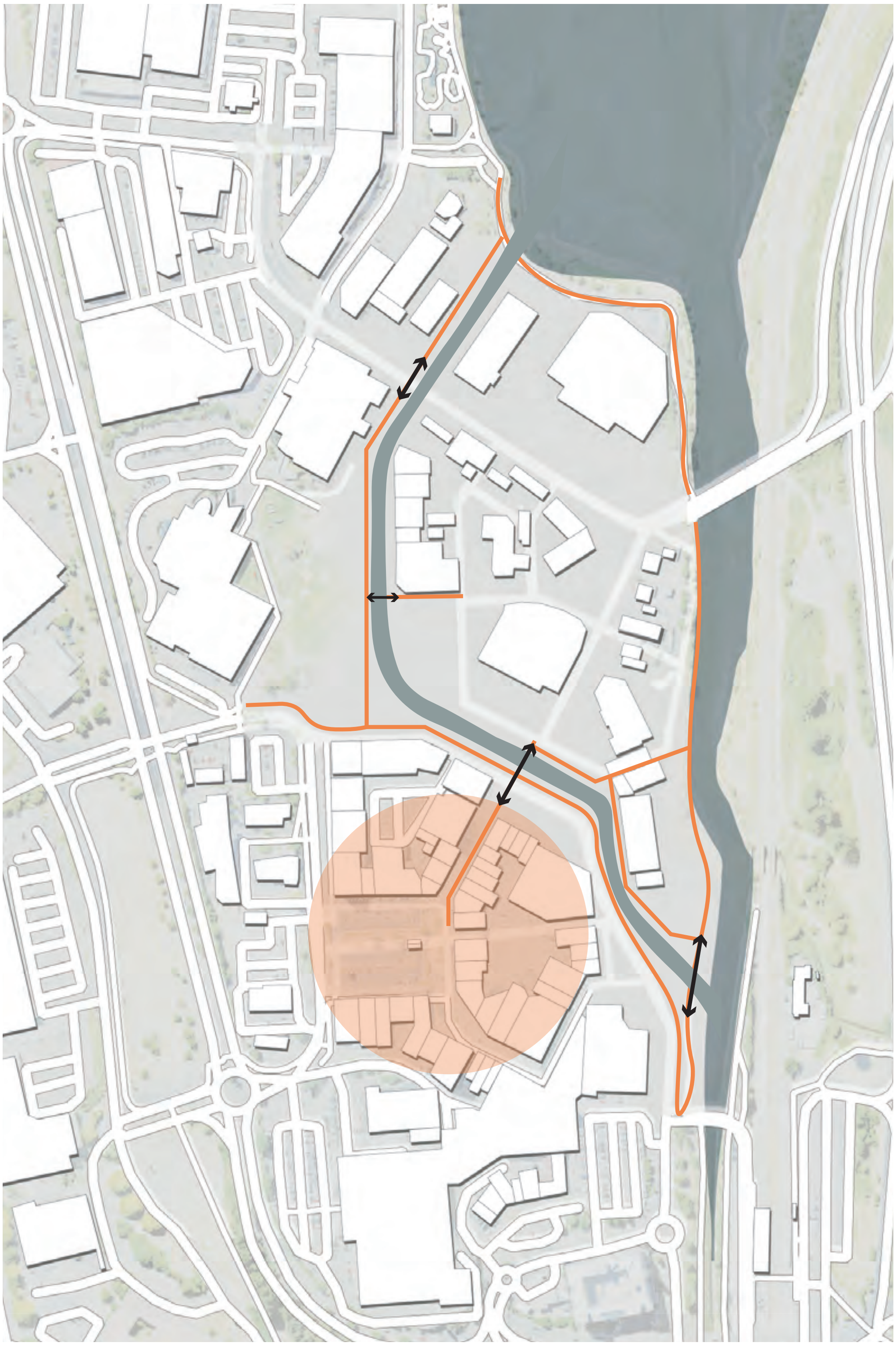
Traffic Management



Established traffic routes.

Part of the exploration of the city's continued function involved exploring new traffic routes. In reality, a project of this scale would require traffic management specialists; however, the decisions made are based on urban design principles and local accessible knowledge. The Transmission Gully highway currently under construction will likely cause changes to traffic flows in Porirua, allowing vehicles travelling further north to bypass the SH1 near Porirua. Therefore, this research assumes this new road link will ease traffic congestion in the city. The final urban plan requires one traffic overpass over the river.

Pedestrian Focused City



Connecting the existing CBD to the harbour and river with a continuous pedestrian flow route.

Existing City Centre
Pedestrian Bridges
Pedestrian and cycle pathways

← *Fig4.13. Map of new traffic routes.*
→ *Fig4.14. Map of pedestrian network and river crossings.*

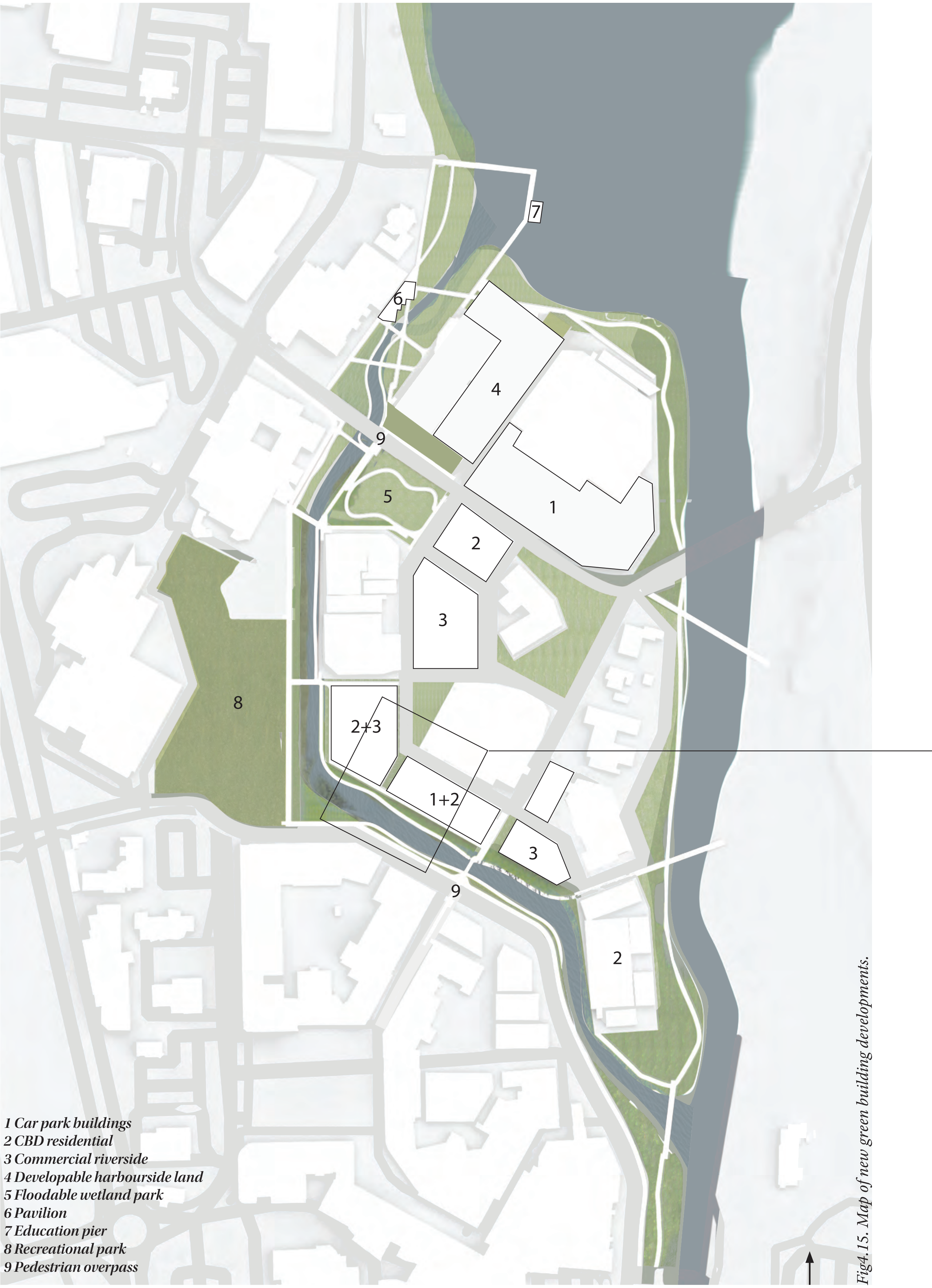


Fig4.15. Map of new green building developments.

Activating the edge

For the city to become a 24/7 city centre, there must be residential zoning within the CBD. The existing plans for Kāinga Ora – Homes and Communities urban development remain outside the CBD; however, this research proposes residential zoning in the city centre. The existing Countdown supermarket car park becomes a mixed-use riverside apartment block combined with car parking and ground floor commercial space.

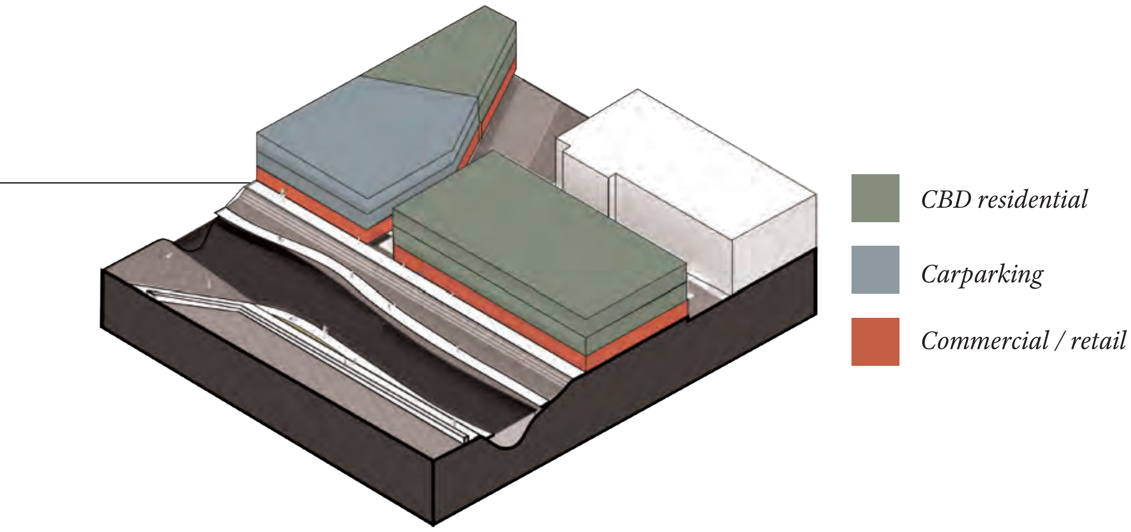


Fig4.16. Isometric drawing of mixed programme riverside developments.

Transforming Norrie Street

Norrie Street is the main pedestrian route linking the CBD and the harbour. The two-lane street with on-street parking is transformed into a sunny north-south riverside strip. The existing shops east of the road become a riverside precinct, activated by new neighbouring mixed residential, commercial buildings and car parking which increase human activity. Riverside paths of differing heights allow continuous human engagement with the river despite fluctuations in water levels (fig4.17).

Fig4.17. Map of Norrie Street transformation.

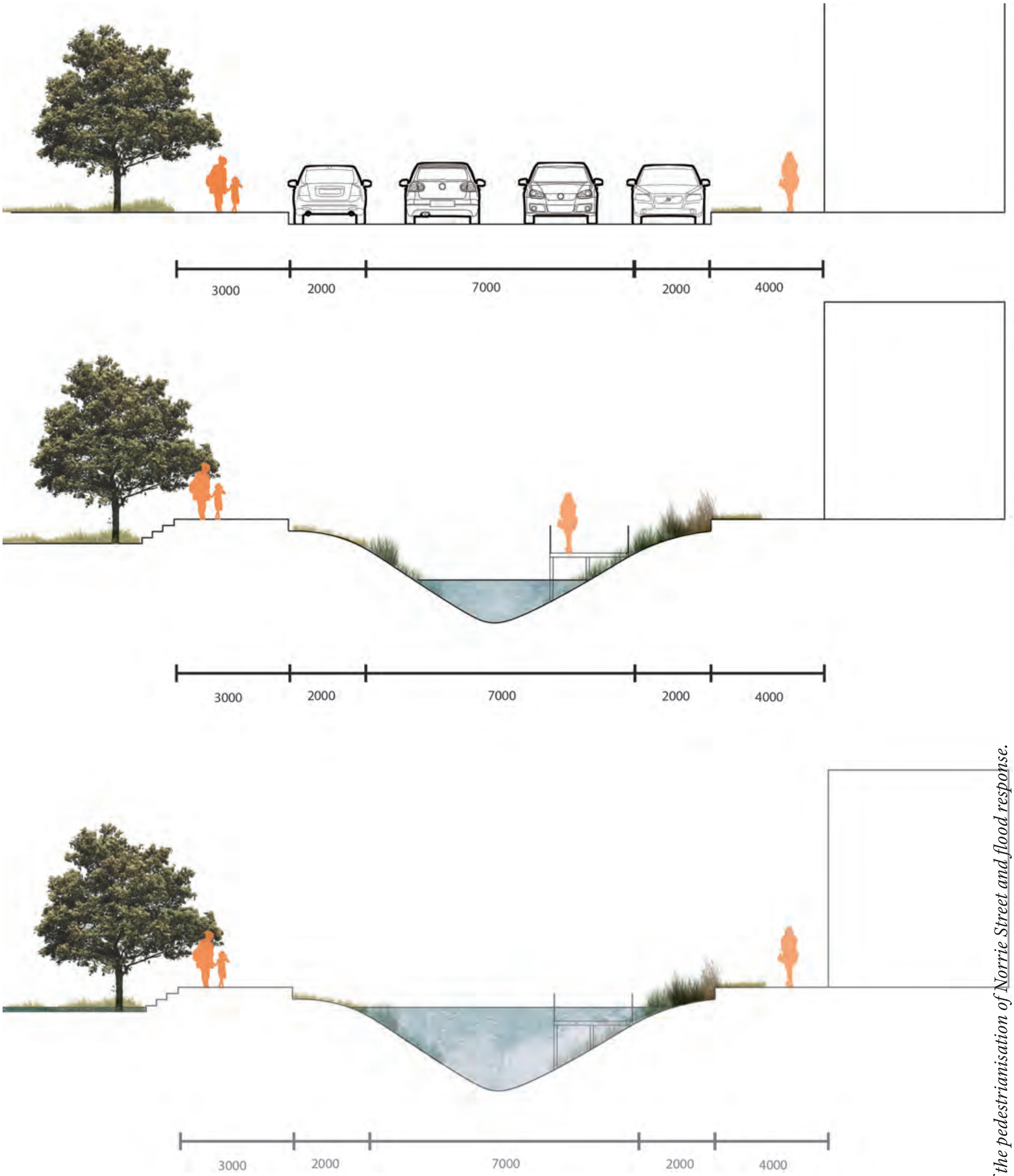
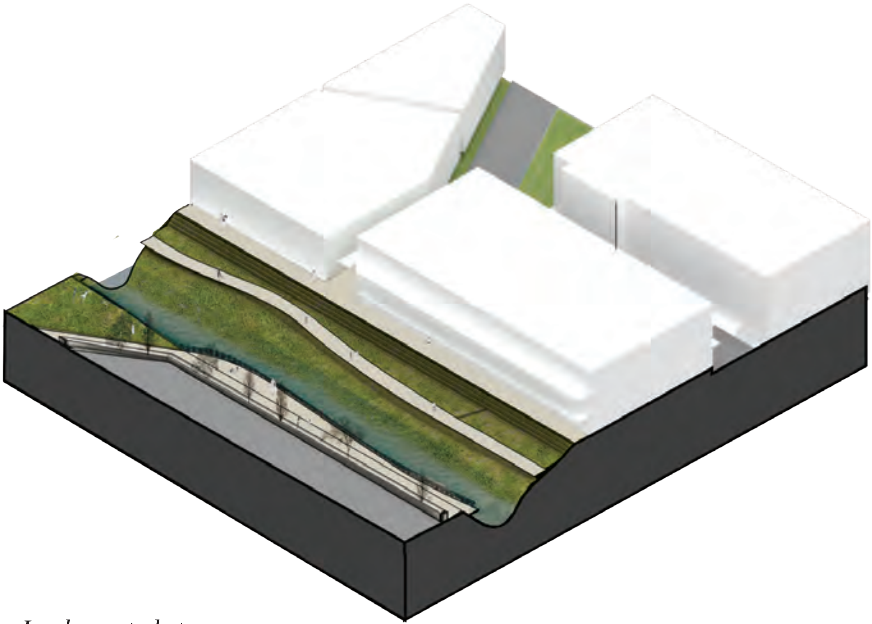
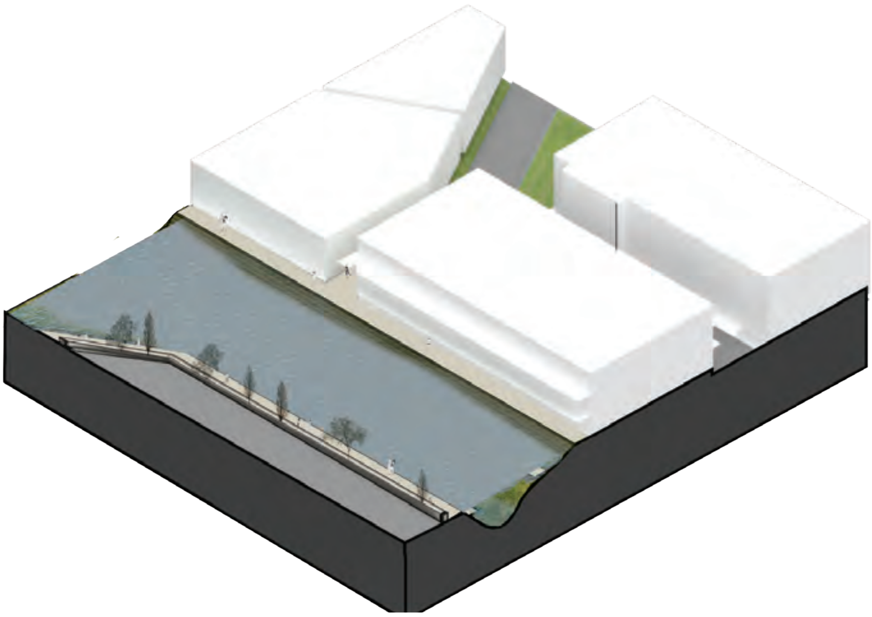


Fig4.18. Section of the pedestrianisation of Norrie Street and flood response.

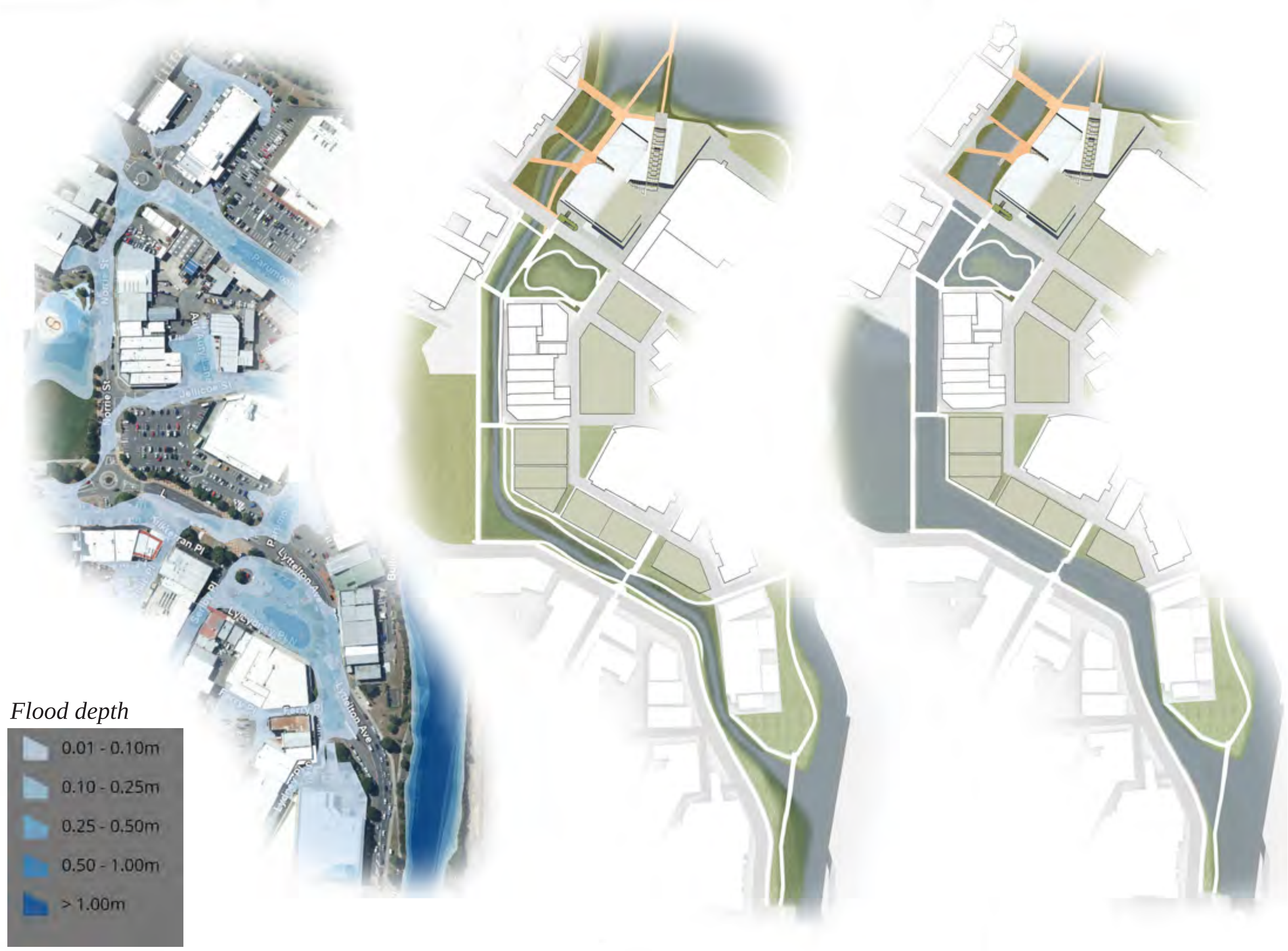


Implemented stream



Extreme flood scenario

Fig4.19. Isometric drawing of the implemented stream and extreme flood response.



Exisitng city's predicted flood zone　*City's new biophilic masterplan*　*1 in 100-year flood scenario*

Flood Response

The predicted flood depth for a 1 in 100-year flood event for the area of the city in this research is between 0.01-1m (Story Map Series, 2019). Rather than the floods affecting built-up areas of the city, the stormwater converges to the wetland stream and its floodable components. Some pedestrian paths submerge; however, streets of higher elevation allow continued civic activity. The stormwater is stored in these civic spaces until it is either removed through groundwater discharge or evapotranspiration.

Fig4.20. Map of existing predicted flood areas and depths.
Fig4.21. Map of new schemes normal water levels.
Fig4.22. Map of new schemes response to 1 in 100-year flood event.

4.4

CRITICAL REFLECTION.

After presenting the initial urban design concept in review 1, the reviewers suggested exploring the architectural response to sea-level rise and flood events. In response to this, the next chapter shifts in scale and explores architectural solutions to inhabit a fluctuating waterfront condition. The next phase requires a shift to designing in section. The reviewers also suggested focusing more on the human experiences of space to increase human-nature connections, leading to improved human wellbeing. In response to this, the following design chapter selects specific areas within the urban plan to refine, exploring how pedestrians occupy the stream through designed access routes. The urban vision was essential to define first, to establish a holistic working concept for the city. The conceptual masterplan sets a foundation to ensure the following detailed design of the scheme's components work together.

Fig4.23. Photograph of existing wetland in Aotearoa.

5

CHAPTER

Structures of the wetland/city interface

Fig5.1. Urban masterplan for Porirua.

5.1

INTRODUCTION.

Having established an urban holistic vision for Porirua as a biophilic city through master planning in Chapter 4, this next section looks closer at the interconnected elements which make up the whole urban system and details the transformation of the city fabric. This section requires a shift in scale, implementing biophilic design techniques at the architectural scale. The initial exploration involves designing the new pedestrian pathways and bridges needed at the existing city's interface with the dynamic wetland to ensure resilience and continued civic function throughout wet and dry conditions. In doing so, the design concepts attempt to challenge the dualistic separation of nature and culture that typically manifests in built environments through controlling, conquering or exploiting nature (Breddia, 2006).

Fig5.2. Pedestrian overpass concept.

Structures of the wetland/city interface

5.2

FOCUSED RESEARCH.

New built forms provide the opportunity for initiating change, exploring options of integration with the living context through emulating the physical, systemic and temporal attributes, functions, structure and processes of the wetland ecosystem to become a synergised whole. A specific characteristic of the wetland explored in this design phase is adaptability to change over time through the continually changing environmental conditions. Designing for change requires challenging the permanency of architecture and considering construction techniques that allow dynamics, movement, deconstruction, and alteration. The formal concept of permanence in architectural discourse originates from Virtruvious' 10 books of architecture, through the term 'firmitas', meaning, "The ability of a building to endure based on its own material strength and soundness of construction; often defying both nature's and time's deteriorating effects " (Touw, 2016, p. 28).

Rather than defying nature and its effects, this chapter explores how embracing and adopting the wetland ecosystem's qualities could provide resilience in fluctuating climatic conditions, maintaining human and ecological amenity simultaneously. A strategy explored was biomimicry; a design technique that emulates organisms and ecosystems by applying ecological and biological knowledge to solve human design challenges (The Biomimicry Institute, 2021). The term biomimicry originated in the 1960s and was popularised by Janine Benyus' book 'Biomimicry: Innovation Inspired by Nature', published in 1997. The three levels of biomimicry are the organism level, the behavioural level, and the ecosystem level (Pedersen Zari, 2018). The most effective type of biomimicry, responding to climate change impacts and biodiversity issues, is ecosystem-based biomimicry at the process and function levels (Pedersen Zari, 2018, p. 63). This requires buildings to work and function in similar ways to how ecosystems would, such as the capturing of energy from the sun, storage of water, and participating in complex systems and materials cycles. This chapter of design enquiry mimics the specific characteristics of the surrounding wetlands, those being adaptable and subject to change. These qualities were explored through a modular timber framework exploration creating a base structure that could be regularly modified, added to or subtracted from when and if necessary.

Another explored concept is stilt structures. Stilt houses are a predominant vernacular architecture in regions such as certain parts of Southeast Asia , which allow communities to live on water through elevated structures. Inle Lake in Myanmar is an example of this, where the community live on the constantly fluctuating water (Bodry, 2016). Elevated structures are a way to ensure that building levels are higher than the flood level to reduce the extent of damage when flooding occurs. This research looks to adopt stilted structures of differing elevations, for pathways, bridges and buildings, as a design technique to work with the fluctuating wetland conditions in Porirua. Lower paths allow human interaction with the wetland during dryer conditions, which during extreme wet conditions can submerge underwater.

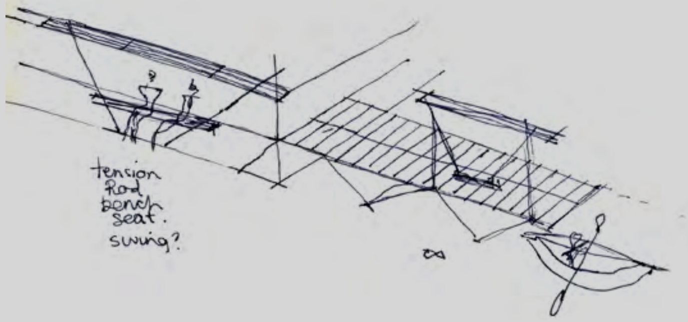
Inle lake in Myanmar

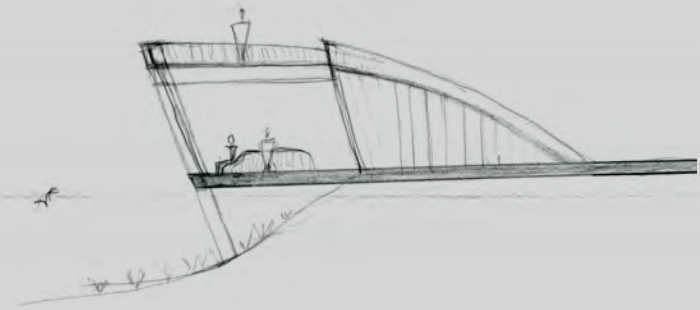
Fig5.3. Stilt architecture of Inle Lake Myanmar.

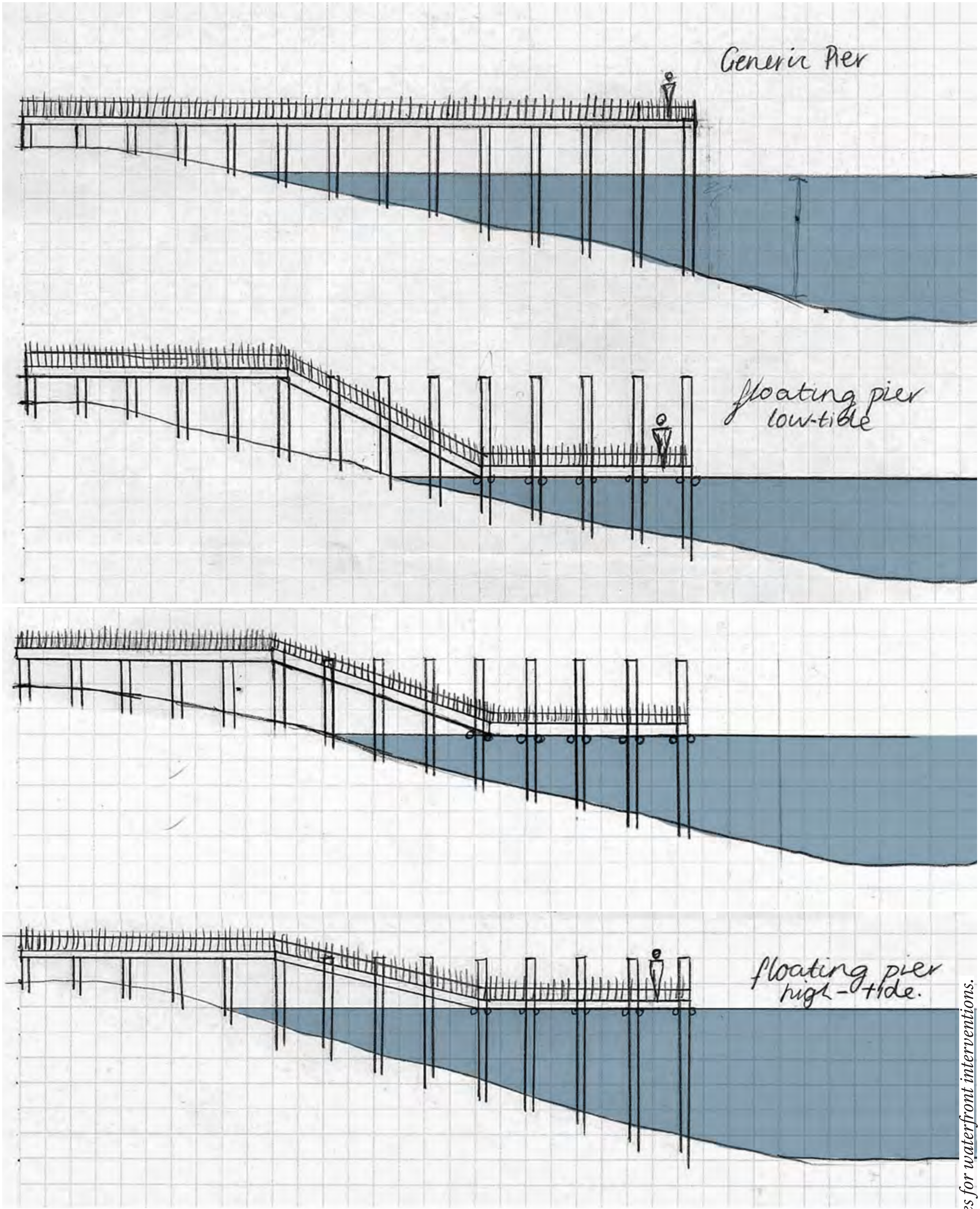
The design research of this chapter begins with potential stilted piers with platforms that move with tidal fluctuations through floating devices. The benefit of floating pathways is they are less disruptive of the ground plane; however, they would need substantial anchoring to contend with the flowing river and constant tidal flux. The depth of the water in the stream may not be enough to justify floating structures; however, any civic space extending into the harbour could adopt this technique. An ecological benefit of structures on the water is a provision of shading to habitat in the water, which is currently degrading in quality due to excessive direct sunlight (Blaschke et al., 2010).

Generic piers allow people to view water from above; however, a kinetic pier can enable closer human engagement with the water at various water levels.

Initial conceptual sketches show potential waterfront interventions that connect humans to the low lying ecosystem through elevated structures weaving throughout the existing urban fabric.







← *Fig5.4. Concept sketches for waterfront interventions.*
→ *Fig5.5. Sections of kinetic piers adapting to fluctuating water levels.*

The New Zealand Building Act says that councils cannot issue consent to build on land subject to natural disasters; therefore, it is likely that building new infrastructure in Porirua will require thoughtful flood consideration mitigation measures. Council regulations across New Zealand increasingly require that new builds in flood zones have a minimum floor level to create resilience against short term storm surge and long term sea-level rise. Porirua City Council is yet to set regulations for the city's flood zone, likely following precedent to Christchurch City Council, who have formed a minimum floor level requirement varying from 300-500mm above the flood level for new buildings in flood zones. This strategy creates circulation and accessibility challenges due to the differing elevation of building level and ground level. The design enquiry detailed in this chapter looks at the design challenges and opportunities that might evolve from elevated structures within Porirua City. All the new buildings added to the city plan implement a +1000mm ground floor height. This creates differing elevations between new buildings, the remaining buildings, and the wetland, posing a design issue that needs resolution by carefully designing the building-landscape threshold and vertical circulation of space between buildings.

The following design exploration analyses the possible formal and spatial composition of pedestrian pathways and bridges interacting with the wetland conditions. Explored are the options which allowing humans to engage with the wetland whilst conserving, maintaining or even enhancing the ecological functions of the ecosystem.

An initial enquiry into timber structures and construction was made because of the following benefits:

- Timber is a natural product that can be carbon neutral during its lifetime of use if sourced from a sustainable yield forest, where replanting occurs after harvesting (Bayne, 2003).
- It has low energy consumption during production compared to other building materials such as steel and concrete.
- It is fast to construct and flexible for future alterations.
- With the proper joining techniques, timber elements can be deconstructed and reconstructed.
- The use of timber in the built environment increases human-nature connections through its raw natural beauty, presenting fundamental material qualities of trees and forests.

The design research explores various arrangements of timber structural elements to create a modular structural framework.

Elevating new structures on timber piles could provide ecological function in estuary locations through supporting a diverse community of filter-feeding organisms (Layman et al., 2014).

Fig5.6. Timber piles supporting

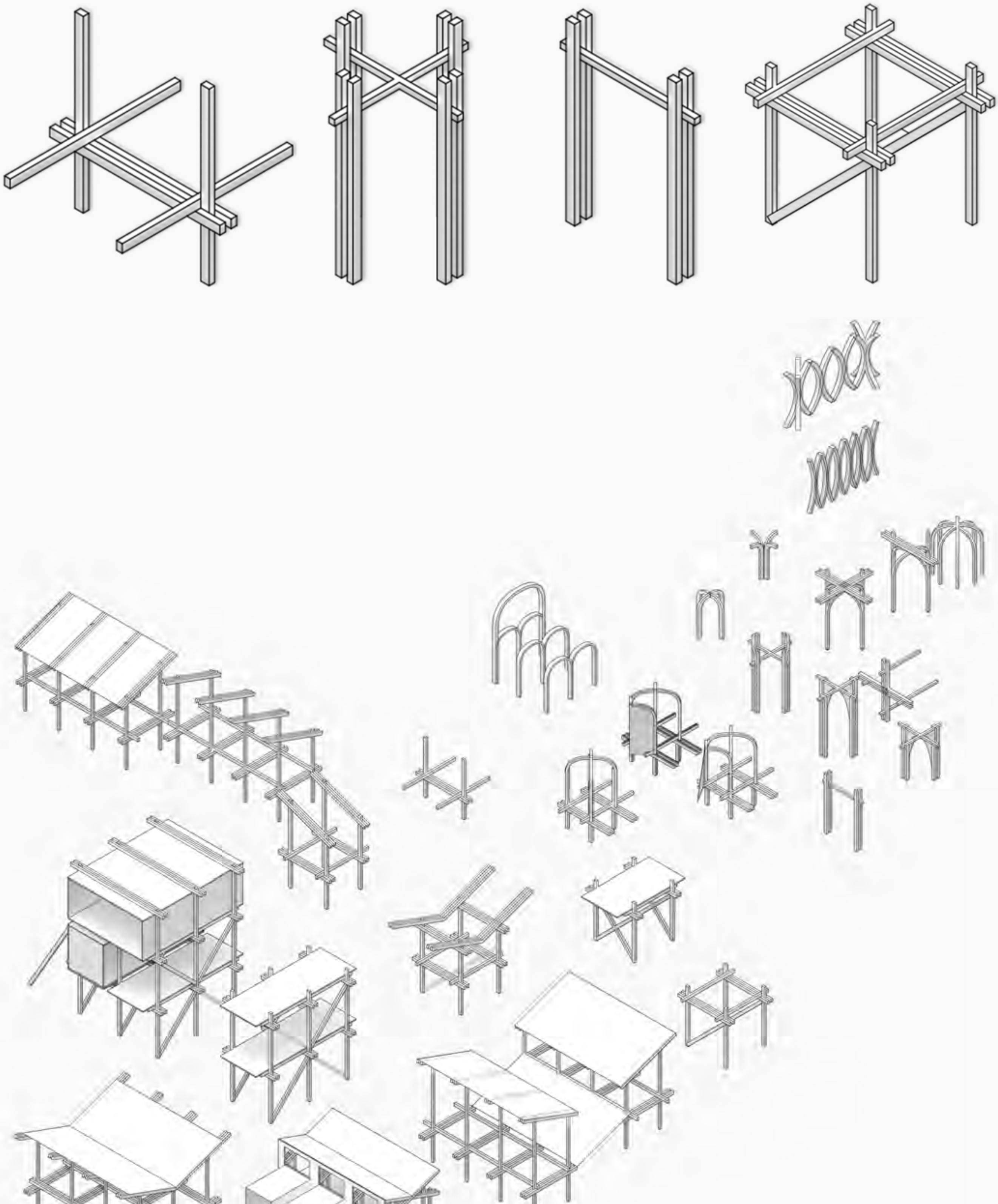
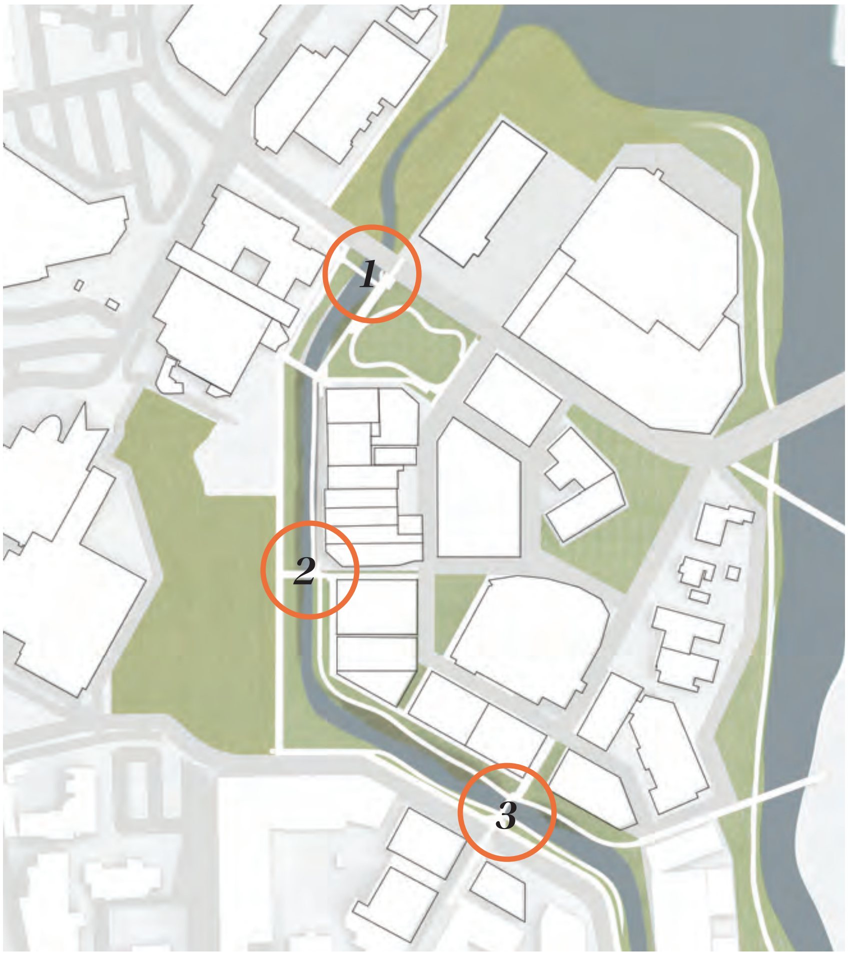


Fig5.7. Isometric of explored timber modular construction.

5.3

INTERSECTION DESIGN CONCEPTS.



1. Wetland civic square access
2. Old and new building interface
3. CBD pedestrian link

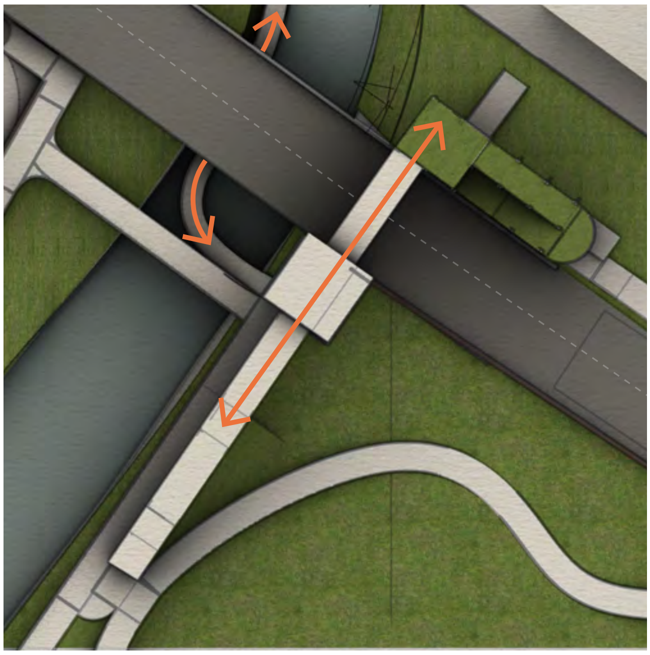
Areas of Focus

The following design concepts explore circulation solutions for the three key intersections (see fig5.8), which negotiate the wetland stream, roads, pedestrian routes, new buildings, and existing buildings. The prioritisation of pedestrian activity and movement around the city requires new pedestrian overpasses crossing the new stream and main arterial routes. The design of the bridges explores potential biophilic qualities, as well as a possible dual function of filtering and slowing down stormwater runoff, mimicking the processes and procedures of the surrounding wetland ecosystem. An existing pedestrian overpass located in Paremata, north of the city, which crosses SH1, was looked at for possible structural configuration and height requirements for the new bridge designs.

Although the bridge is an interesting piece of structure it can only be accessed via an accessible ramp which covers a considerable amount of ground to reach the required height of the overpass. It therefore takes a long time for pedestrians to cross the bridge which can be a tedious experience. It is especially unpleasant in rough weather conditions with no overhead or side shelter from wind and rain. In search of a bridge which creates a pleasant human experience, the new bridges are designed to integrate aspects of the biophilic design framework, such as the human experience of dynamic light qualities as the public travel through the space achieved through timber slats (Fig5.25 and Fig5.26). A physical presence of nature is achieved through integrated green roof shelters and walls. Vertical circulation includes both stairs for quick access as well as accessible ramps for inclusivity.

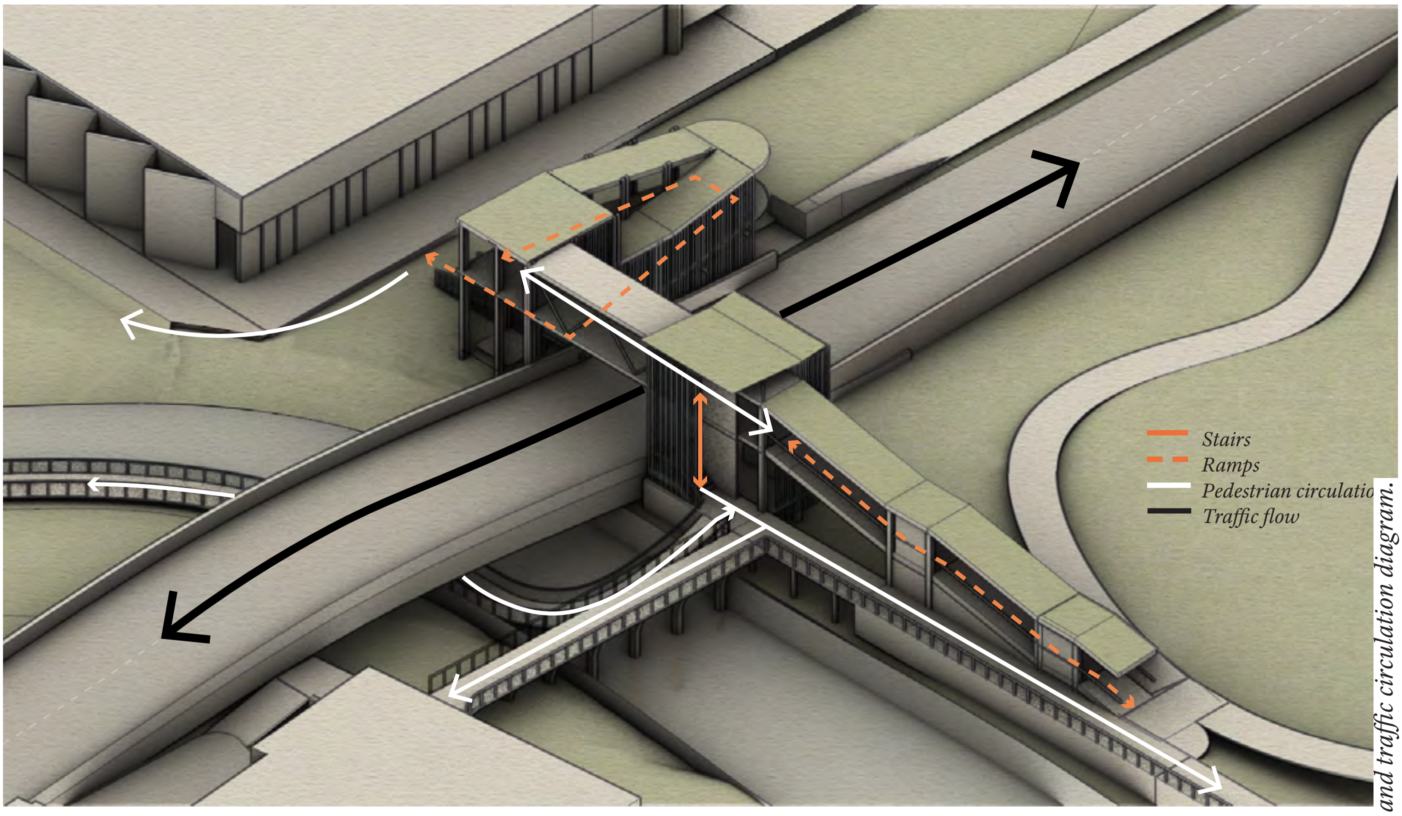
←Fig5.8. *Map of three intersections of focus for chapter 5*
→Fig5.9. *Paremata train station pedestrian overpass.*

Structures of the wetland/city interface



1. Wetland Civic Square Link

This area requires the negotiation of a main traffic flow route with the wetland stream. The solution explores implementing a pedestrian riverside walkway under the road overpass, as well as a pedestrian overpass. The pedestrian bridge creates human prospect through elevated pedestrian movement, which overlooks the wetlands and harbour. These elevated structures ensure no disruption to pedestrian flows when the stream water levels are high.



Green roofs on bridges provide links between green spaces fragmented by roads and habitat for bird species.

↑ *Fig5.10. Roof plan.*
← *Fig5.11. Isometric pedestrian and traffic circulation diagram.*

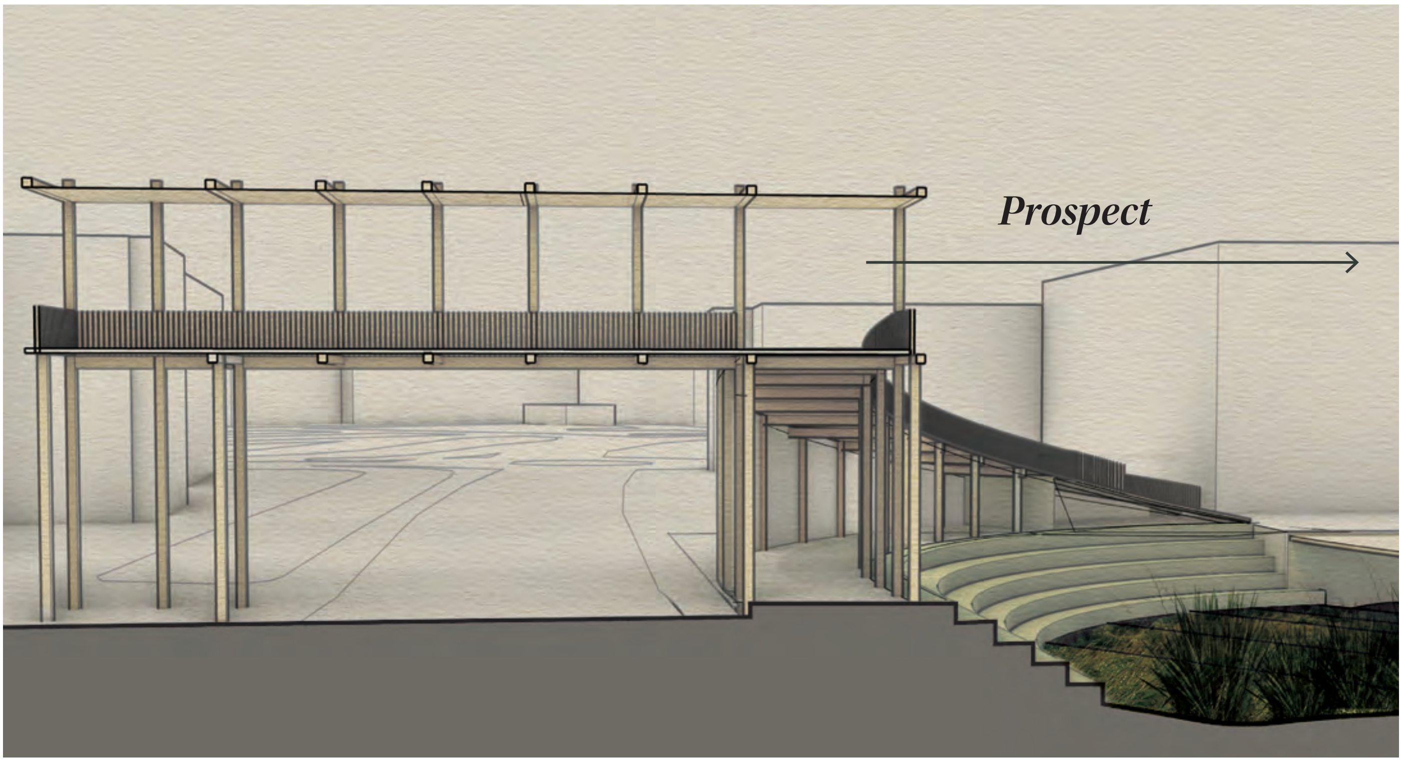


Fig5.12. Pedestrian overpass section.

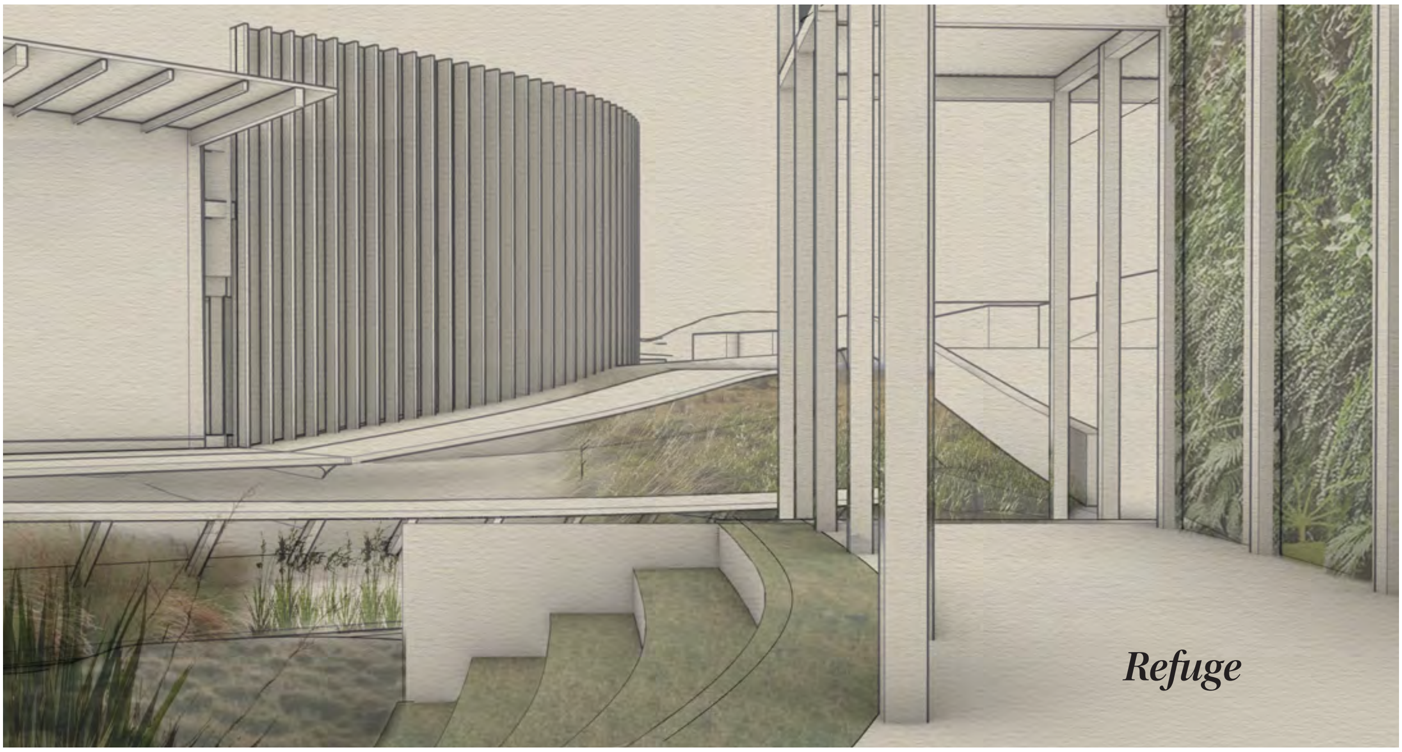
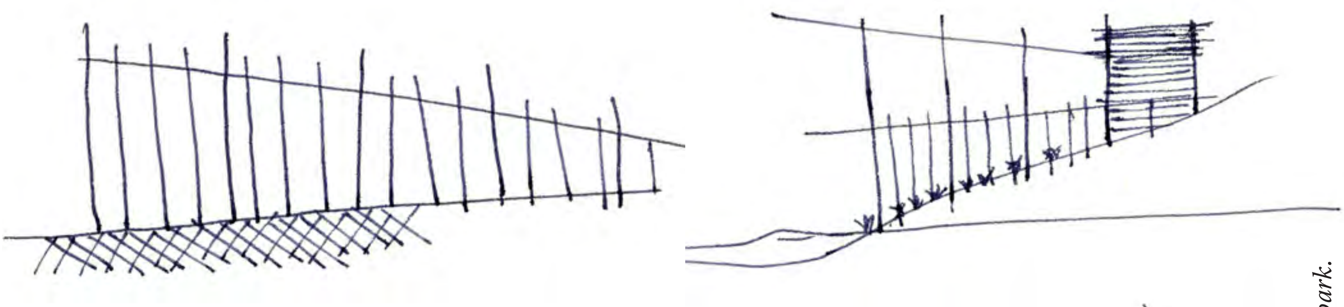


Fig5.13. Amphitheatre under the pedestrian bridge.



↑ *Fig5.14. Pedestrian bridge from wetland park.*
↓ *Fig5.15. Initial conceptual sketches of edge structures.*

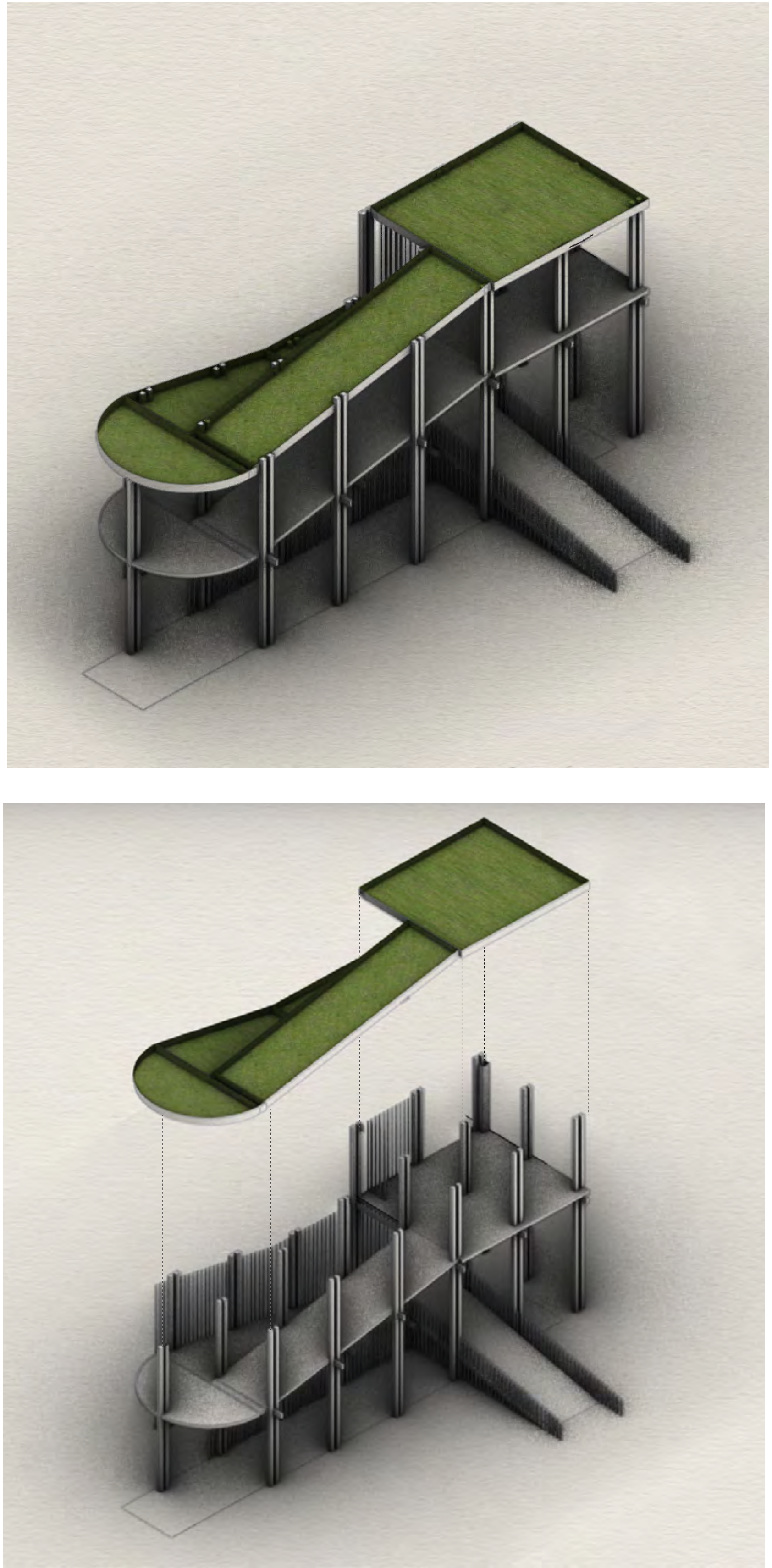
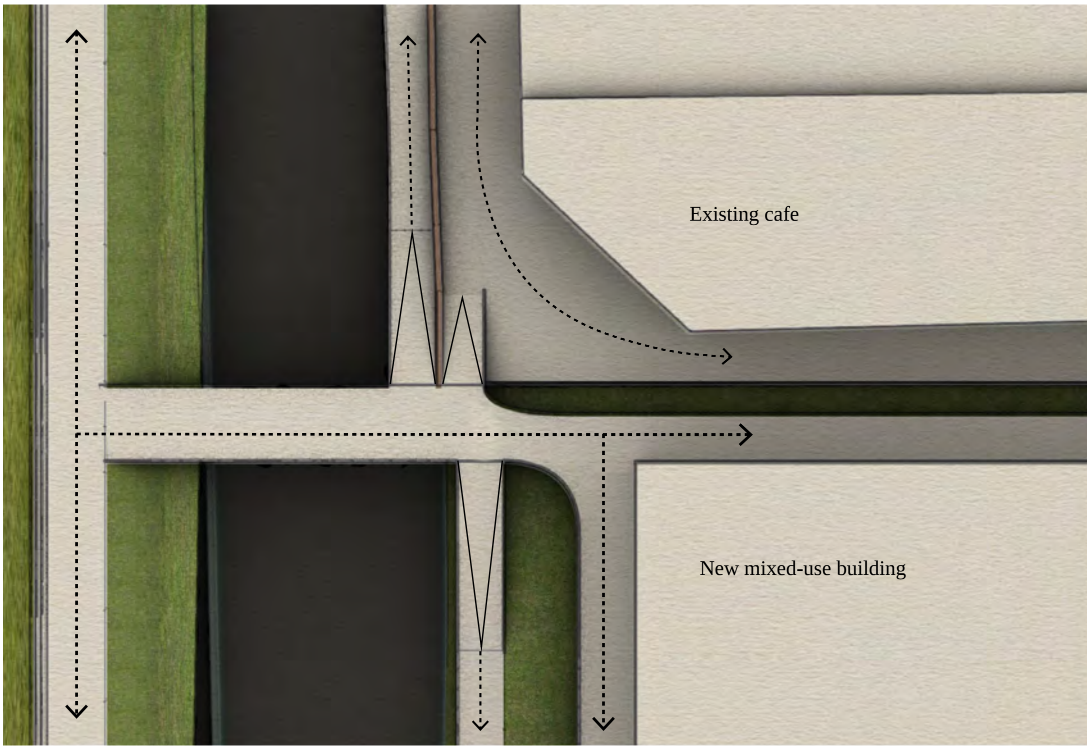
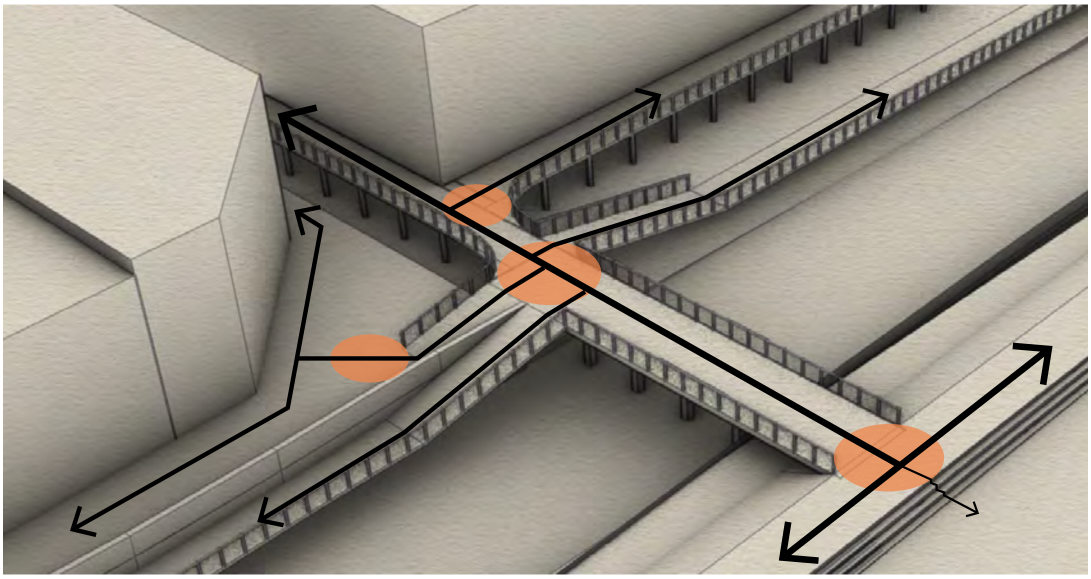


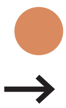
Fig5.16. Isometric diagram of the accessible ramp and its green roof covering.

2. Old and New Building Interface

This area explores the negotiation of existing buildings with new elevated structures and the wetland stream. Differing elevations between the existing building level and bridges crossing the stream are resolved through accessible ramps.







↑ *Fig5.17. Circulation Masterplan.*
↓ *Fig5.18. Isometric of circulation routes and around the complex intersection.*

Fig5.19. View of existing shop's interface with new wetland stream.

3. CBD Pedestrian Link

This area explores the pedestrian overbridge connection between the existing CBD and the city's north area across the main traffic flow road and the wetland stream. The bridge is accessible by both ramp and stair.

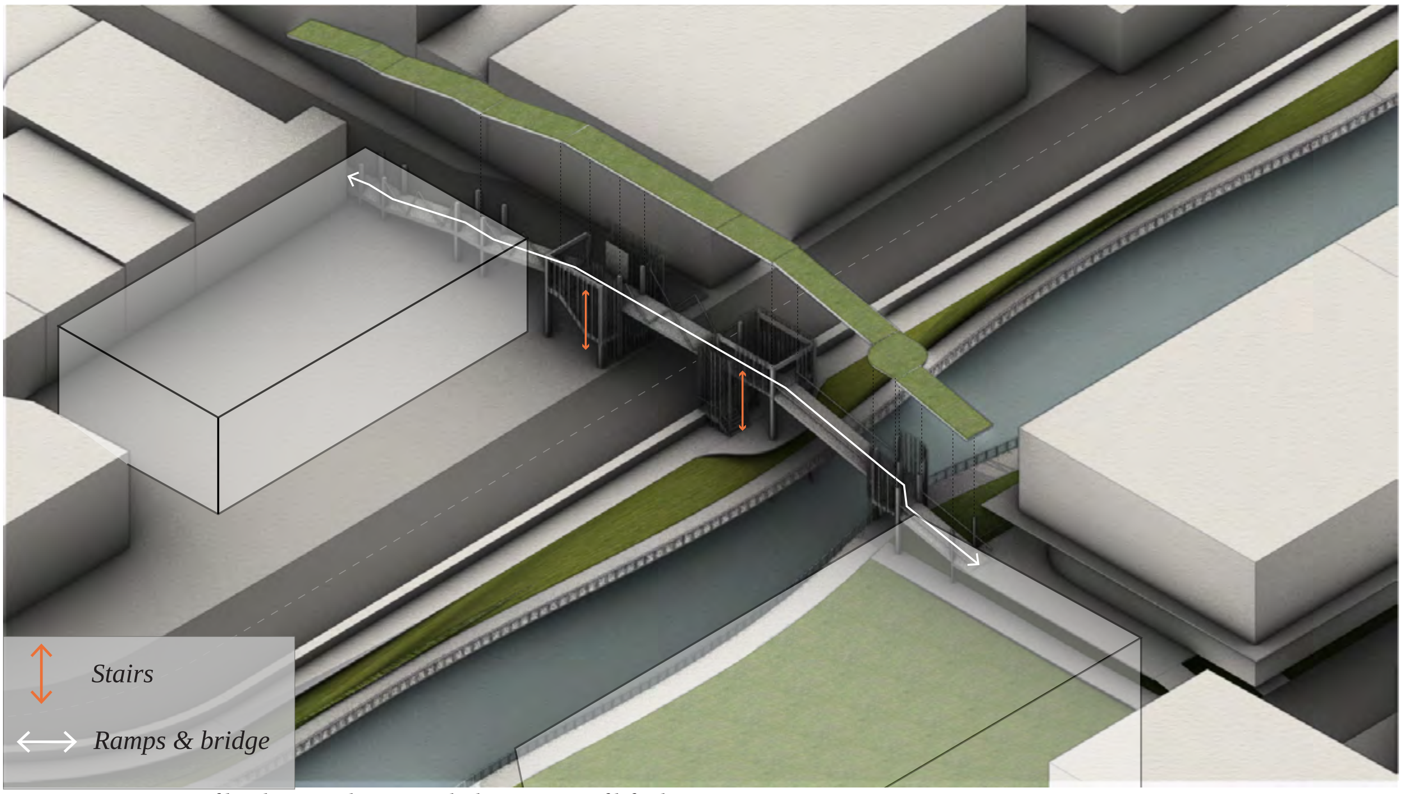
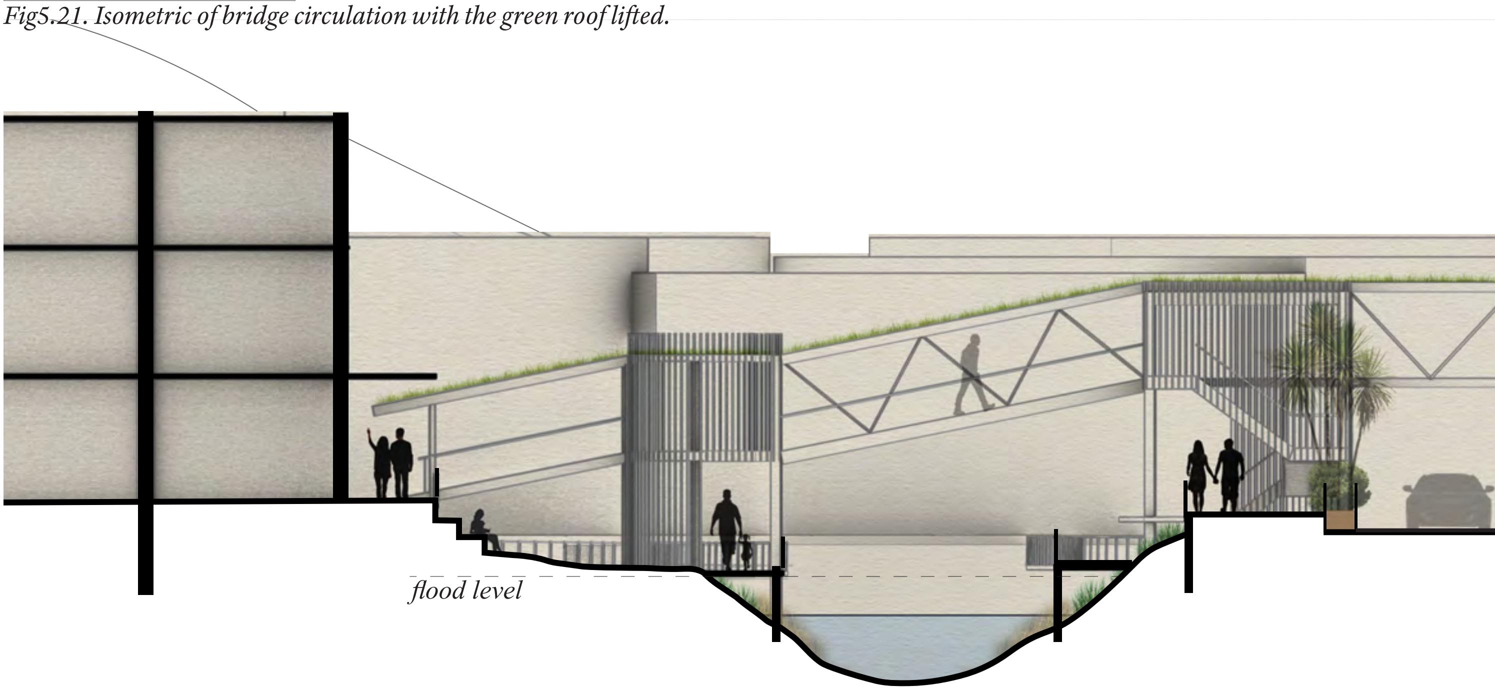


Fig5.21. Isometric of bridge circulation with the green roof lifted.



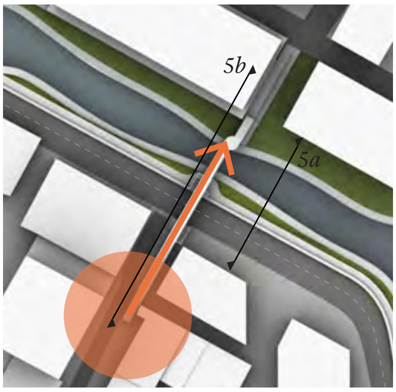


Fig5.20. Plan of required pedestrian connection and section cuts.

existing CBD
required pedestrian link
section cut

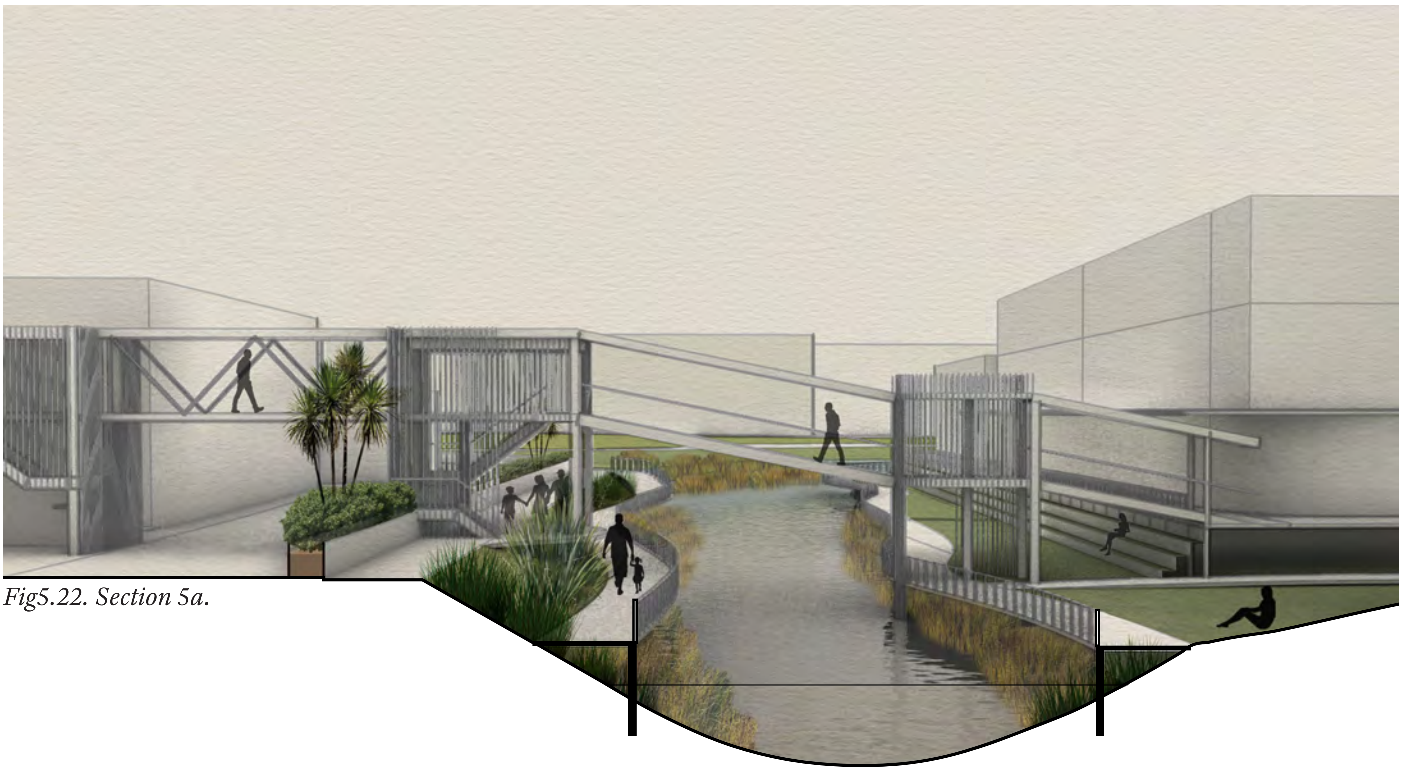


Fig5.22. Section 5a.

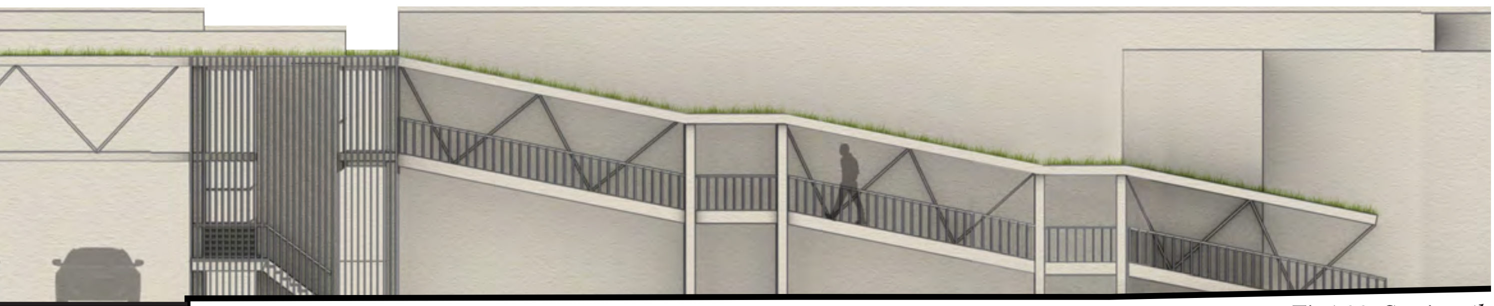
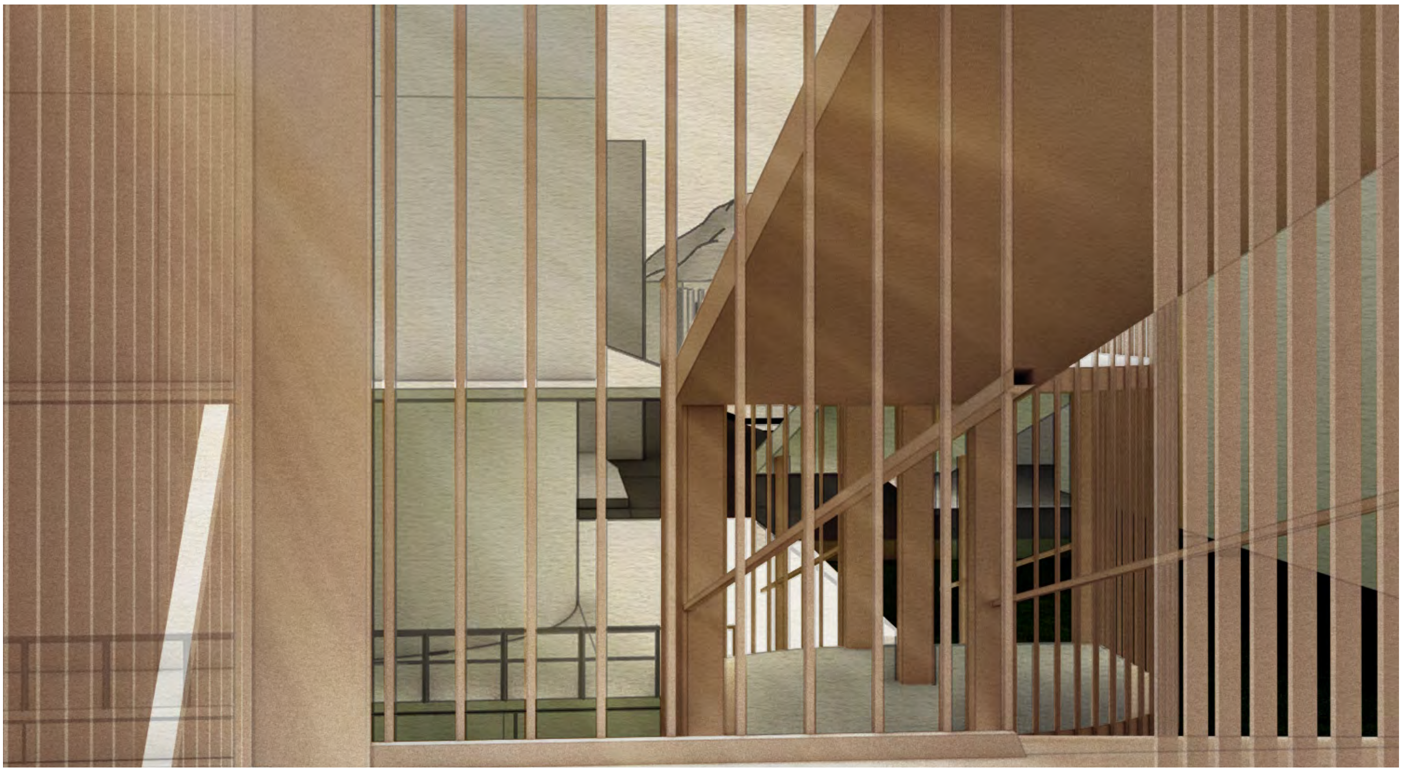


Fig5.23. Section 5b.

The bridge structure integrates biomorphic forms evoking forest cover.

Fig5.24. View from riverside path.



Timber structure provides material and colour connections with nature.

Fig5.25. View from the pedestrian bridge.

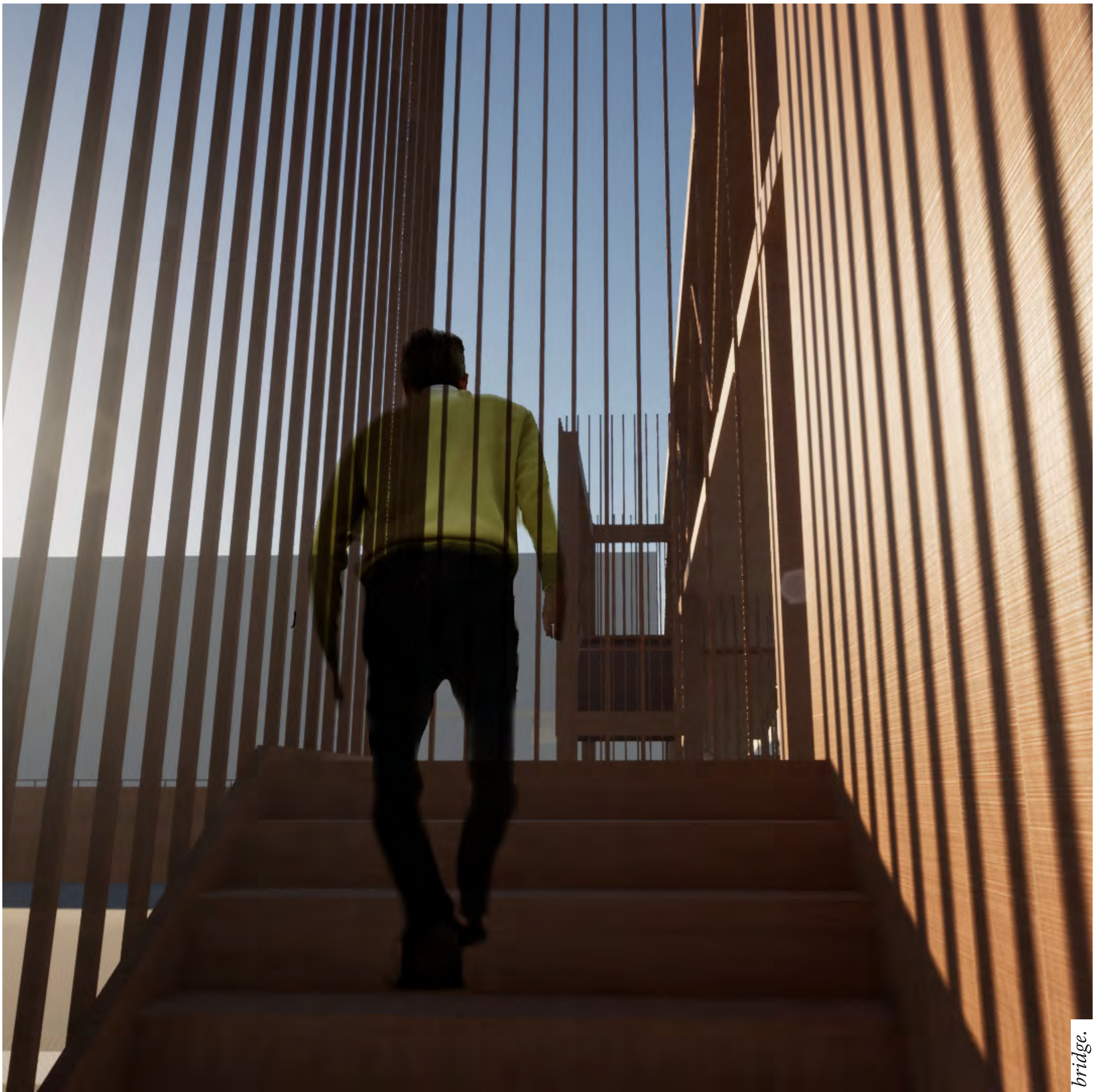

Timber slats create dynamic light and shadows in the space.

Fig5.26. Stairwell of a pedestrian bridge.

5.4

CRITICAL REFLECTION

The implementation of the bridges successfully creates a city where pedestrians have priority because they can walk from the train station to the CBD and the waterfront civic square without having to stop at any road crossings.

After presenting the work in a design review, the reviewers suggested that the design results could be more transparent in showing the new implemented landscape's interactions with the maintained existing buildings. Focusing on the new structures creates a body of work that ignores Porirua's existing buildings and creates a typology that could be any wetland in New Zealand. To truly resolve Porirua's issues requires acceptance that many of the remaining undesirable buildings are a reality of the city's long-term urban condition. Realistically, this research cannot change an entire city. Therefore, having established a working urban plan and conceptually designed some critical urban spaces and links between existing and new buildings, the next section will choose an area to transform in detail through biophilic design intervention, including the existing surrounding buildings.

The chosen area to transform is the wetland civic square, where the implemented stream enters Porirua Harbour, including the existing building located at the edge of the harbour and stream. This area will become the heart of the city, and a centre for community and ecological wellbeing, hosting civic activity and creating an inviting connection to the water, which the city is currently lacking. Rather than focusing on the landscape and the linking pathways between existing buildings, the following section will transform the existing building located in the square through a biophilic retrofit. Retrofitting existing buildings will be essential for sustainable practice in the future built profession because the demolition of existing buildings causes the loss of a vast store of carbon and resources (Dyer, 2012). Therefore, we must learn how to alter the inefficient and outdated buildings existing currently rather than continuously replacing them.

6

CHAPTER

Biophilic Retrofit
(Porirua City Council)

6.1

INTRODUCTION.

Having focused on the space between existing buildings by exploring the essential new infrastructure required at the interface of the wetland and city, this next design phase looks at how an existing building in Porirua might respond to the effects of climate change and urbanisation. An existing vacant waterfront building at 16-18 Parumoana Street is repurposed as the new location for Porirua City Council's services and offices. This vacant waterfront building becomes a vital component of the city, located at the mouth of the implemented wetland stream entering Porirua harbour. The following design concepts explore techniques that seek to improve human nature connection through the nature of space/place and nature in space aspects within the biophilic framework. The demolition of existing buildings causes the loss of a vast store of carbon and resources; therefore, we must learn how to adapt rather than replace. A biophilic retrofit involves the integration of passive design techniques through working with local climatic conditions, transforming inefficient buildings into energy and material effective bioclimatic buildings.

Framework Checklist:
3.1 Bioclimatic buildings
3.2 Biomorphic buildings / spaces
3.3 Dynamic natural light
3.4 Thermal and airflow variability
3.5 Material and colour connections with nature
3.6 Celebration of nature/ climate / bioregion
3.7 Prospect / view
3.8 Refuge / sanctuary
3.9 Mystery, surprise, and curiosity
3.10 Risk and peril

→ Fig6.1. Location of the existing building to retrofit.
← Fig6.2. Existing waterfront facade of vacant building to retrofit.

6.2

BUILDING PROGRAMME.

Developing the building's programme involved identifying the vital services for the heart of the city. As the local body which makes decisions for the future of the city, it seemed appropriate to relocate the Porirua City Council to the wetland civic square space. The programme analysis involved identifying the number of people working in each department to gauge the required office space. The existing PCC building plans were looked at to identify other key features such as several meeting rooms, the council chambers, kitchenettes and toilets. The New Zealand Building Code guides the number of bathrooms and fire stairs required concerning occupancy numbers.

Part of this research involved a field trip to look at the existing PCC building and offices to gauge a better understanding of programmatic requirements and planning information unavailable in archives or online. The escorting council employees provided some insight into how the current offices were used providing suggestions for the office relocation. Comments concerning new spaces included a mudroom containing boot storage and shower amenities near a building entrance which would be appropriate for staff who regularly visit sites and return to the council with soiled clothing. They also highlighted the importance of prayer rooms in the workplace. Another suggestion was integrating childcare into the council building because many staff members have children. Having tamariki (children) at the heart of the city is critical to shape young minds and empower the future generation.

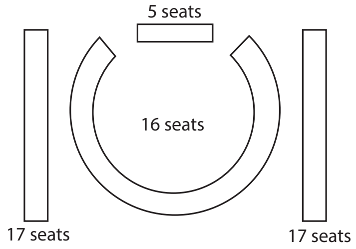
The decision to integrate space for charity-led community groups such as WELLfed in the wetland civic square came through a requirement to create a centre of wellbeing for the community where people feel a sense of belonging in the heart of the city irrespective of income or race. WELLfed's mission is to 'nourish communities through food and connections' (WELLfed NZ Trust, 2020). They provide cooking classes and resources to help people make decisions for a better life. The mix of building programme attempts to fight Porirua's current issue with suburbs separated by income, allowing the city centre to be a place for everyone.

PCC Offices

Department	***Number of people***
Reception	*5*
Building Assurance	*24*
Coorporate support	*5*
Environment & City Planning	*10*
Monitering & Compliance	*12*
Resource Consents & Monitoring	*14*
Regulatory Commercial Analysis	*6*
Strategy & Policy	*3*
Policy, Planning & Regulatory Services Management	*2*
People and cabability	*8*
Communications & Marketing	*12*
City Partnerships / Commercial & Development / City Growth & Partnership Management	*22*
Property	*8*
Business Tech Group	*16*
Risk Assurance	*4*
Finance	*24*

PCC Chambers

Reception - 2 pax
Waiting room - 14 pax



Community Group Amenities (Wellfed Community Group)

Meeting hall
A flexible, open space for hosting various community events

Kitchen
A space for cooking demonstrations

Toilets
To meet occupancy requirements of NZBC

Community Gardens

Childcare Services

Toilets
To meet occupancy requirements of NZBC
Staff only
Child friendly toilets

Offices
Reception
Staff room

Playrooms

Kitchen
Staff only

Fig6.3. Table of PCC departments and number of people and dual programme breakdown.

6.3

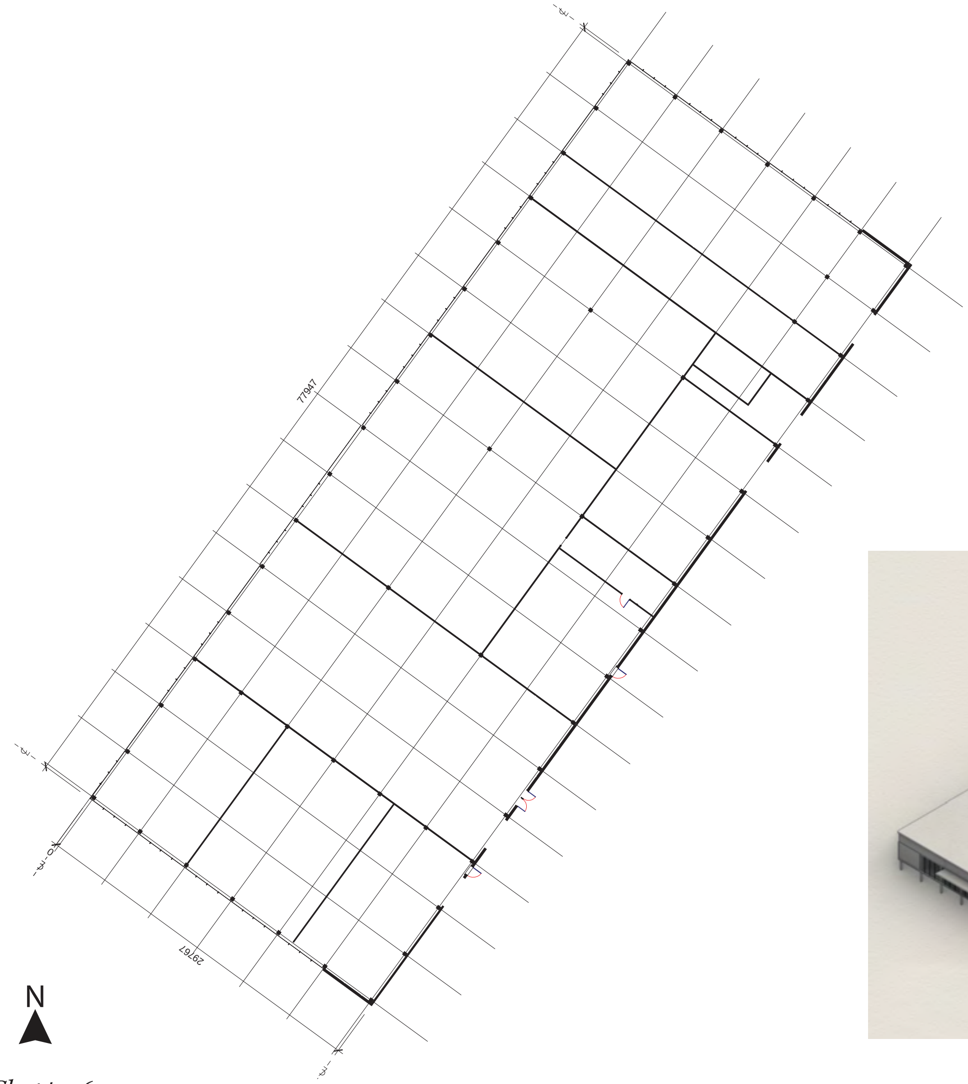
DESIGN CONCEPT 1.

An important aspect of biophilic retrofit involves integrating passive design techniques through working with local climatic conditions in order to transform inefficient buildings into energy and material effective bioclimatic buildings with comfortable interior conditions (Pedersen Zari, 2019).

New Zealand's climatic conditions typically require winter heating for comfortable building interiors; therefore, a north orientation is most desirable for maximum solar gain in winter. The existing building orientation ignores the climatic and regional conditions, underutilising the site's potential for passive solar and passive cooling design solutions.

To address inefficient orientation, the initial exploration looks at slicing the existing building to create penetrations for direct sunlight. Changing the roof to install skylights and clerestory windows creates more opportunity for passive solar heating of the building interior through enabling direct sunlight to heat the existing high mass (concrete) floor and additional carefully placed walls made of high thermal mass (mudbrick) .

The existing west-facing glazed wall at the edge of the wetland square poses glare and overheating issues during the afternoon. When the building's programme changes to the PCC offices, diffused light is desirable to avoid computer screen glare. The following design concept looks to implement timber façade screens over existing glazing on this façade to create suitable interior light conditions .



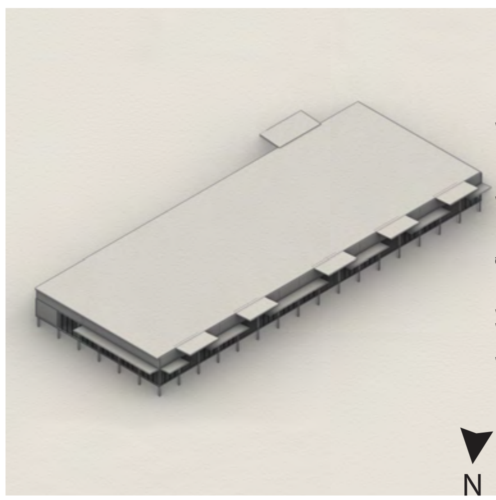


Fig6.4. Existing building floor plan and isometric view.

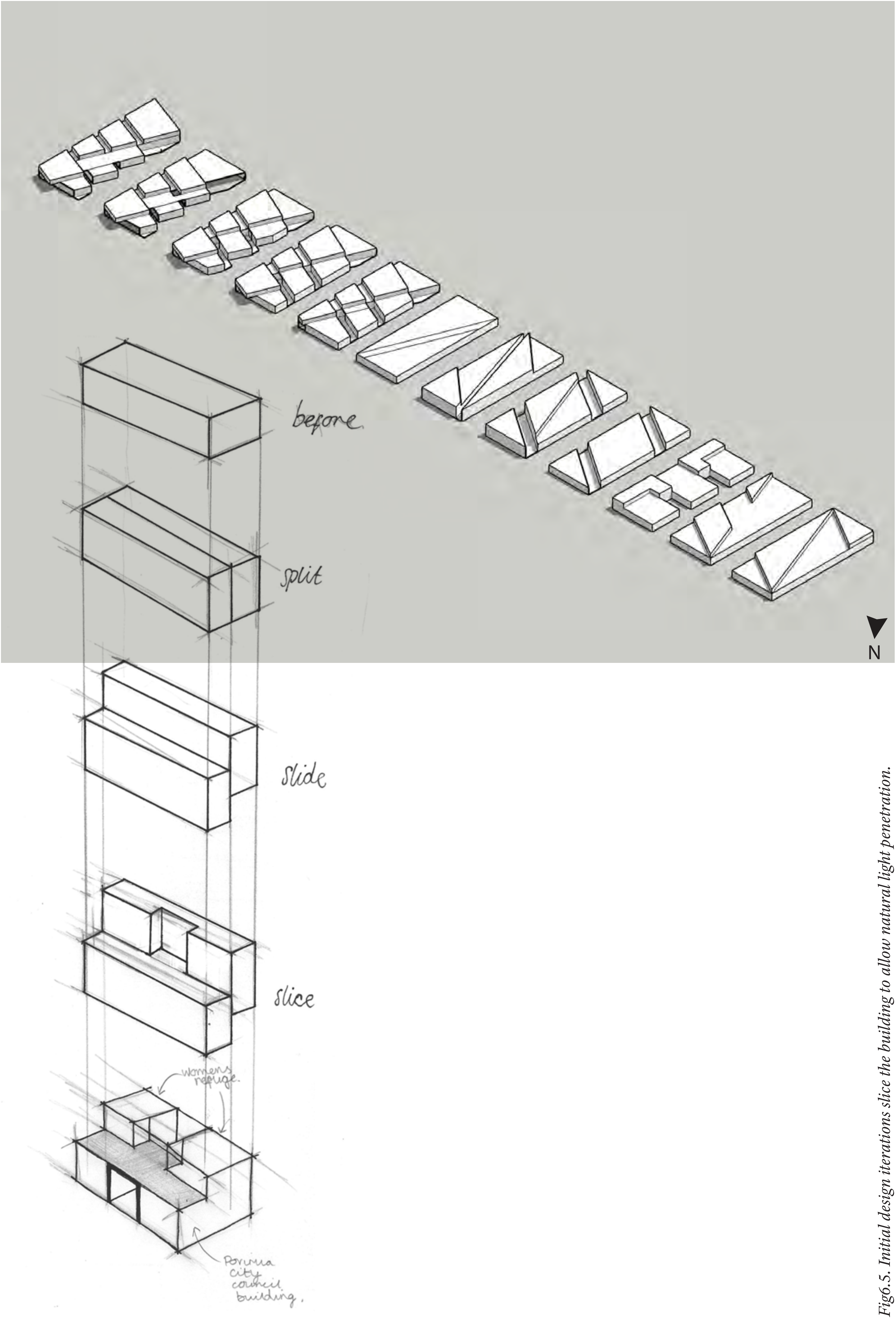


Fig6.5. Initial design iterations slice the building to allow natural light penetration.

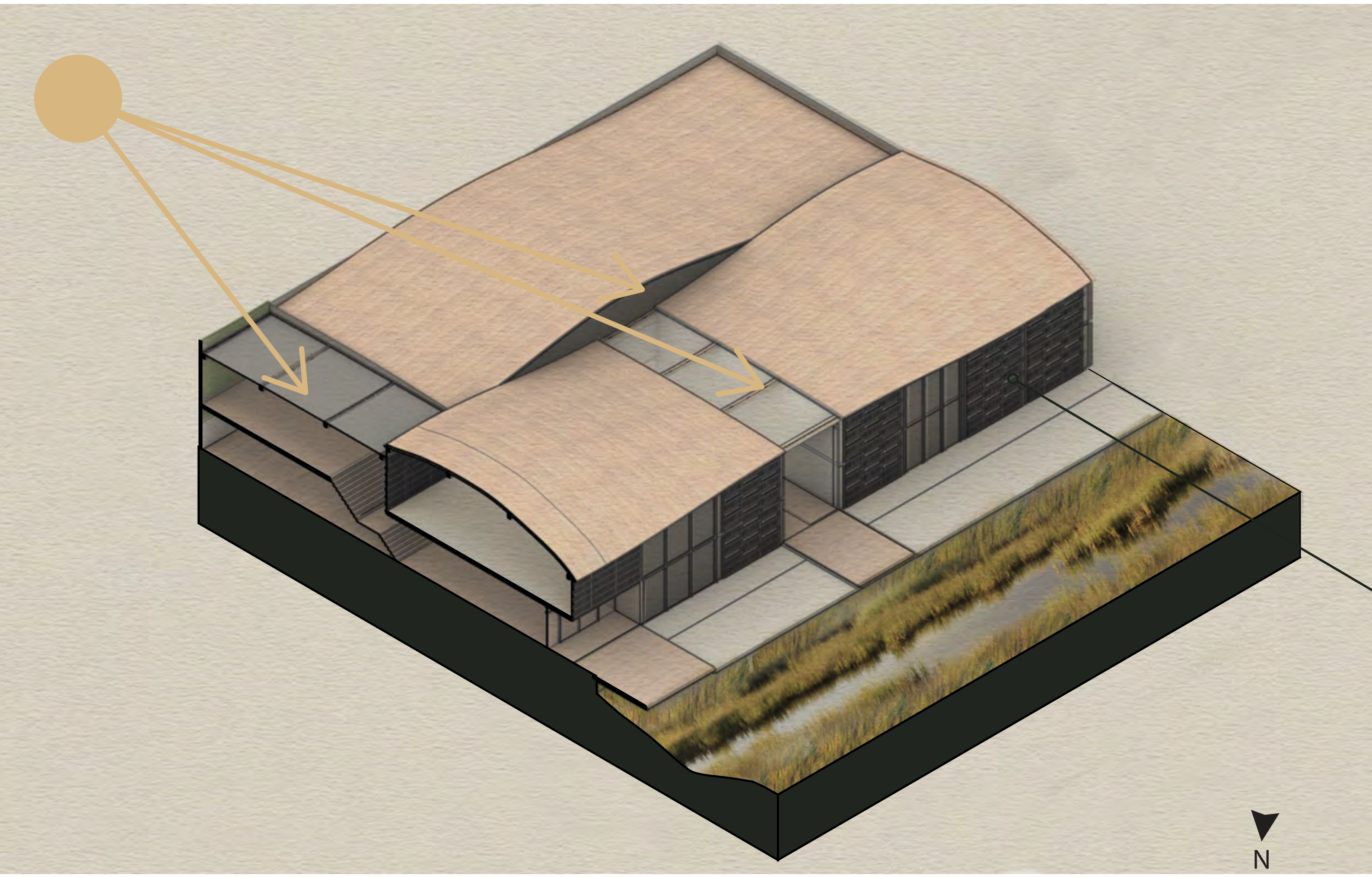


Fig6.6. Isometric section of retrofit building concept 1.

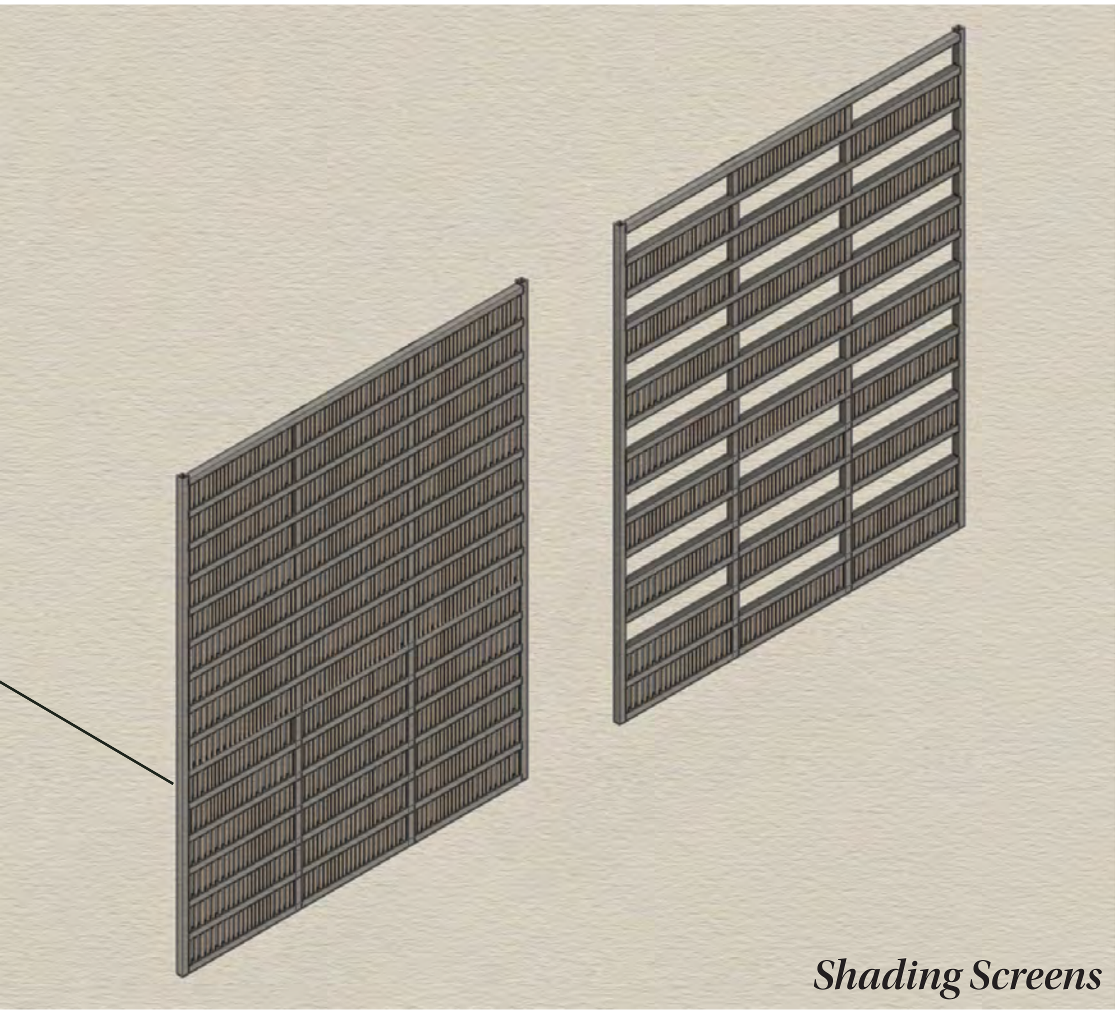


Fig6.7. Timber screen isometric.

Fig6.8. Photographed fence as materiality precedent.

This aspect of the design meets the biophilic framework in the following ways:

- Responding to the sun positions.
- Biomorphic forms of curved roof and fractal pattern of screens.
- Shading screens made from local timber providing material connection with nature.

Designing Experiences of Space

This aspect of the design meets the biophilic framework in the following ways:

- A visual connection with wetland from the building atrium enables prospect and visual references to nature from the building interior.
- A sense of refuge/sanctuary is created in the cave-like interior atrium space.
- A sense of mystery, surprise, and curiosity are present as the wetland's view slowly reveals as the person moves through space.
- A sense of risk and peril is present in the staircase, with the upper level having floating qualities over the building exit.

← Fig6.9. Mudbrick walls.
↑ Fig6.10. Visual connection to wetlands from building interior.

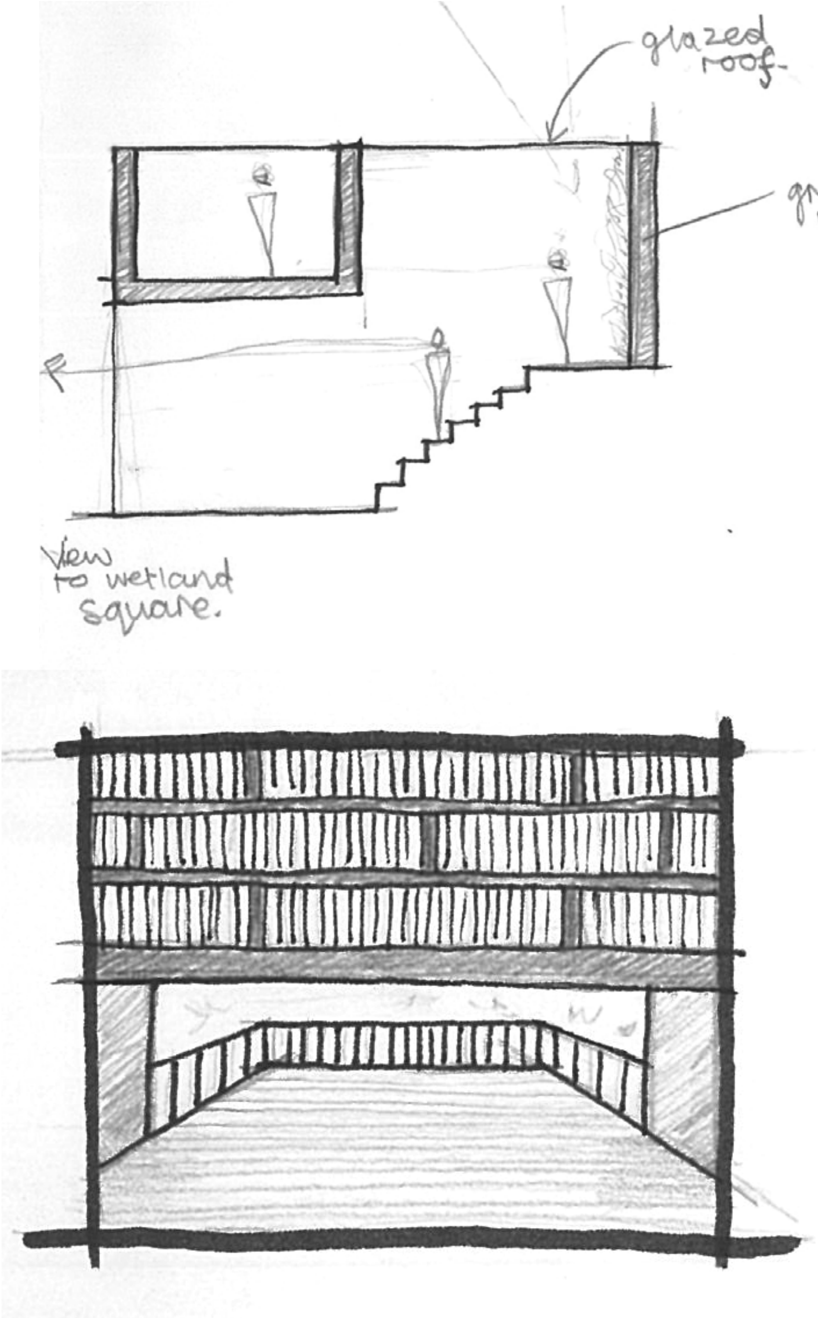


Fig6.11. Initial concept sketches for the atrium space.

Roof Replacement

Ecorevealatory design seeks to engage users by revealing ecological phenomena (Achilles & Elzey, 2013). The concept assumes that exposing the public to the environmental processes which sustain them installs a sense of care for these systems. The following sketches explore how downpipes could become an expressed feature within the building, bringing awareness to the processing of stormwater collection through clear pipes. By exposing this usually concealed process, the public is more aware of the precious resource.

Fig6.12. Implemented roof from building interior.

This aspect of the design meets the biophilic framework in the following ways:

- Roof form mimicking natural curves of nature.
- Celebration of climate through revealing natural processes.
- Downpipes become water features on building interior and exterior through transparent water wall.
- Sensory stimuli occur through water features.

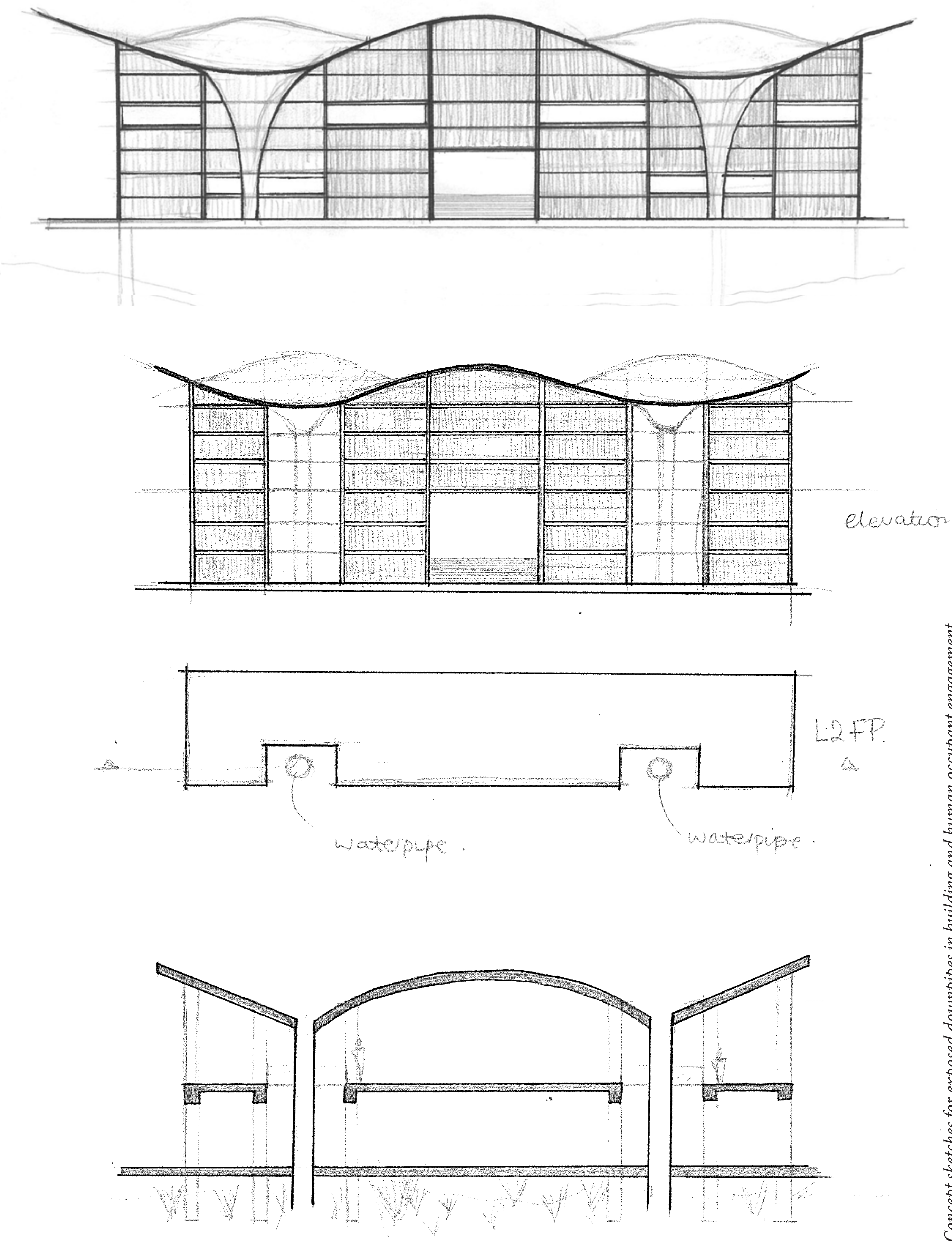


Fig6.13. Concept sketches for exposed downpipes in building and human occupant engagement.

Fig6.15. Photographed existing view from the location for comparison.

Chapter 6

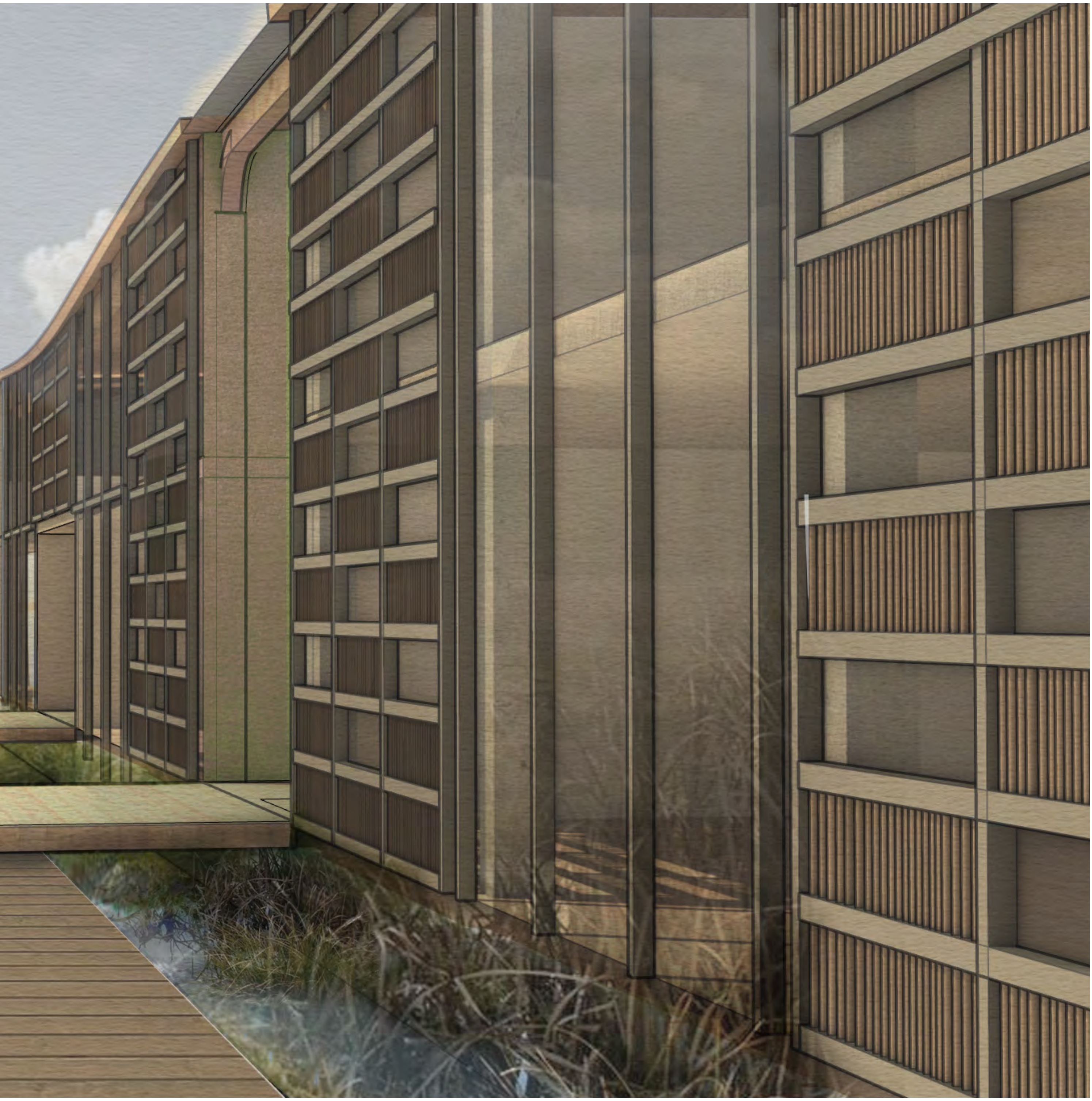


Fig6.14. Concept 1 building and wetland square interface, looking towards the harbour.

Reflection

The initial design exploration successfully meets several elements of the biophilic design framework at the architectural scale through retrofitting the existing building. However, the radical changes to the building, including the skylight lit atriums, additional floor levels and complex roof system, would require significant strengthening of the existing structure. To address this, the following design concept explores retrofitting through additions, extending the building's footprint and maintaining the existing basic structure. Design concept one addressed the inefficient building orientation through skylights and clerestory windows. In contrast, the following concept will extend the building footprint to create wings that reorientate the building to face north (figure 6.17). Good building orientation can reduce or even eliminate the need for auxiliary heating and cooling systems within a building (McGee, 2013). Explored are the building additions and their relationship to the surrounding context as they infringe the wetland square. The extensions are the focus of this concept, exploring how their design could enhance the existing building's biophilic qualities and functional effectiveness.

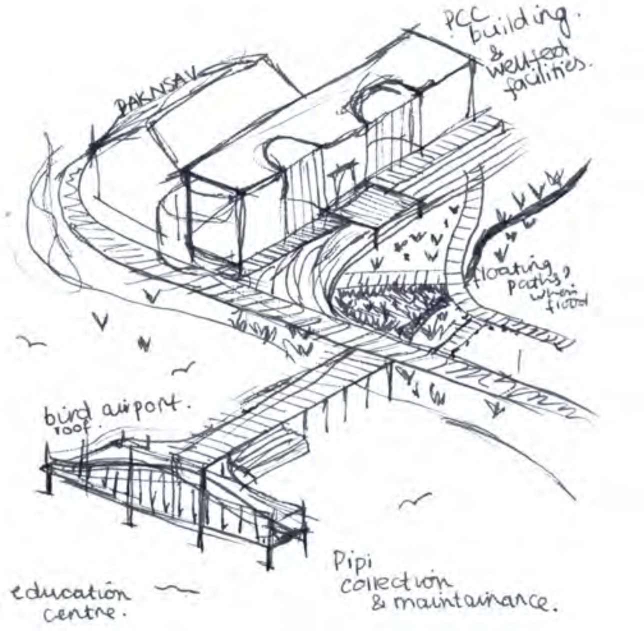


Fig6.16. Civic square concept sketch.

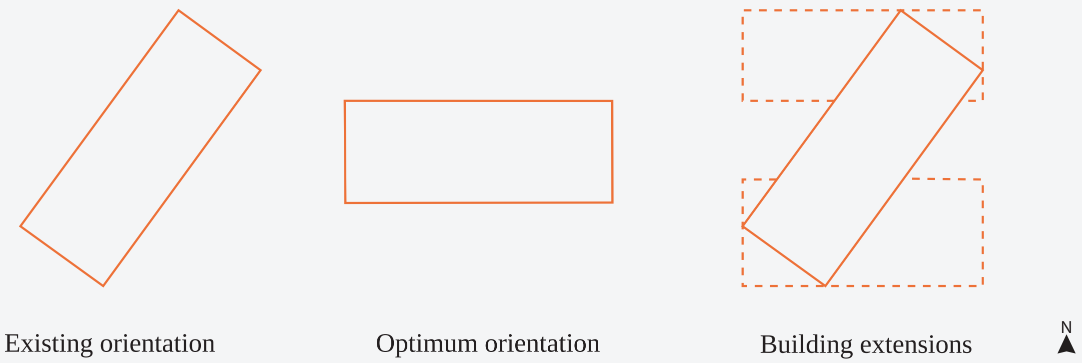
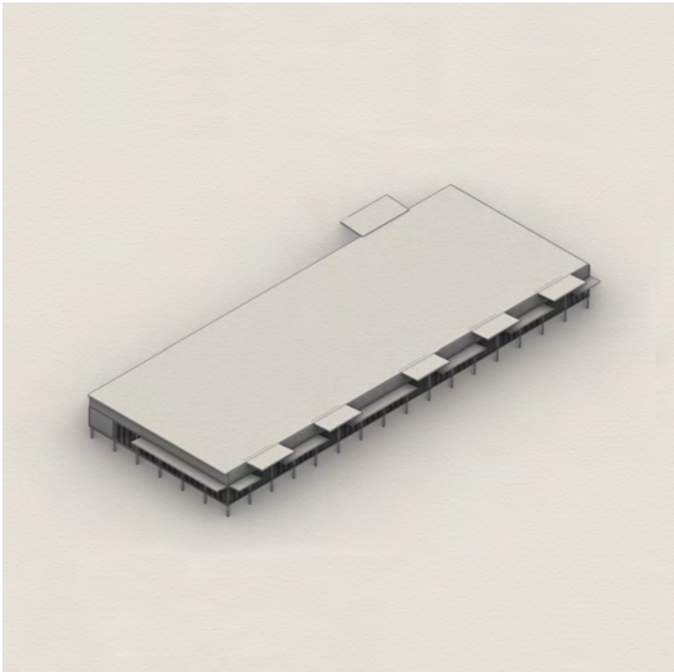
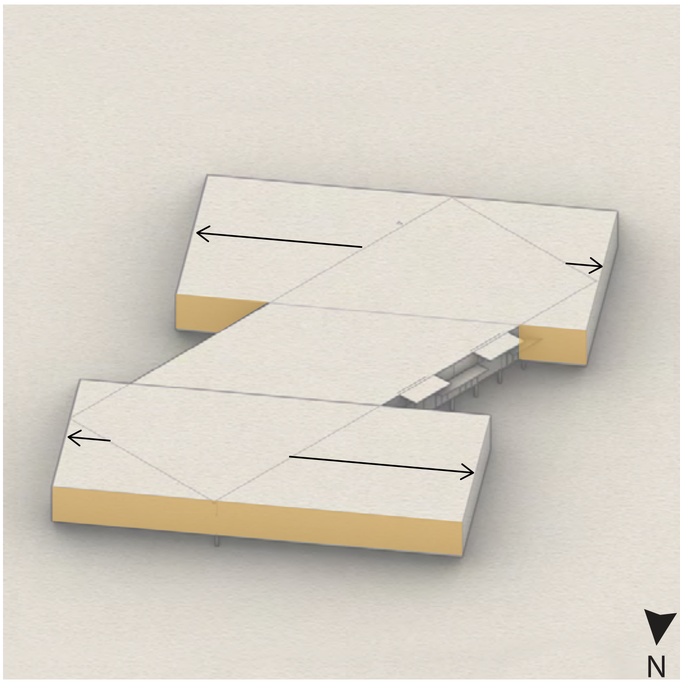


Fig6.17. Illustrated building extensions.

6.4

DESIGN CONCEPT 2.





north-facing walls

Fig6.18. Isometric of building extensions to reorientate building to face north.

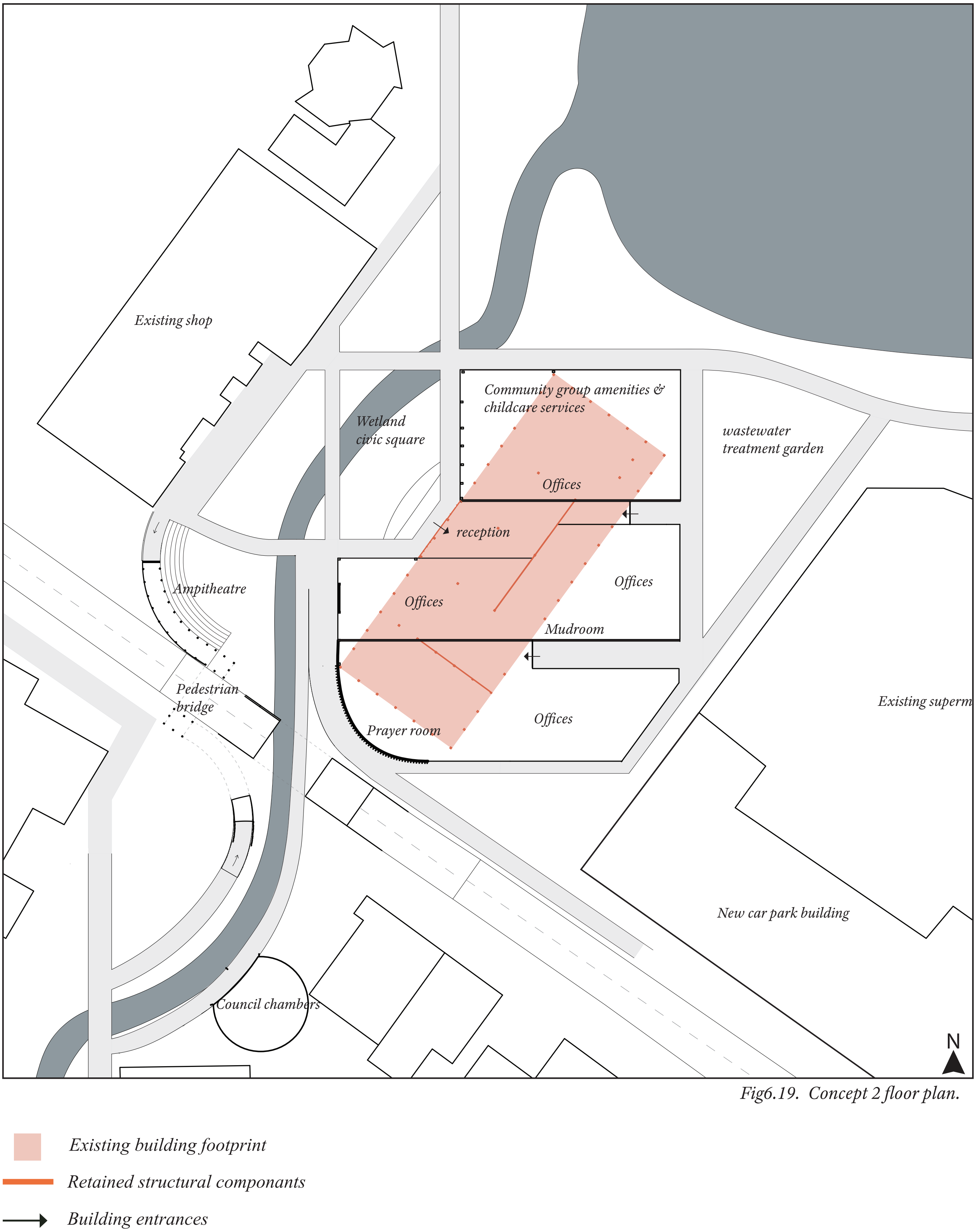
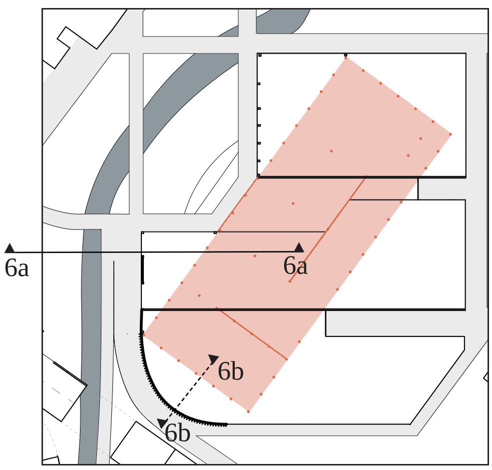


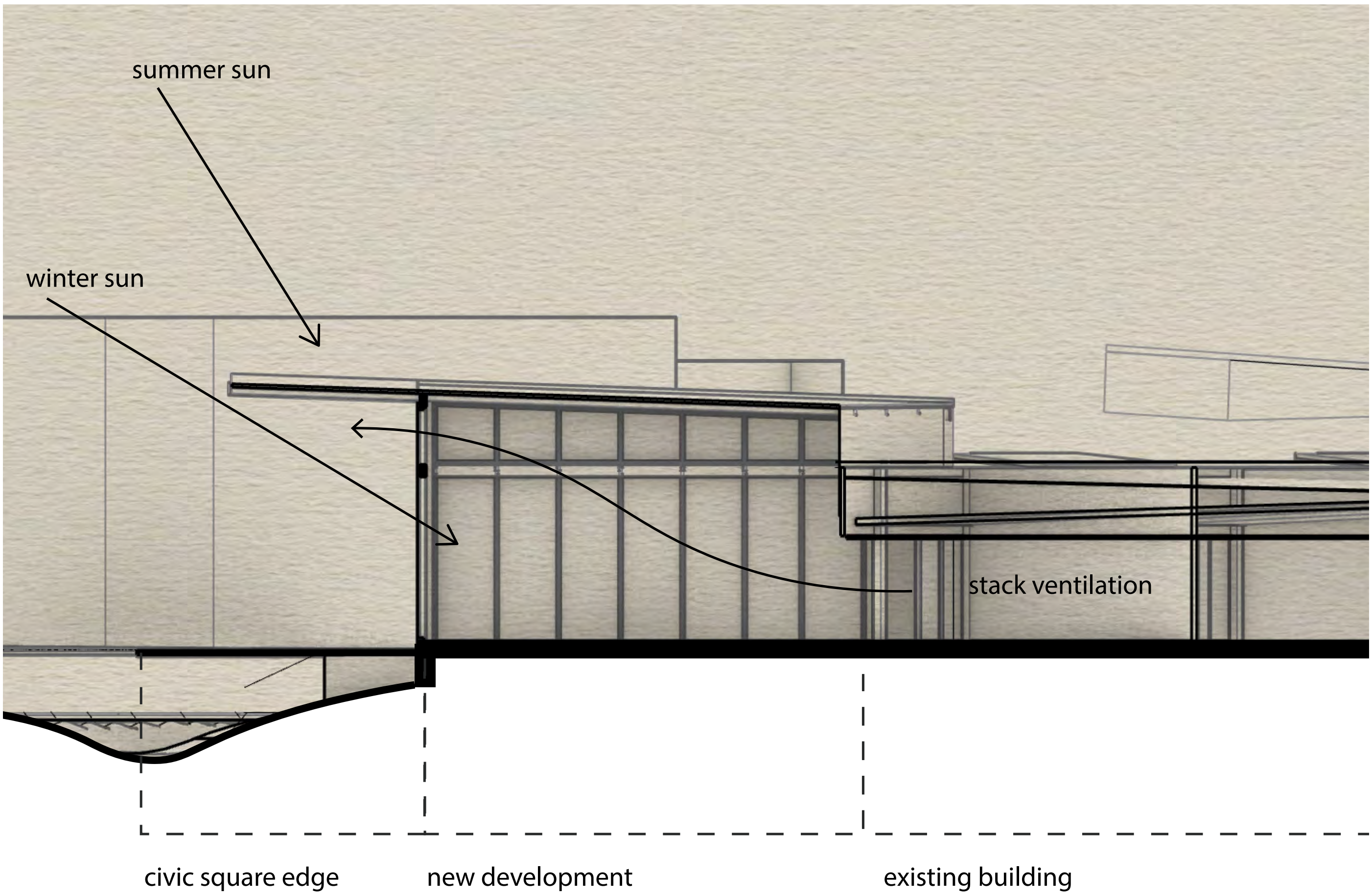
Fig6.19. Concept 2 floor plan.

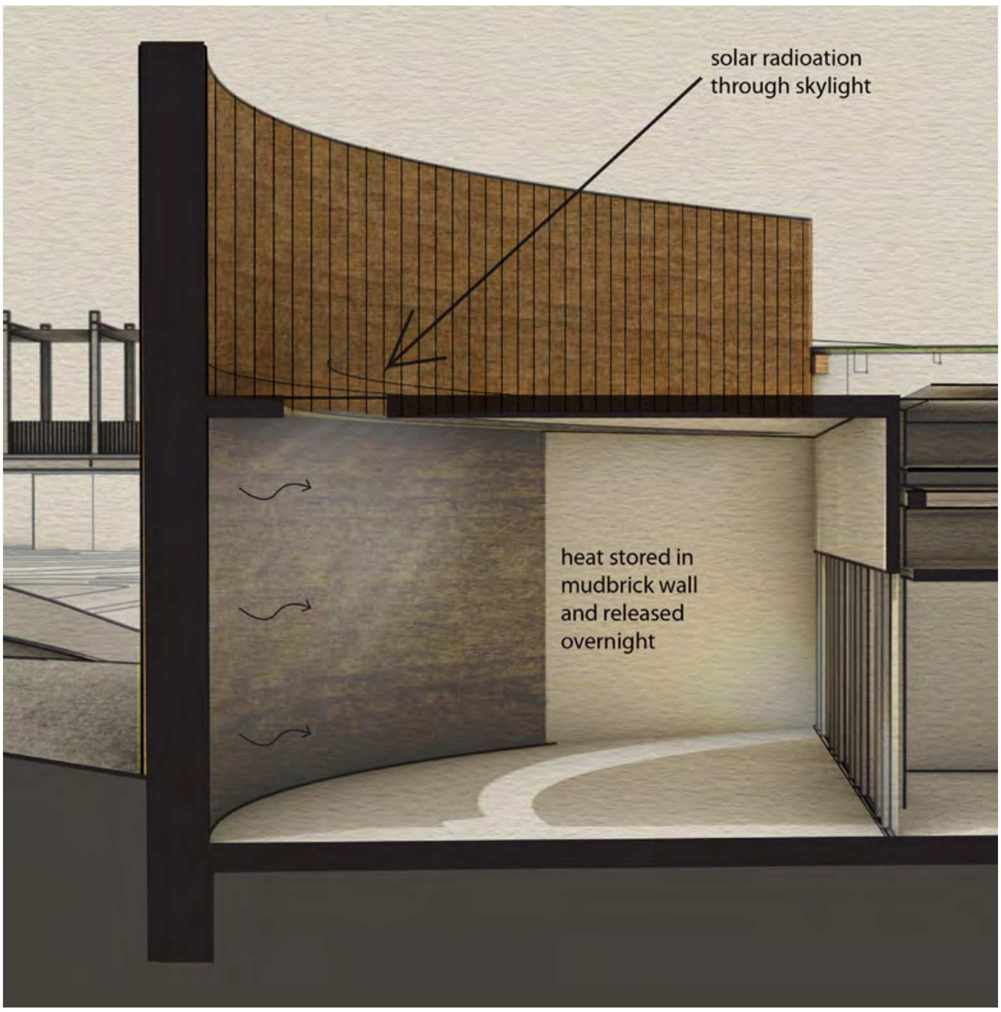
Bioclimatic Features

The building sections show the bioclimatic features of the building additions. This includes elevated openable windows for stack ventilation and north-facing glazing with a roof overhang to allow for solar gain in winter and less solar gain in summer. Skylights allow direct sunlight into the south end of the building, where heavy mudbrick walls store heat, reducing temperature fluctuations and heating and cooling loads (McGee, 2013). Skylights form dynamic light qualities, enhancing the mudbrick's material qualities. The reason for choosing mudbrick walls are their possibility for communities to be involved in their making process. Te Kura Whare, belonging to the people of Tūhoe, is New Zealand's first living certified building (Grohnert, 2015). The construction process allowed the community to be involved in the making process of bricks made from local earth, which line interior walls to regulate the internal climate (Grohnert, 2015). Not only does allowing the community to be involved in the making process inflict a sense of belonging to it, but it also creates opportunities for newly learned skills which might lead to future employment opportunities.

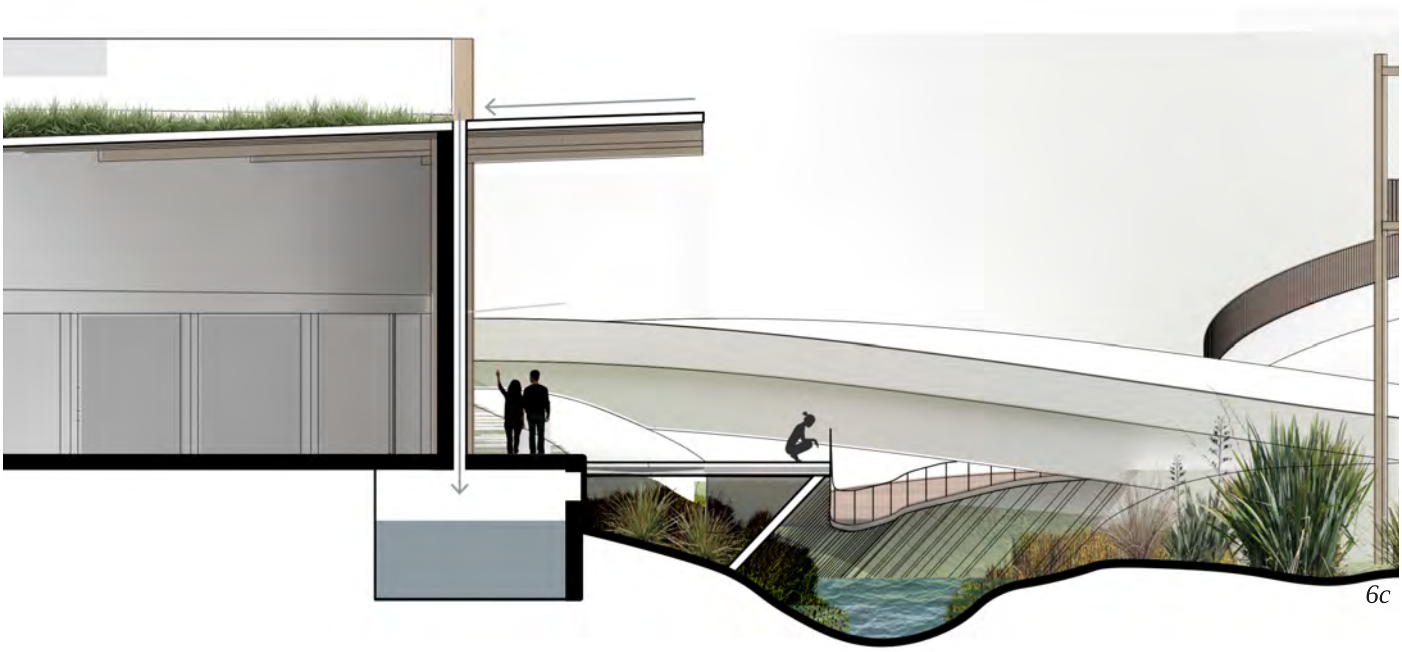
Fig6.20. Te Kura Whare mudbrick laying process.







↑ Fig6.21. Section 6a- offices.
↓ Fig6.22. Section 6b - prayer room.



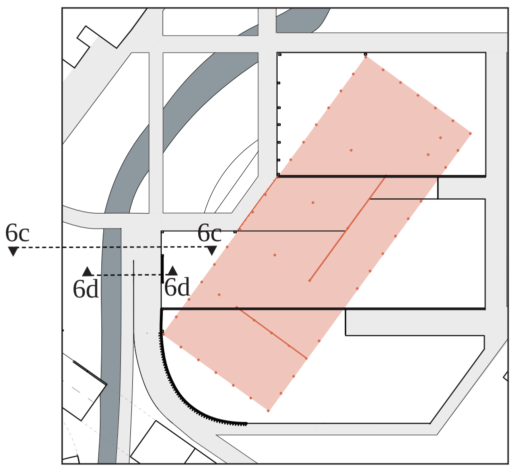
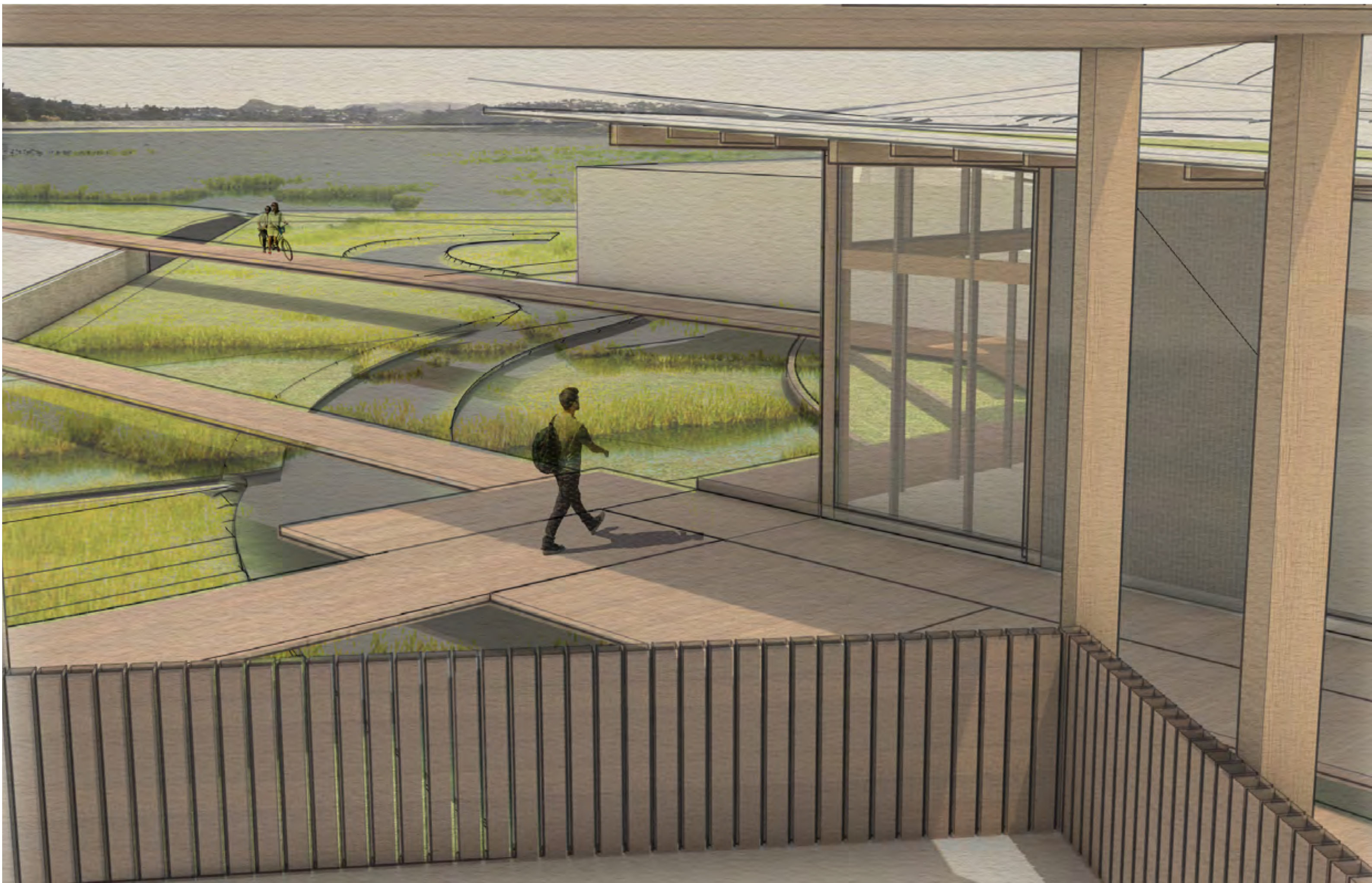


Fig6.23. Section 6c.

Building / Wetland Interface

Sections 6c and 6d show the possible building interface with the wetland stream. This includes rainwater collection and storage underground, with glass downpipes visible to the public eye, becoming a performative element. Elevated paths and platforms allow humans to engage with the wetland habitat without disrupting it.

Fig6.24. Section 6d.



6.5

CRITICAL REFLECTION.

The design work from this chapter was presented and discussed in a design review at the midpoint of this thesis research in August. One of the reviewers asked the question, who is in control? The stream or the intervention? The harsh edges of the building extensions and elevated pathways dominate the softness of the flowing wetland stream. Reflecting on the design process, the formal concept came from reorientating the building to face north. Whilst this has bioclimatic benefits, it has resulted in a very rigid grid plan with qualities oppositional to the dynamic conditions of the neighbouring wetland square. Rather than designing the building as an individual entity, the building should become part of the wetland allowing the qualities to influence the overall building form. Therefore the subsequent design chapter looks at developing the master plan for the civic square as a whole, rather than as separate elements. This way, the wetland square and the components within it will influence each other and become an integrated whole. It is possible to better orient the building without creating harshly defined building edges.

Although elevated walkways create the least disruption to the wetland ecosystem, there should be more opportunities for human interaction with it as currently, they feel disjointed. This will require focusing more on the edge condition of the wetland and building interface. To make decisions on circulation routes and access points of the council building requires a more detailed master plan of the civic square as a whole and the elements within it, and the critical links between them.

↑ *Fig6.25. View of building extension from wetland square.*
↓ *Fig6.26. View of wetland square from the pedestrian overpass.*

7

CHAPTER

Wetland Civic Square

7.1

INTRODUCTION.

This chapter resolves the design of the wetland civic square at the implemented stream's mouth as it enters the harbour. Rather than exploring the square's components separately, this section explores the retrofit civic building, the wetland square, the harbour and its civic features as an integrated whole. The chapter explores the spatial composition of the civic square and council building in plan through the layering of existing grids with new grids. Cultural narratives of place form the exploration of new grid layouts and influence the concepts for the spatial composition of the civic space. These conceptual drawings are then brought to the 3-dimensional realm through physical modelling. The conceptual design outcome then draws from previous chapters' findings to propose a final detailed design of the civic square and its components.

Cultural Narratives

This section explains each narrative that informs the spatial grid layouts, both existing and new.

The coloniser's grid

The existing grid layout of Porirua, as determined by the colonisers' urban development of the city.

Toward the mountain - a new direction

Tohu is one of the Te Aranga design principles, which acknowledges significant places and cultural landmarks (Auckland Council, 2021). Whitireia is the mountain of Ngati Toa, containing several wāhi tapu (sacred sites). Using this cultural landmark to inform the civic square design reinforces a sense of place and identity through celebrating the local cultural context.

A stone in the stream - a radial grid

The civic square is the heart of the city and the centre of wellbeing for the community. It is a pivotal point of change for Porirua. The civic space's centre becomes the middle point of a radial grid, like a stone thrown into the new wetland stream and its ripples affecting the surrounding city.

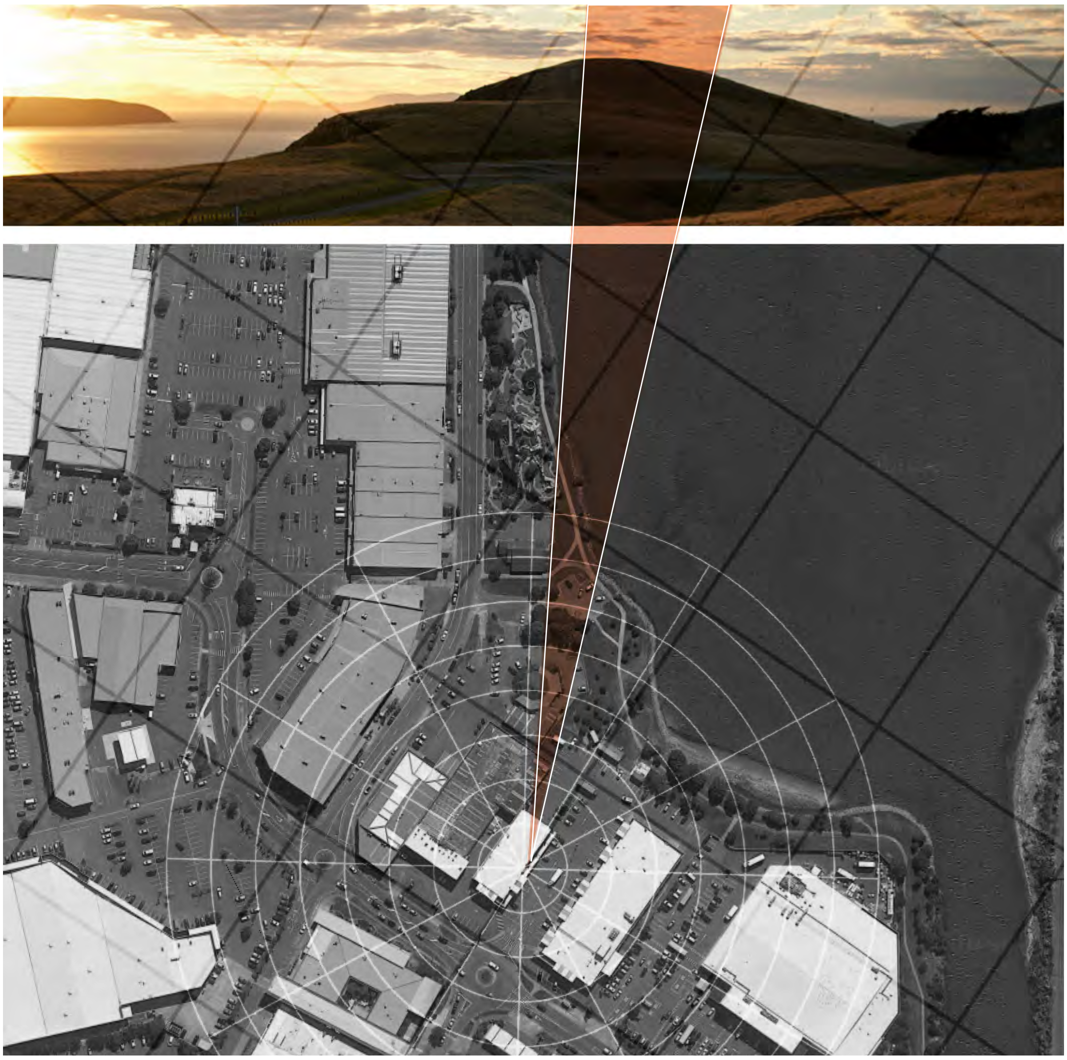
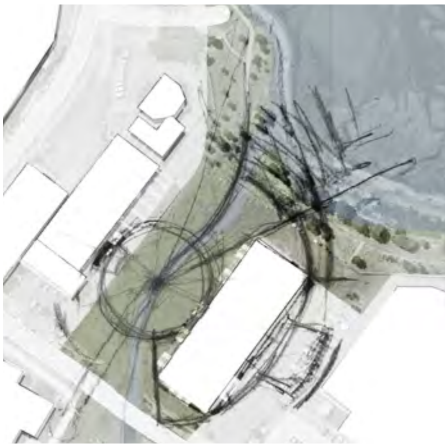


Fig7.1. Graphic representation of the cultural narratives informing the civic square design.

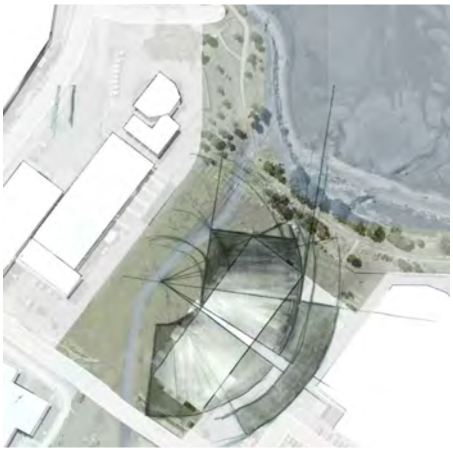
7.2

CULTURAL NARRATIVES.

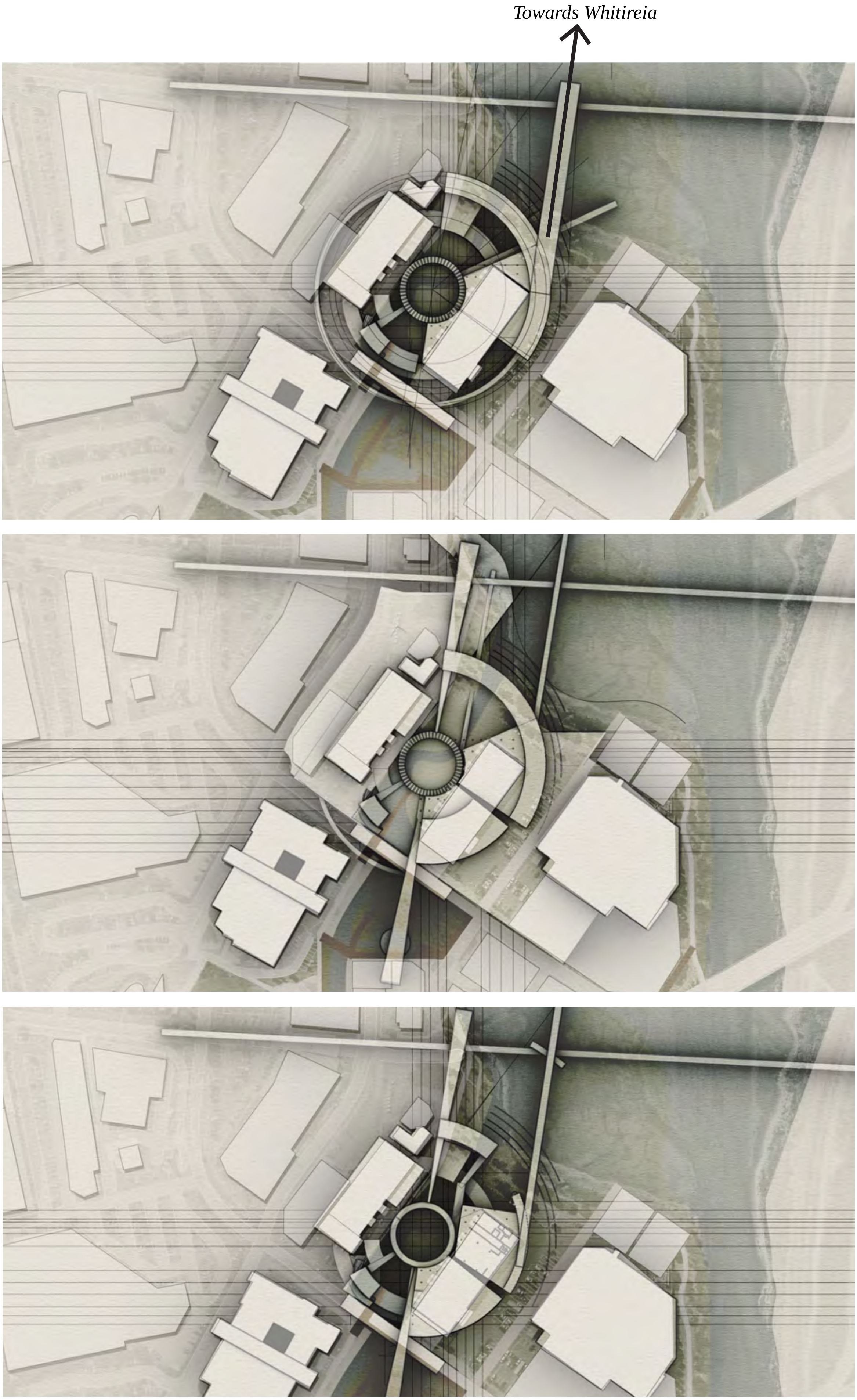


Radial Grid Exploration

The centre of the civic square became a point of rotation for the next design moves. The slicing of the existing building becomes a way of breaking the existing coloniser grid. This slice is removed and rotated toward Whitireia, leaving traces of movement in the landscape.



Ideas from ‘The Groves of Life’ suggest to be genuinely humble in our use of the world, we should have areas that we simply leave untouched by humans, allowing these areas to influence us rather than the other way around (Park, 1995, p. 302). The radial grid’s central zone becomes a space for wild nature, forcing humans to walk around rather than directly through the square giving power to nature over humans.



← Fig7.2. Hand sketches iterations of radial grid exploration.
→ Fig7.3. Radial grid digital design iterations.


Towards Whitireia

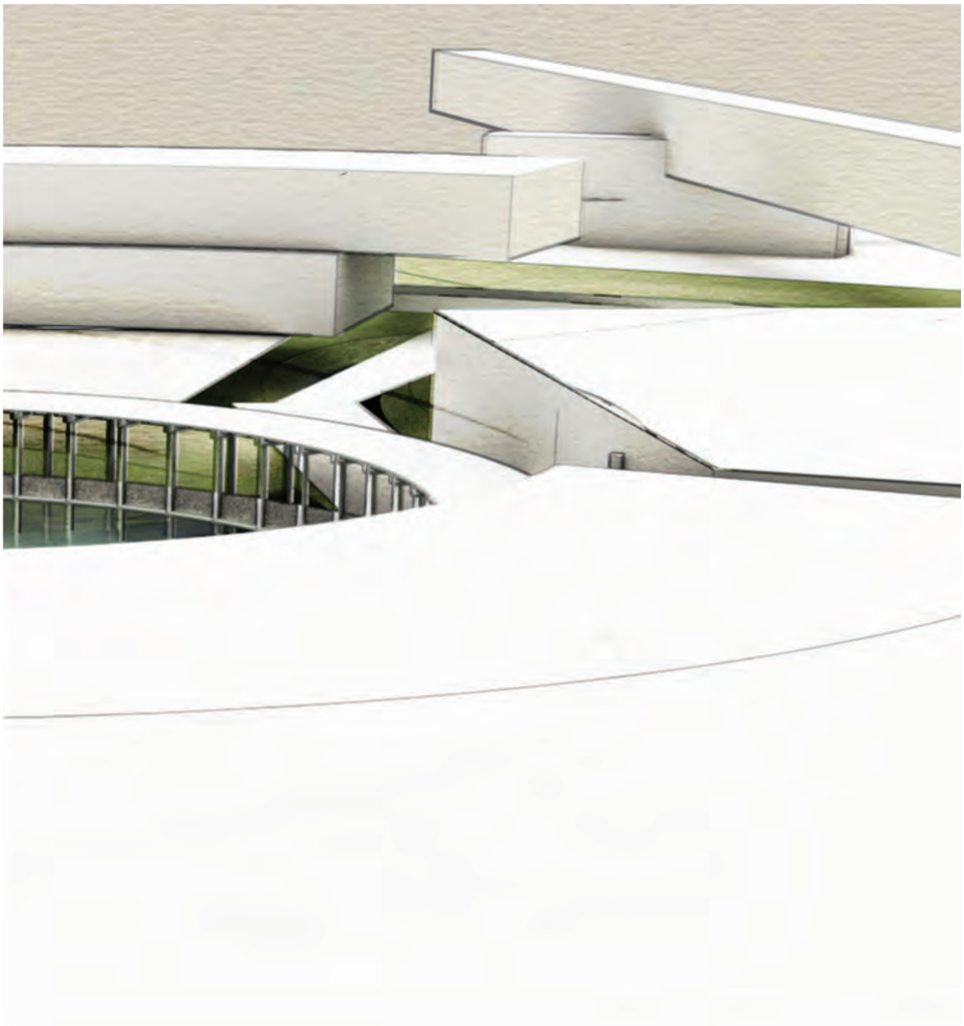


Fig7.4. Radial grid civic square concept image.

Reflection

The radial grid emphasises a singular point of the overall scheme, requiring something of great importance to be at the centre point. Because each civic space component is of equal importance, the exploration shifted from the radial grid to an investigation of points, lines and surfaces.

A series of sketch models brought these points, lines and surfaces to the three-dimensional realm, analysing how they become linking pathways, bridges and buildings.

points, lines and surfaces

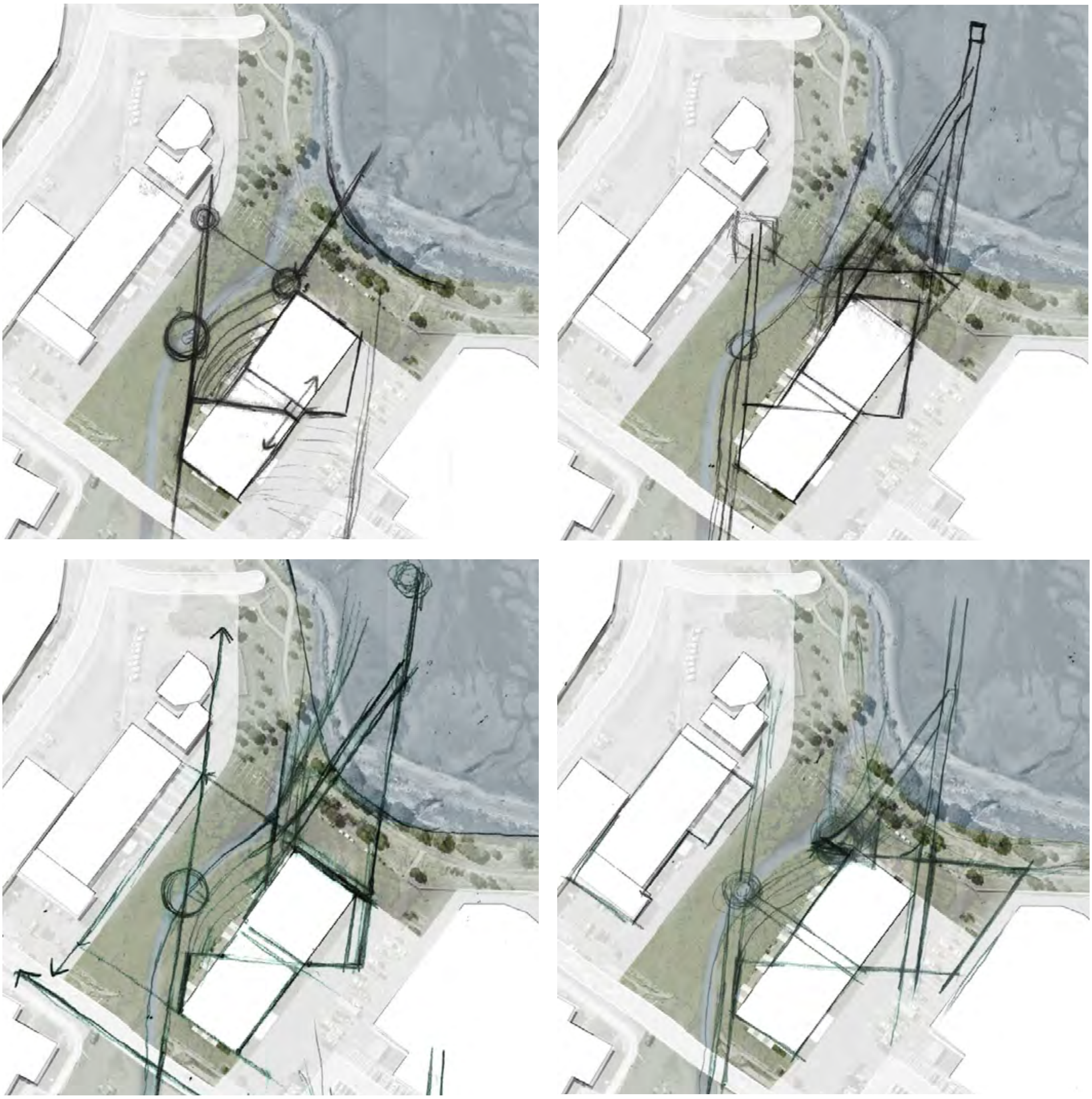
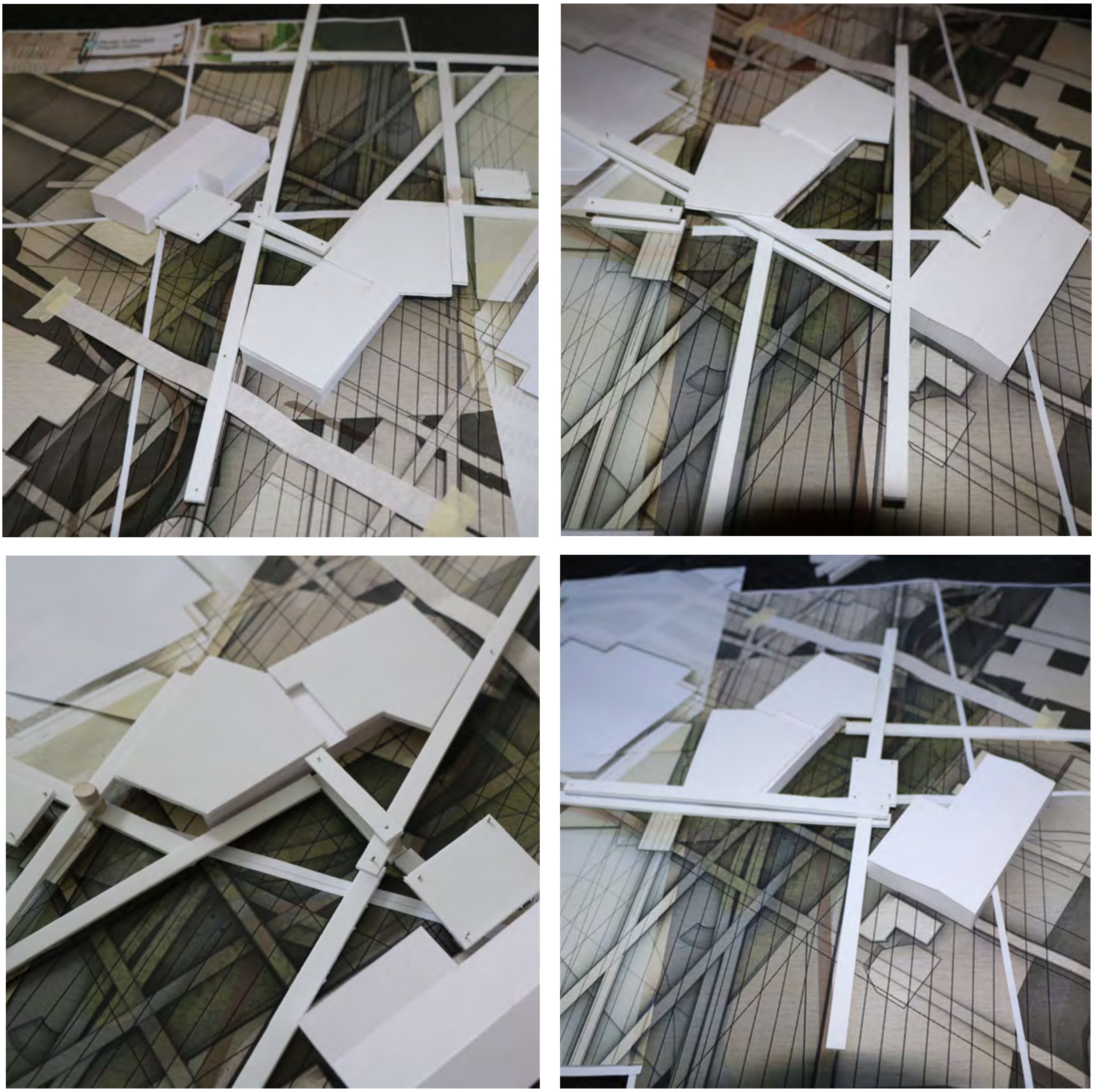


Fig7.5. Sketch iterations of points, lines and surfaces.



A series of sketch models brought these points, lines and surfaces to the three-dimensional realm, analysing how they become linking pathways, bridges and buildings.

Fig7.6. Photographed physical sketch models.

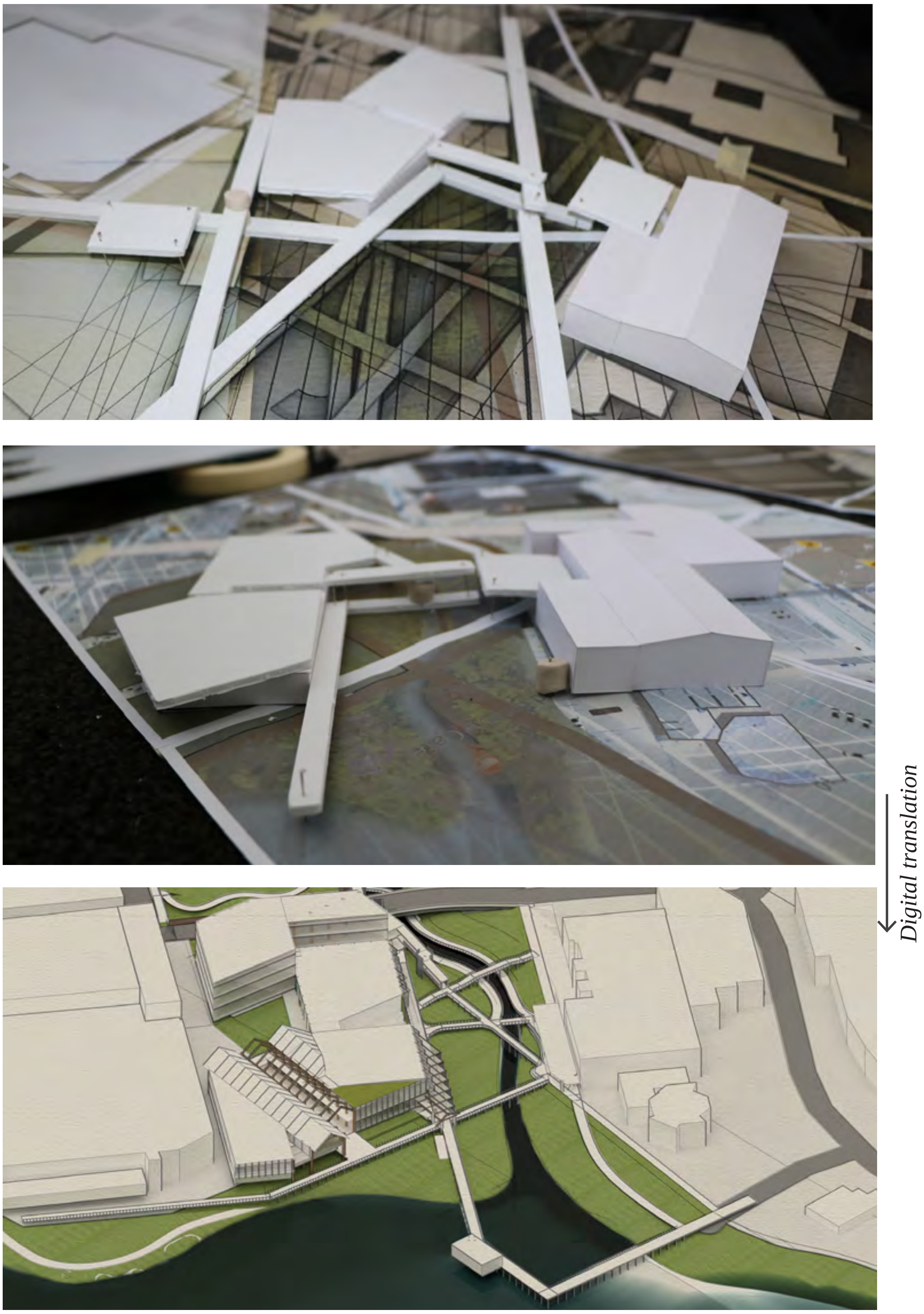


Fig7.7. Physical to digital model translation.

The three major components of the civic square are the PCC building, the pavilion, and the pier. The pavilion was a necessary addition to frame the civic square, encourage movement across the stream and provide a covered space for civic activity opposite the PCC building. The pier intends to blur the edge where the city and harbour meet further by extending a primary pathway of the civic square into the water.

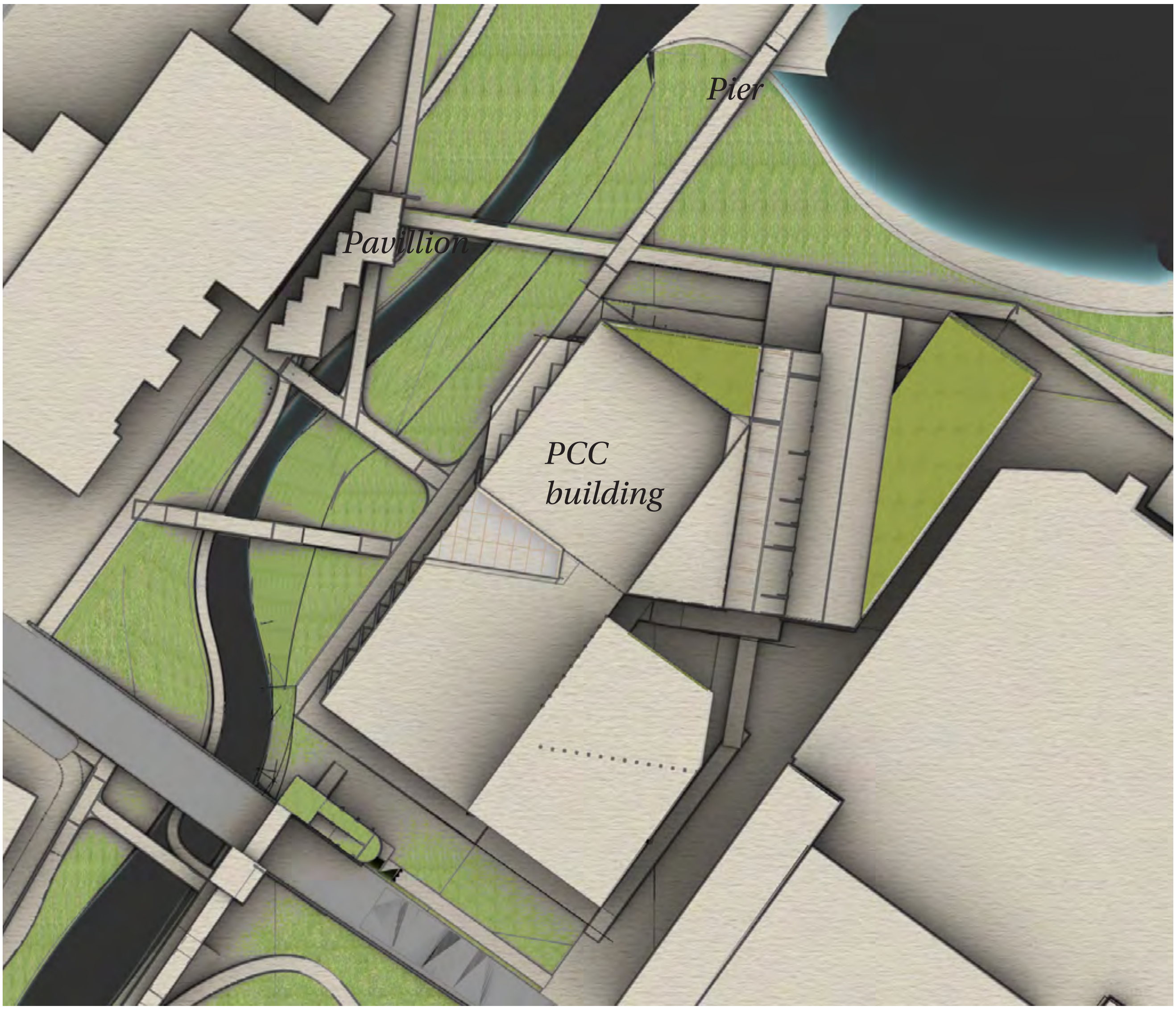


Fig7.8. Conceptual civic square masterplan and labelled components.

The PCC Building

The proposed ground floor plan for the PCC building contains a series of linking atrium courtyards. The atriums are public spaces intended to be used for indoor civic gatherings and the central circulation for the building occupants. The longer atrium, looking out onto the harbour, hosts indoor markets when they cannot be outside due to weather conditions. A community garden and bicycle parking are located near the atrium's south entrance.

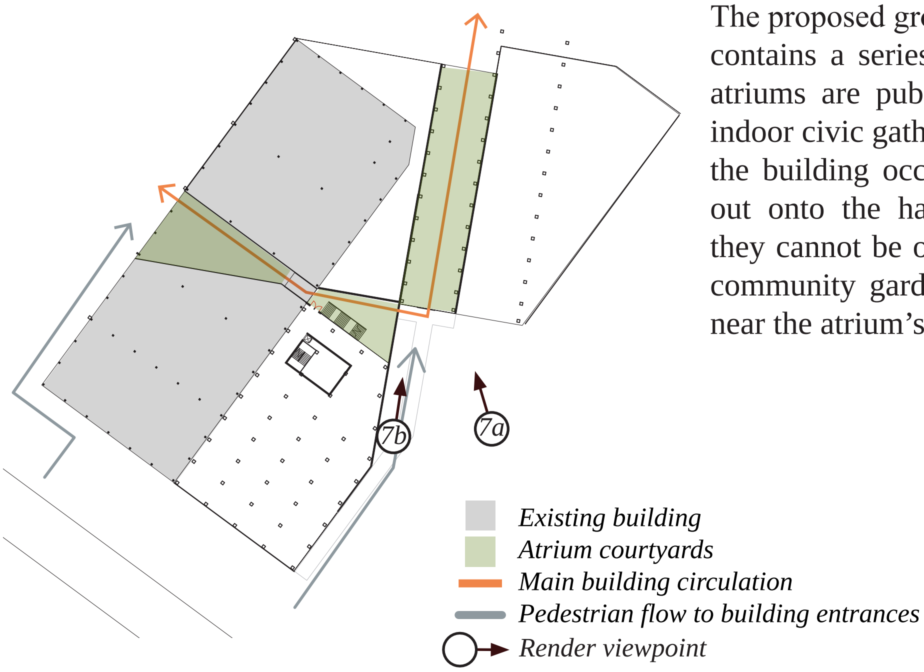


Fig7.9. PCC conceptual ground floor plan.

Fig7.10. View 7a - South facing facade.

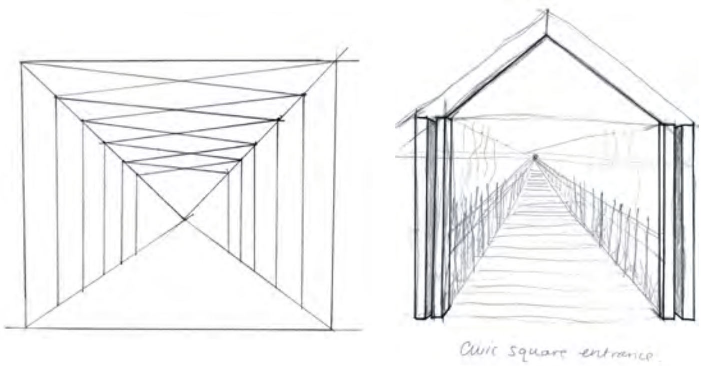
Fig7.11. Exposed timber framing on building interior.

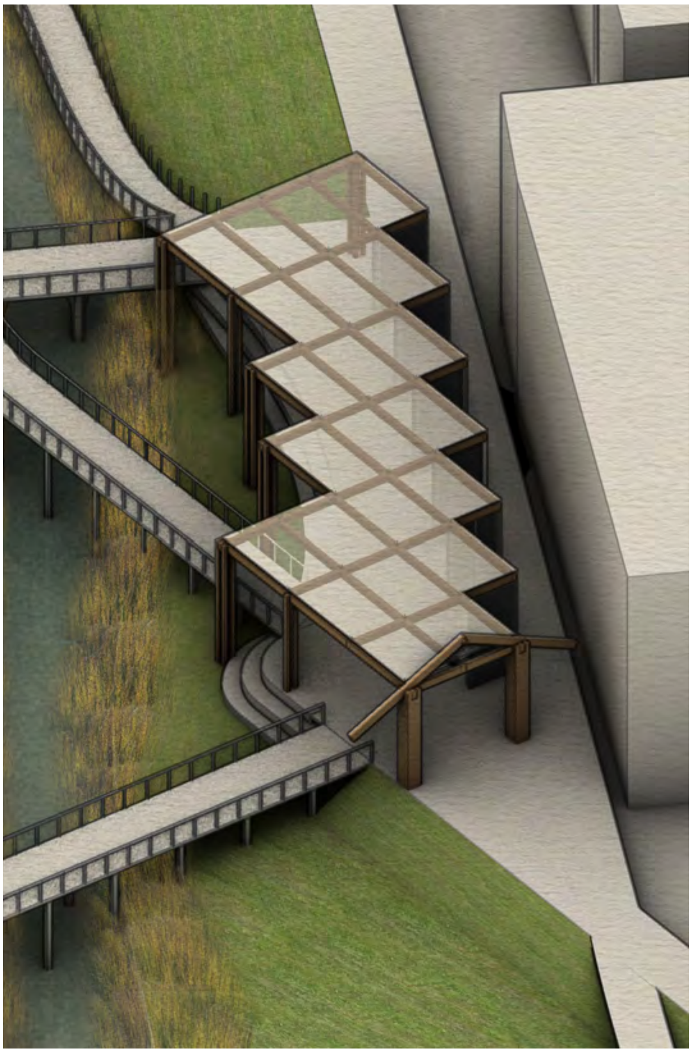
Fig7.12. View 7b- community gardens outside long atrium entrance.

The Pavilion

Response to climate was a key design driver for the pavilion. This space intends to provide a heightened experience of the climatic conditions through the architecture. Timber slat windscreens protect gathering space from prevailing northerly winds, producing significant variations in airflow between areas of protection and areas exposed to wind. The roof shelter is a timber waffle structure, meeting the quad timber column through slotted joinery, making the components deconstructable.

The glazed roof sits on top of the timber structure, attached by pronged steel members. Exposed to direct sunlight, the roof structure will form dynamic light qualities on the ground. In wet conditions, the water residue on the glazing will project attractive water refracted patterns. Stepped areas allow the public to get closer to the wetland stream.



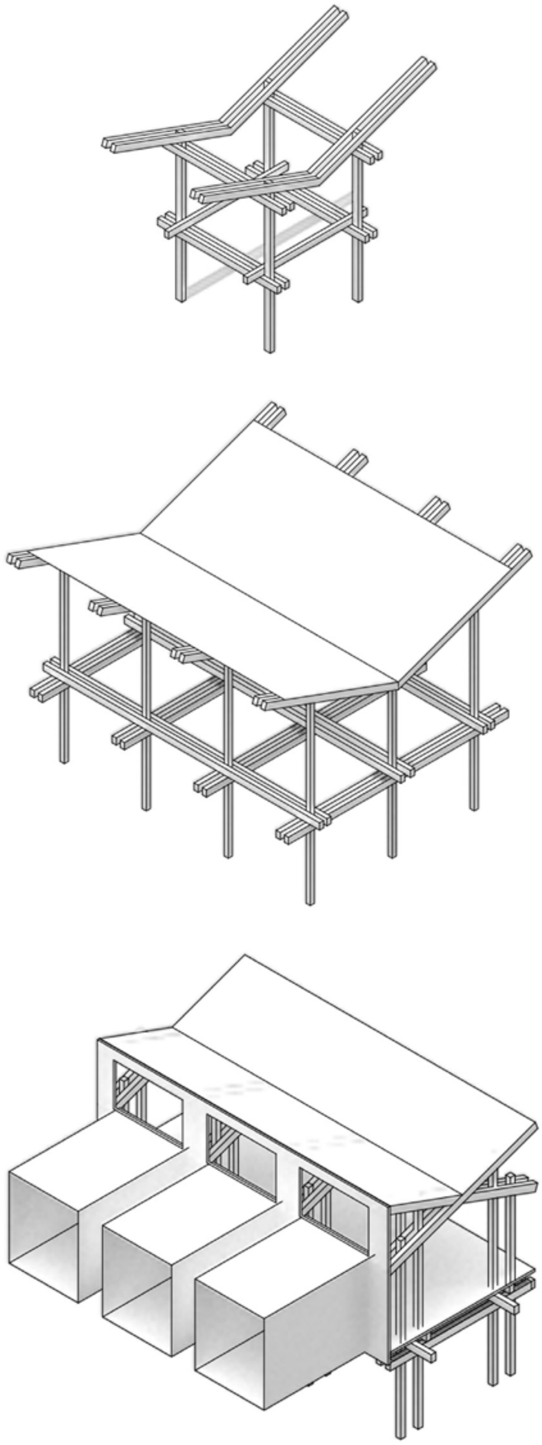


← Fig7.13. Conceptual sketches for the pavilion experience.
↑ Fig7.14. Isometric view of the pavilion.

Fig7.15. Perspective view of the pavilion looking towards the harbour.

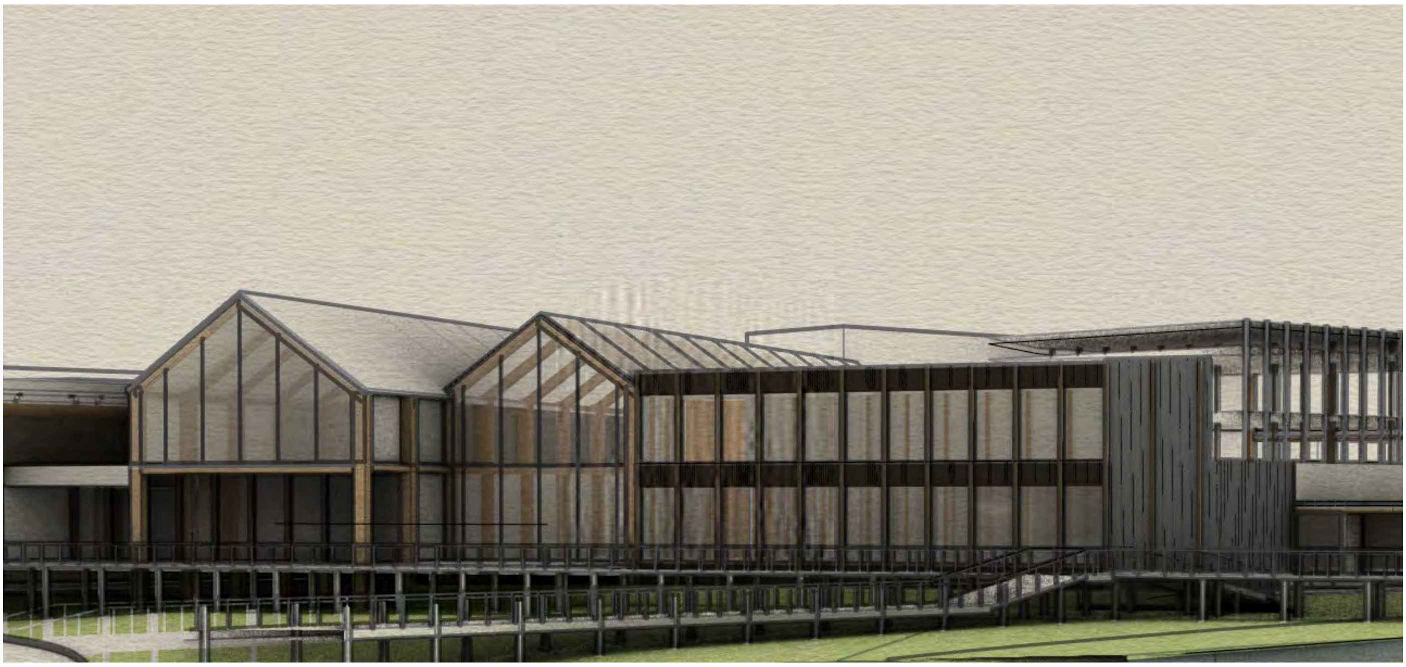
The Pier

The pier building is a sheltered space on the harbour, allowing a physical connection of people to the water. The structural form came from adopting structures from the modular timber exploration in chapter 5. Cubicals overhang the edge creating a sense of risk and spaces to stop – a perfect spot for fishing. The structure floats, with sliding members attached to anchoring piles, allowing close engagement with the water during fluctuating water levels.



← Fig7.16. Isometric render of the pier building.
→ Fig7.17. Isometric illustration of the structural components of pier building.

Fig7.18. Looking back from the pier towards the new waterfront-facing facade of the PCC building.



Timber structure is used in the atrium cut-outs of the existing building and overhead shelters added to the existing building edge.

Fig7.19. Concept images of digitalised civic square and PCC building.

Reflection

After critically analysing the design, it was clear that the civic square's landscaping elements needed a more detailed investigation to discover how humans might occupy the space through various civic activities such as Waitangi Day celebrations, music concerts or outdoor markets. Currently, the connecting bridges across the stream successfully link the components of the square; however, because they are elevated to a height of 1000mm on piles, people cannot access the wetlands below from there. In developing the final concept, the design enquiry focuses on the structures' edge conditions, which might slope or step down to the lower wetland spaces. Although this might make these spaces susceptible to flooding, if they are designed with suitable materials, they can be quickly replenished post flood. Doing so shifts the eye level of the public from above the wetlands, to the same level as the wetland's plantings therefore are surrounded by the landscape rather than walking above it.

7.3

FINAL DEVELOPED DESIGN.

This concluding section presents the final design outcomes of this research. Included is the final urban master plan for Porirua, transformed into a biophilic city as an urban scale response to climate change and urbanisation. Within this urban plan, the Wetland Civic Square and its components are shown in detail through detailed drawings and renders.

The Pier.

Wetland Civic Square hosting the PCC building and the pavilion.

Wetland Civic Square link.

Wetland park.

New and old city intersection (see chapter 5.4).

CBD pedestrian link (see chapter 5.4).

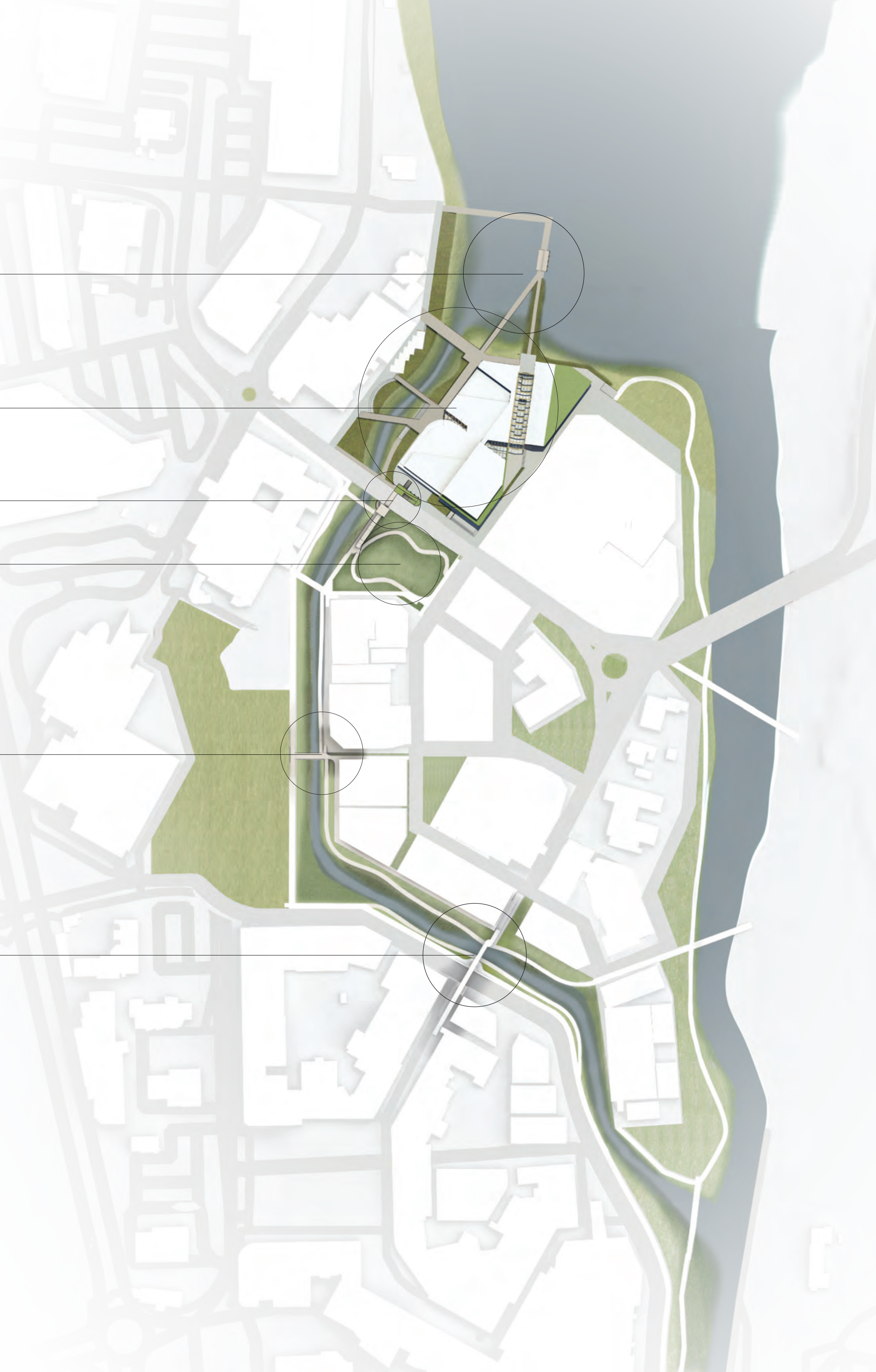


Fig7.20. Masterplan of the final urban scheme.

Wetland Civic Square Masterplan

During civic events, the community is immersed in ecology. The wetland stream runs down the centre of the civic square, which can be crossed via four separate bridges. The PCC building occupies one edge of the square. Across the stream, on the opposing edge, lies the pavilion, amphitheatre and several sloped grass banks. These areas are spaces for the public to congregate and overlook the PCC building entrance platform, which becomes a performance stage during civic events. The wetland ecology becomes part of the performance foreground.

Fig7.21. Perspective view of a music concert performing on the PCC building entrance platform and viewed from the amphitheatre.

Pier building.

Built up land mass.

Living shoreline.

Stream mouth crossing.

Pavilion.

Amphitheatre.

Grass bank.

PCC building entrance platform.

Wetland plantings.

Pedestrian overpass access ramp.

Pedestrian overpass.

Stream crossing.

Pedestrian overpass access ramp.

Wetland park.

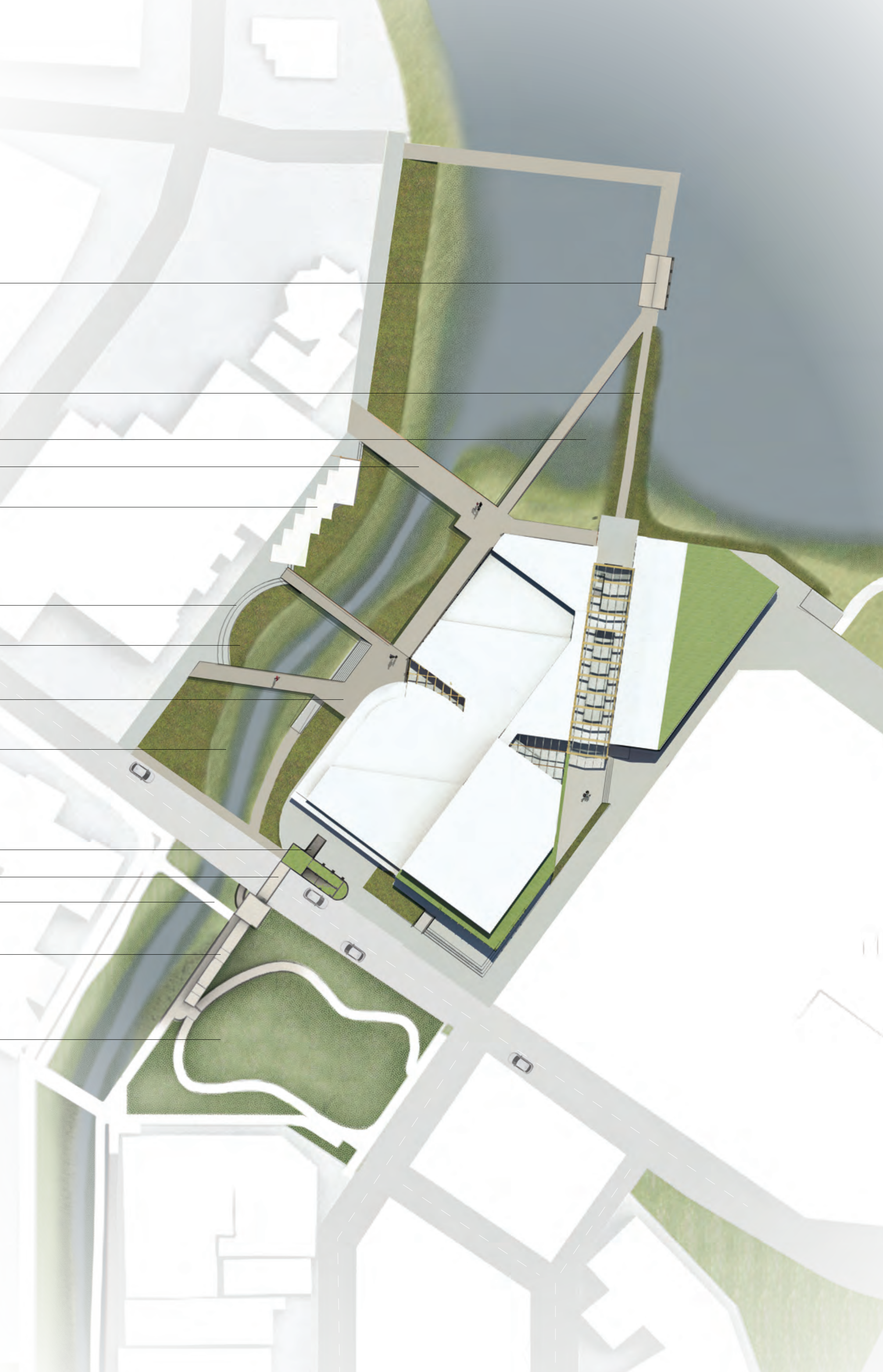


Fig7.22. Masterplan of the Wetland Civic Square.

Fig7.23. Interior view of space 11- events room for council chambers and community groups.

Space 11 is an adaptable room located at the north corner of the building overlooking the wetland square and the harbour. The difference in floor height between the existing structure and new additions creates a dynamic interior space with split levels.

The openness of the space represents the transparent governance of the local council. The shared nature of the room for both important council meetings and charity community groups meetings challenges the hierarchical separation of members of the community.

The building plan addresses the programmatic requirements established in Section 6.2 of Chapter 6. Each level has an allocated prayer room. The central core contains an accessible toilet with a shower on every floor level and an adjacent mudroom for any storage of clothes used for off-site activity. Childcare facilities are located in space 13 on the ground floor, overlooking the harbour.

The long atrium becomes a new interior thoroughfare for the public to access the waterfront and provides space for weekly markets indoors when necessary. Space 14, at the buildings south corner, is a café, activating the building edge. The office spaces are open plan, adaptable for any potential future changes in programmatic use.

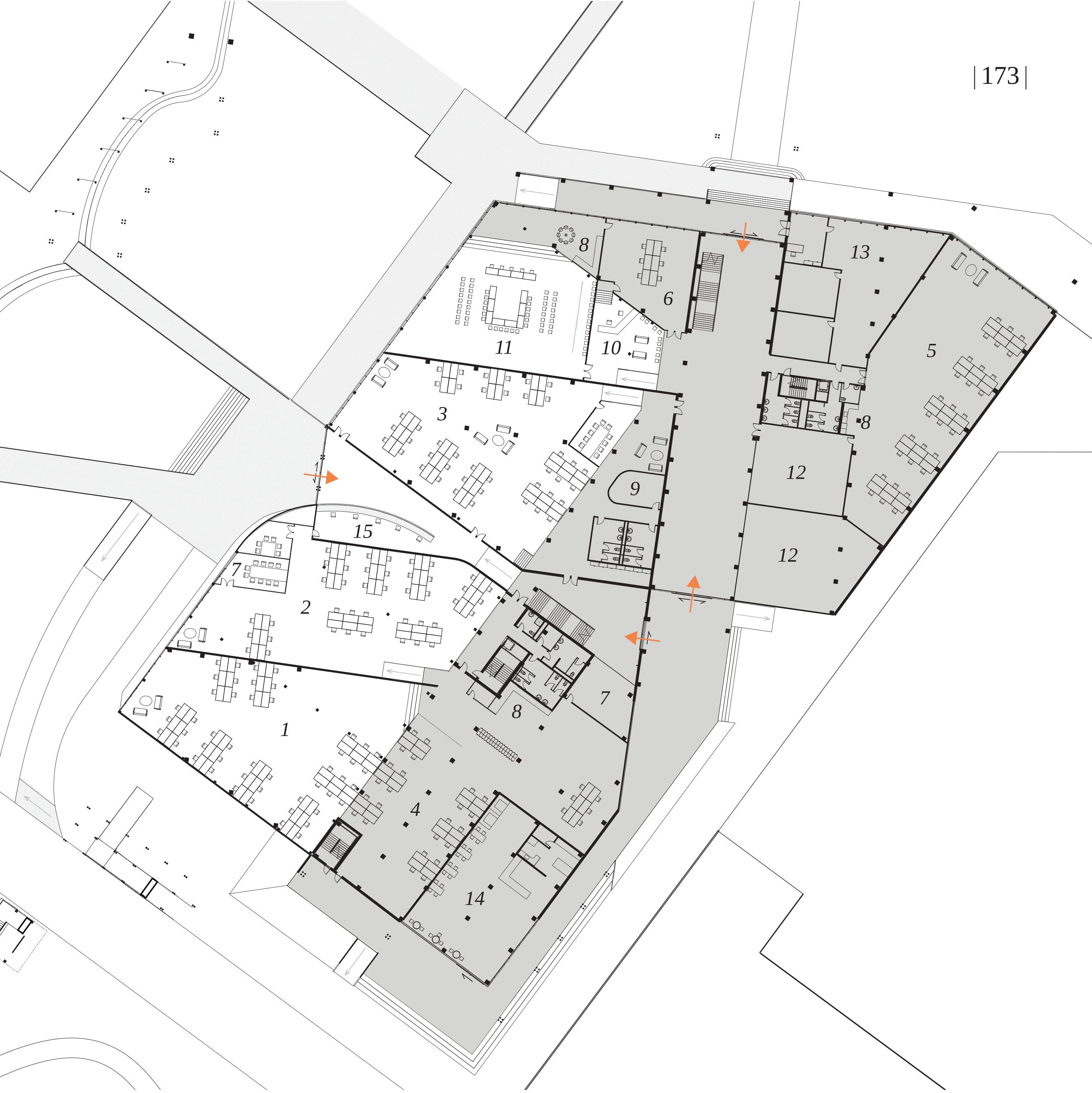


Fig7.24. Ground floor plan of PCC building.

PCC Building Ground Floor Plan

1- Office (business tech group)
2- Office (building assurance and risk assurance)
3- Office (environment and city planning)
4- Office (monitoring and compliance)
5- Office (resource consents and monitoring)
6- Office (corporate support)
7- Meeting room
8- Kitchen
9- Prayer room
10- Council chambers reception and waiting room
11- Events room for council chambers and community groups
12- Open exhibition space or meeting rooms
13- Childcare
14- Cafe
15- Main reception

Building addition floor area raised +1000mm above existing building

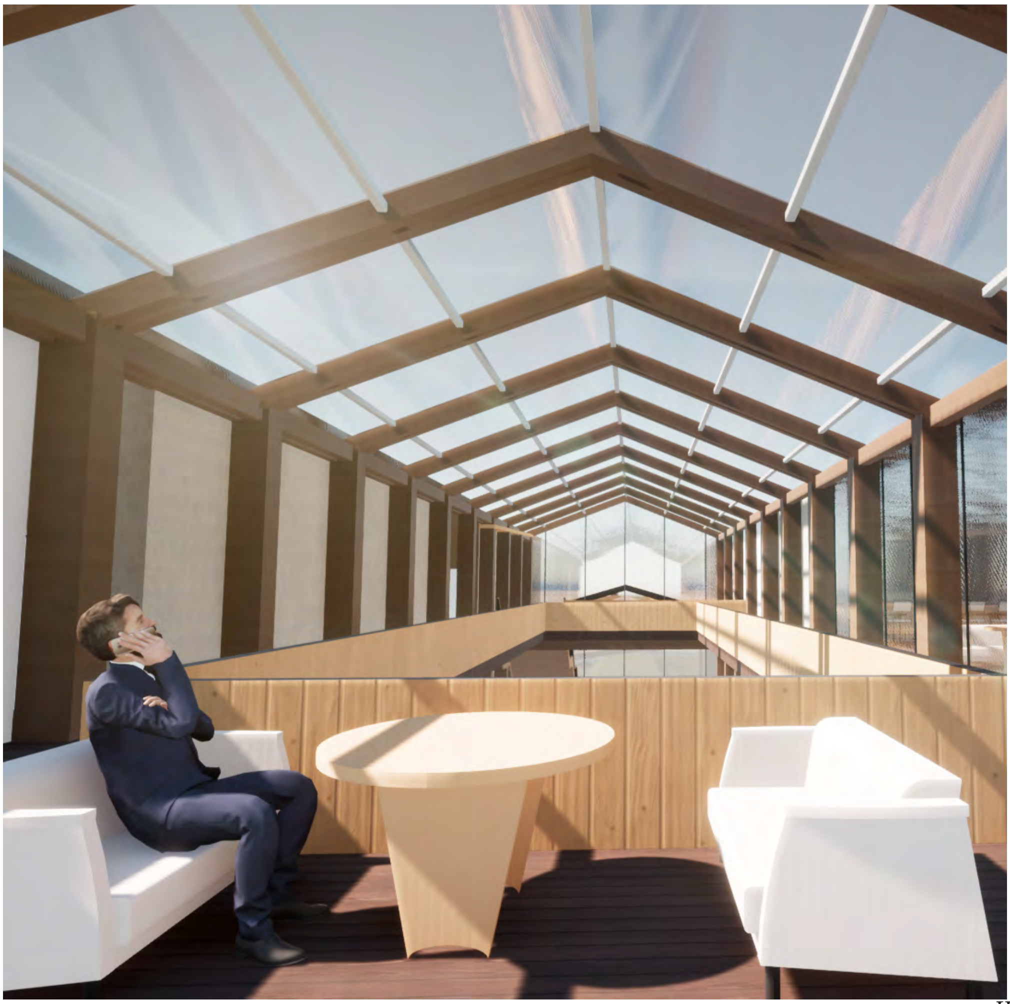
Ramp down direction

Main building entrances

Fig7.25. Level 1 floor plan of PCC building.

PCC Building Level 1 Floor Plan

1- Office (regulatory, commercial analysis, strategy & policy and policy, planning & regulatory services management)
2- Office (city partnerships / commercial & development / city growth & partnership management and property)
3- Office (communications & marketing)
4- Office (people and capability)
5- Meeting room
6- Prayer Room



↑ Fig7.26. Level 2 circulation space.
↓ Fig7.27. Long atrium from level 2 balcony.

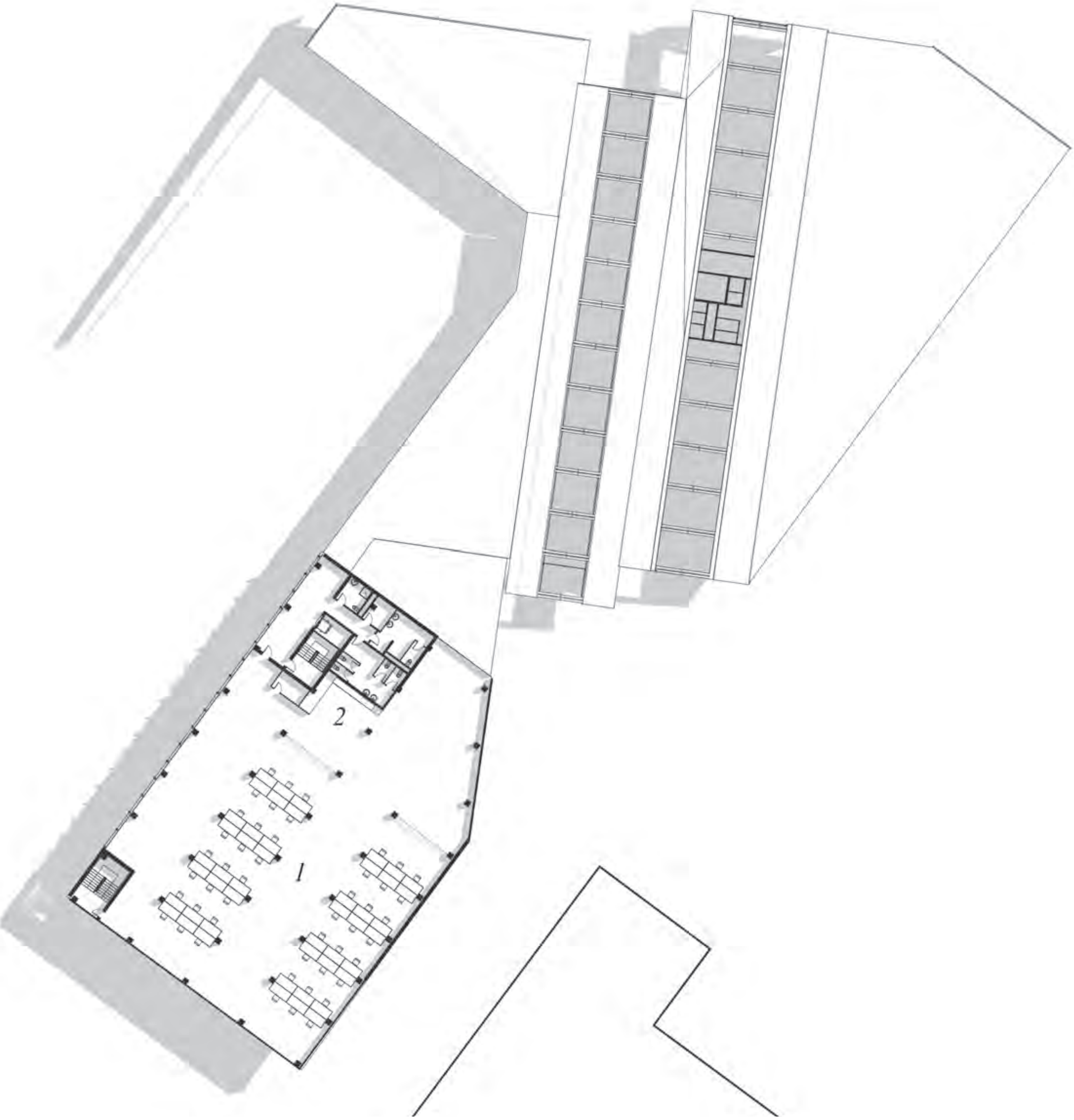


Fig7.28. Level 2 floor plan of PCC building.

PCC Building Level 2 Floor Plan

1- Office (finance)
2- Kitchen

Fig7.29. Level 3 Office interior.

Fig7.30. Level 2 Office 2 interior with exposed timber waffle slab.

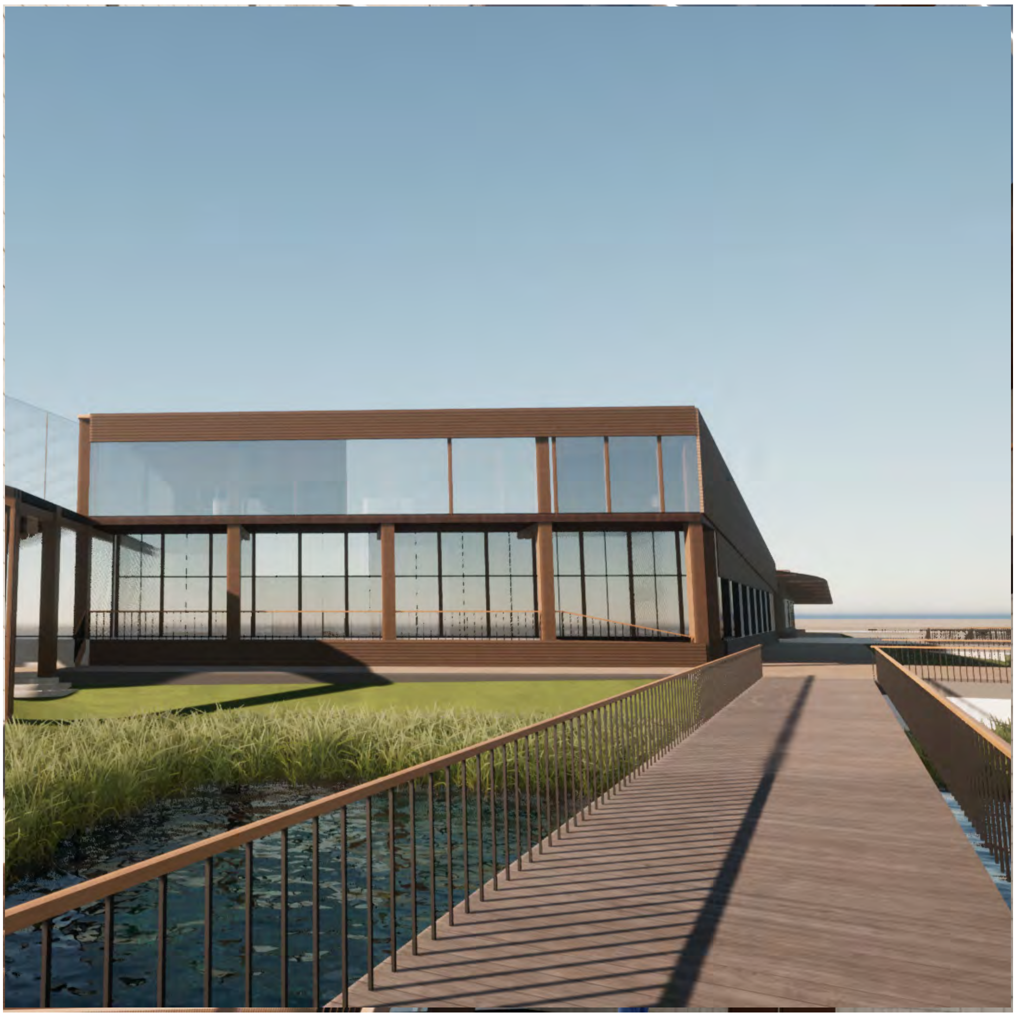
Areas of pause
Linking pathways
Linking pathways (higher elevation)
Services lane

This diagram shows the gathering areas of the square where the public might congregate, pause, meet others. These include several sloping grass banks which at the streams edge. Steps allow access to the wetland below, also providing seating overlooking the wetland.

Fig7.31. Civic square circulation diagram.

Fig7.32. View 7c of PCC building south extension with cafe on the corner ground level.

This image displays the designed edge condition to navigate the difference in height between the new structure, which is +1000mm above the existing ground plane. Techniques used include grass banks, steps and accessible ramps.



↑ *Fig7.33. View 7d*
↓ *Fig7.34. View 7e*

Fig7.35. Isometric plan showing main building entrances and buildings edge condition.

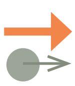


Fig7.36. Indicative plan of section 7a and view 7f.

The section cut 7a (Fig7.38) is at the axis created through the cultural narrative 'Towards the Mountain', facing slightly off north to face Whitireia. A sense of wonder is created through a long view shaft which is continuously framed through the architecture as people journey through space towards the harbour.
The pier building frames the view towards Whitireia (Fig7.37). It can be accessed through the raised section of ground extending into the harbour, as well as the kinetic piers.

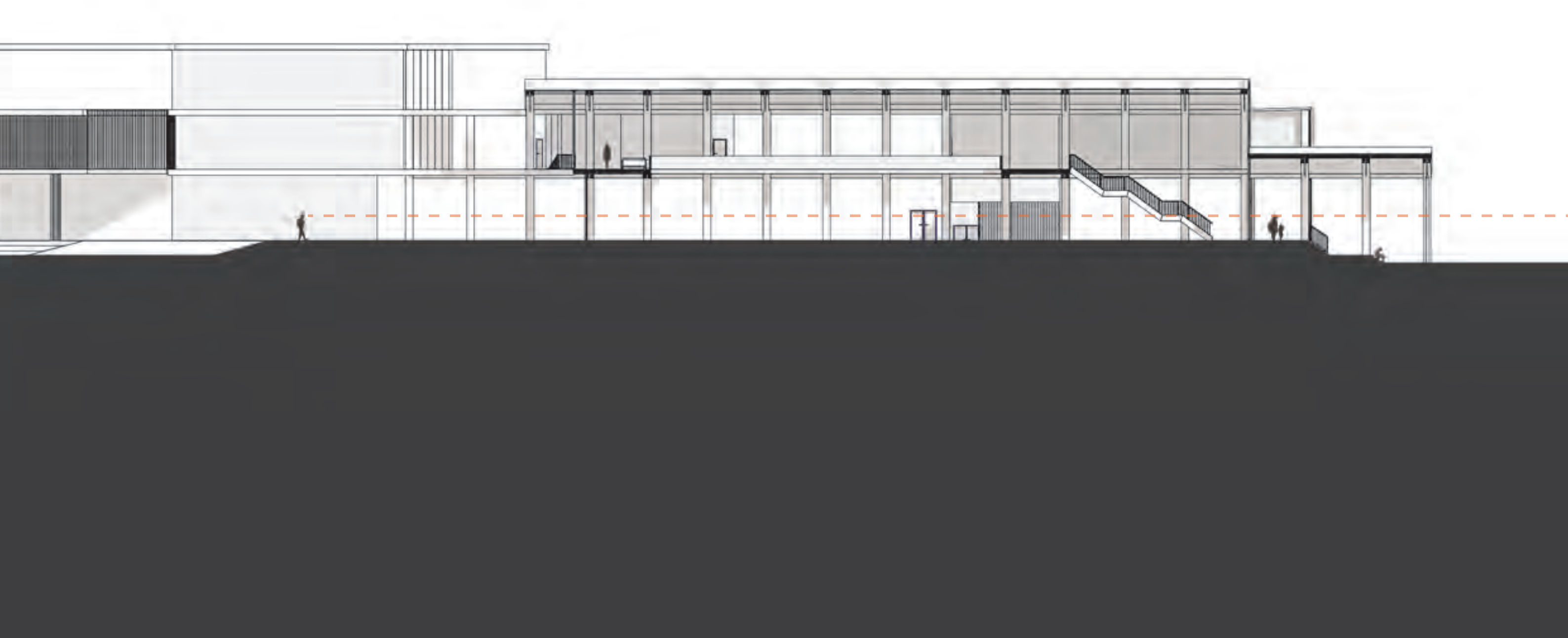


Fig7.37. View 7f - Looking towards Whitireia from the built-up ground extending into the harbour from the long atrium.

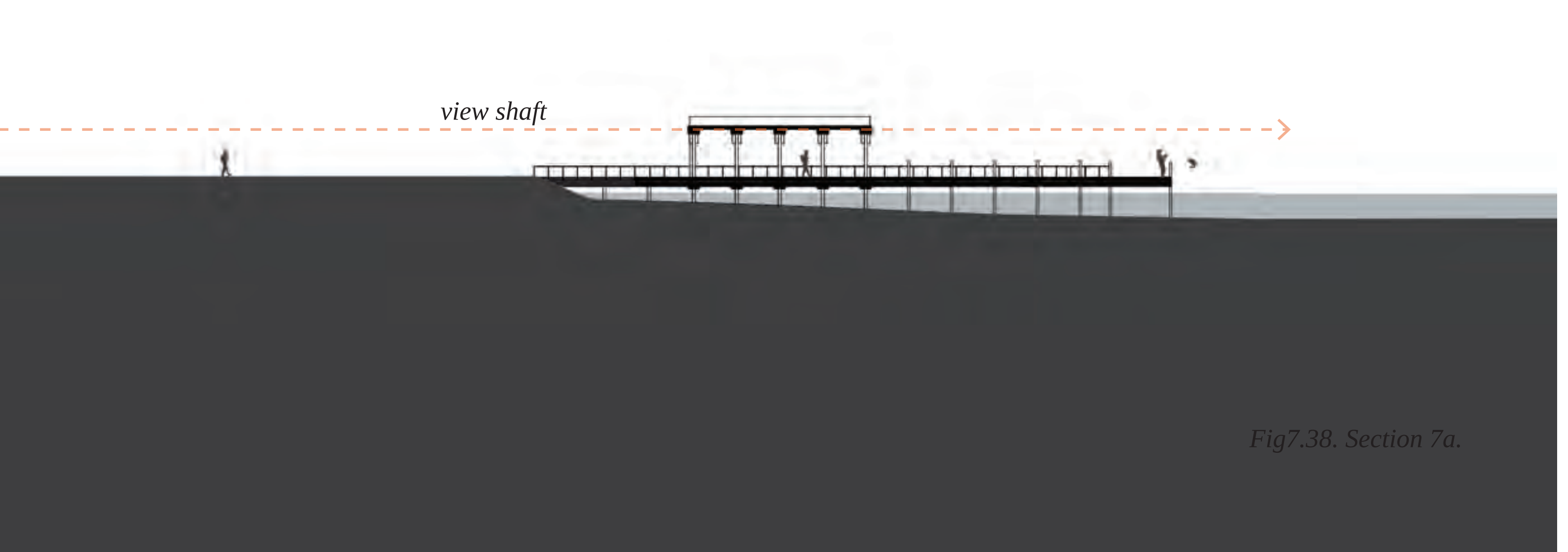
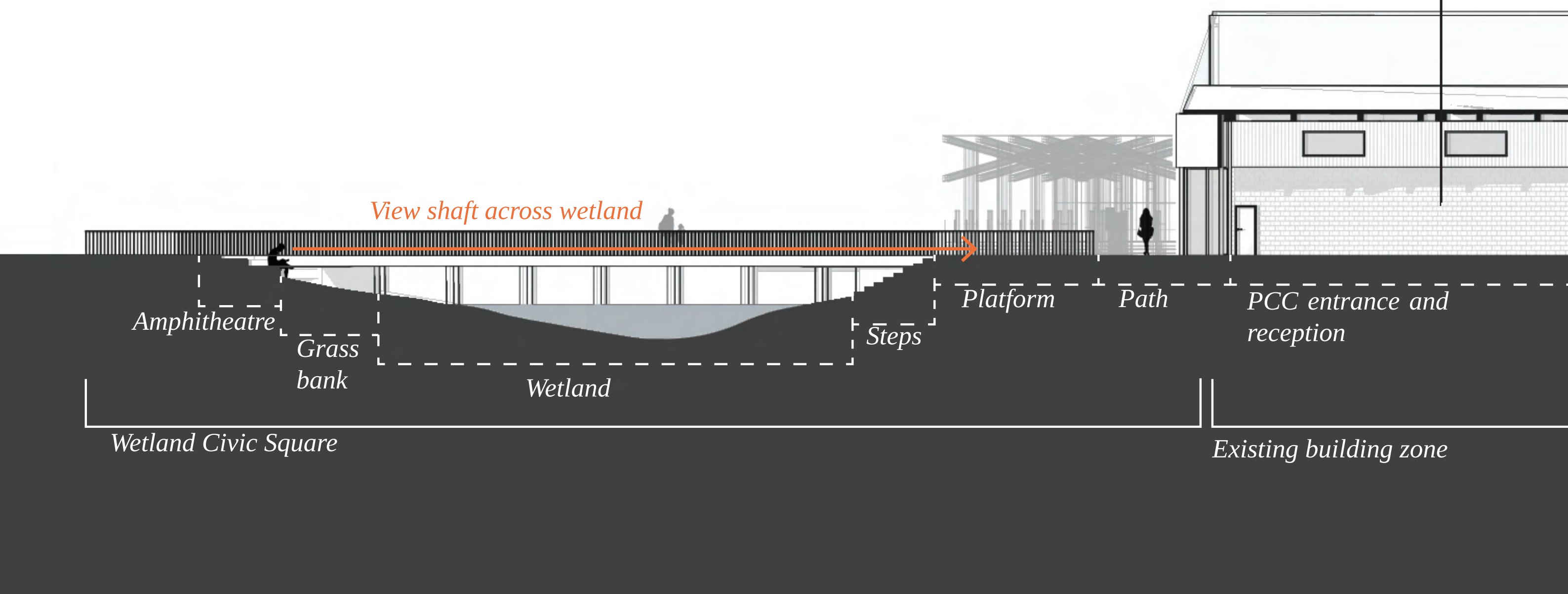


Fig7.38. Section 7a.

Fig 7.39. Indicative floor plan of section 7b.

Fig 7.40. Civic square atrium interior showing main reception.



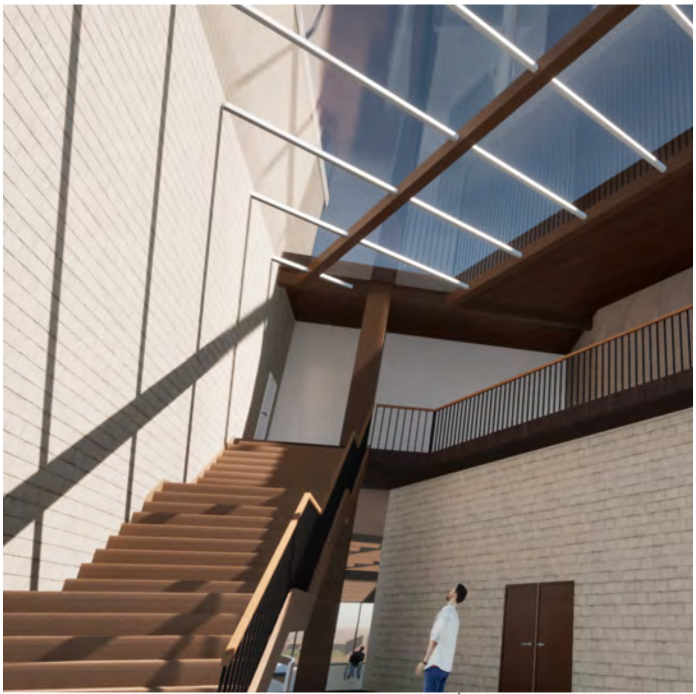


Fig7.41. South atrium interior view.

The existing building's cut-outs creating atrium spaces with glazed roofs are strengthened with additional timber structure (Fig7.40). A double-height atrium in the extension of the building brings daylight into the south wing (Fig7.41).
Section cut 7b shows the internal ramp connecting the existing building zone to the new building extensions elevated +1000mm above the existing ground floor level.

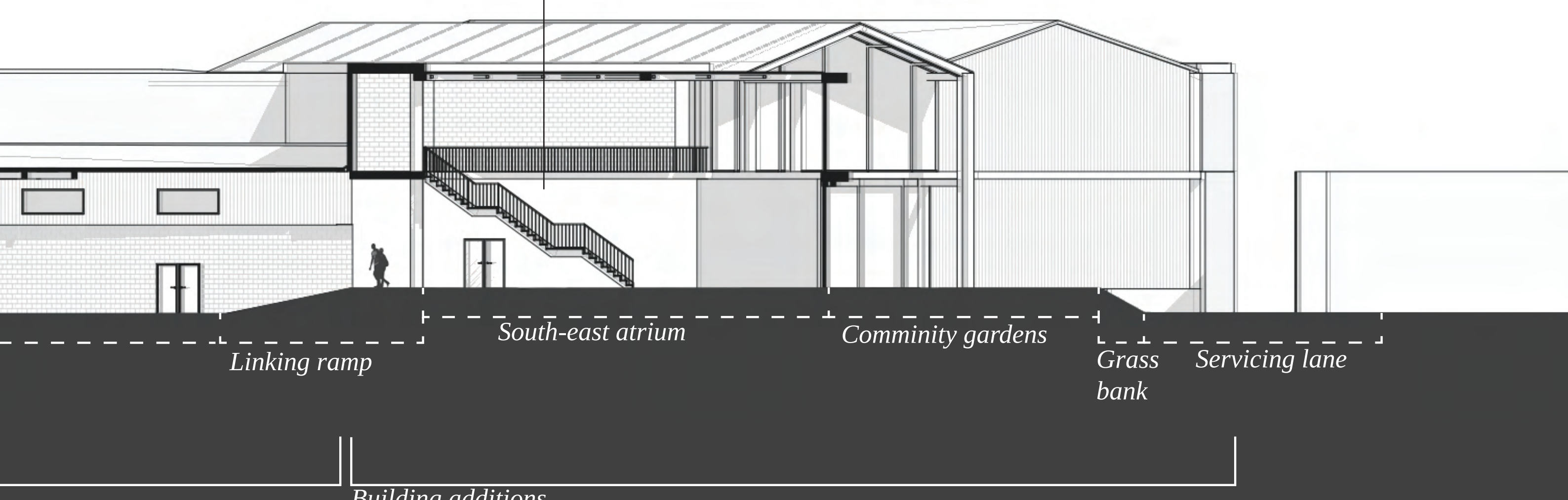


Fig7.42. Section 7b.

Fig7.43. View from the amphitheatre across the wetland stream.

Fig7.45. View 7g - lowest pathway in civic square normal function.

Fig7.46. View 7g - lowest pathway in the civic square during a 1 in 100-year flood.

View from lowest pathway in the civic square. During a 1 in 100-year event flood the pathway submerges under water, however pathways of higher elevations remain and maintain essential circulation routes.

Fig7.44. Indicative floor plan of view 7b location.

The quad columns used in the pavilion structure are carried through into the pedestrian coverings extending from the PCC building into the surrounding landscape.

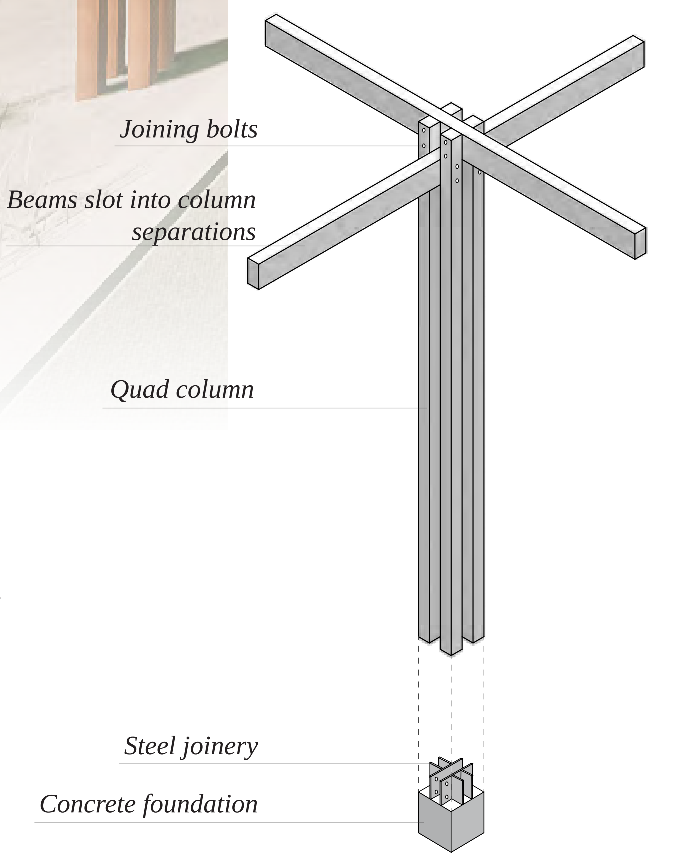


Fig7.47. Timber quad column construction detail.

Fig7.48. Long atrium entrance from waterfront's raised landmass. ↑
Fig7.49. Southeast facade of the building extension from the service lane. ↓

Fig7.50. The new waterfront from the bridge crossing at the wetland streams mouth entering Porirua Harbour.

8

CHAPTER

Discussion & Conclusion

8.1

DESIGN EXEGESIS.

The principle aim of this design-led research was to explore the potential role of biophilic design in addressing issues relating to climate change-induced flooding, ecological degradation and human wellbeing within the urban setting of Aotearoa. Biophilic design's focus on increasing human-nature connections created an overarching theme for the research. The integration of some fundamental Māori values and narratives allowed a deeper level of thinking about the relationship between humans and nature, which then influenced the design progressions that perhaps better reflect the cultural and ecological context of Aotearoa beyond the standardised understanding of a global kind of biophilia.

The three design objectives of this research were:

1. Implement a physical, ephemeral, and virtual presence of nature into urban conditions and infrastructure.

2. Design opportunities for humans to interact with and learn about nature within the urban setting.

3. Create biophilic civic spaces and buildings which respond to the local climate, ecosystem, and culture.

Engaging with biophilic design principles relating to increasing human/nature connections was a valuable tool for designing potential solutions to transform cities into more livable, resilient places of wellbeing for the community. Although large in scale and magnitude, these are the types of design moves we should be making in cities, taking a whole infrastructures approach, rather than designing individual zones or buildings, given the urgency of climate change impacts in urban settings. This research demonstrates the possibility of adapting cities through integrated landscape and architecture remediation of the spaces on, in and between buildings as well as the infrastructure required to allow the city's continued functional working. This research acknowledges that many undesirable and problematic buildings and spaces remain in the city plan; however, it is unrealistic to change an entire city at one time. The removal of the small number of buildings is enough to design a catalyst whereby the creation of a city with regenerative urban space is able to begin. In this particular example of design-led research, the main area of transformation lies in the wetland civic square and its components to become the centre of wellbeing for the community where ecological function and civic activity converse.

Porirua City provided a great case study opportunity for the research because several land pockets throughout the city are dedicated to car parking, which meant transforming these areas wouldn't require significant demolition of existing buildings. Being a city on a smaller scale means it is a small example of how to potentially implement biophilic climate change adaptation catalyst projects for larger cities facing similar problems, such as Wellington, to take inspiration from.

It became clear through this research that the concept of placemaking, including site-specificity of projects, is of critical importance for projects to have a tangible impact on the ecosystem and community of life within it. For projects to have any ecological benefit, the applied nature-based solutions must respond to the specific ecological place. The decision made in this research to produce a city in a wetland came from an intensive site analysis of the site before human occupation, which revealed the site used to be a tidal wetland. Considering that many New Zealand cities are located on reclaimed land, they have similar pre-development conditions to Porirua; therefore, they might implement similar nature-based solutions to tackle sea-level rise, while addressing individual and collective wellbeing. Wetlands are a resilient solution to climate change-induced sea level rise; however, throughout this research, I have developed an understanding of the cultural significance of wetlands in Aotearoa and the importance of restoring where possible the 90% lost over time through human development (Environment Foundation, 2018). Wetlands are often a natural condition of the edge of the ocean and land. If we want to continue to inhabit the edge condition, we will have to learn to build for these dynamic conditions and integrate a degree of fluctuation and wildness into urban conditions as a dynamic, resilient response to climate change. Implementing a physical presence of nature in urban settings provided opportunities for exploring the nature-based solutions to sea-level rise and storm surge events suitable to the context. Rather than the controlled and manicured landscapes, often with a high proportion of impervious surfaces, which typically exist in urban settings, this thesis suggests a partial rewilding of the city with more dynamic landscapes that integrate with architecture. Hards edges of land and sea generally are easier to control, but if we continuously try to fight against nature, we are fighting a losing battle, particularly in the context of climate change. We need to build and occupy our coastal cities differently. This research offers nature-based alternatives to the hard-edged mitigation methods and architectural solutions to continue the occupation of these continuously changing landscape conditions.

A way to strengthen this research would be to collaborate with experts from a range of disciplines throughout the design phases. The knowledge relating to ecology and landscape architecture was limited to information available through literature, online, and research supervision knowledge. In an ideal situation and through actual architectural practice, architects should collaborate with professionals from these disciplines to truly understand how architecture can work interdependently with landscape, ecology and culture professions. The landscape remediation in this research would be strengthened with professional urban ecology and landscape architectural knowledge for the detailed design of plantings and technical requirements for such large scale implementation.

8.2

CONCLUSION.

The effects of climate change and urbanisation on interconnected systems of ecosystems and human wellbeing are a pressing issue for built environmental professionals to understand and respond to urgently. The way we have built, continue to develop and live in urban environments has led to ecological degradation and biodiversity loss and urban conditions severely impacting people's wellbeing physically, mentally, and spiritually as individuals but also collectively culturally.

As we are now beginning to see the devastating effects of the current climate crisis through more frequent and more intense storm events and sea-level rise, designing solutions that adapt to and mitigate the impact of climate change is critical. The answer lies in a complete reevaluation of the way we build and live in cities. These issues are human-made, and to truly resolve them, humans must shift their thinking about their relationship with nature and the ecosystems which sustain them. The capitalist structures dominating society today have created a society driven by consumerism focused on exploiting finite resources for individual gain, including ideas around land ownership (Elkington et al., 2020). Infinite growth in a finitely resourced system (re the planet) is not sustainable (Meadows et al., 2004).

This dominant way of viewing and relating to the land should now perhaps shift to how hapu and iwi think about land and waterways, which is collectively held and cared for, for the benefit of all community members, including future generations (Elkington et al., 2020). We have a collective duty to protect, restore and regenerate the natural world. As built environment professionals, it is our responsibility to design opportunities for humans to reconnect with nature in day to day life to create shifts in thinking through exposure and meaningful connections. If our urban environments provide opportunities for communities to engage with and protect nature, they will more likely find a sense of responsibility to protect and restore it (Achilles & Elzey, 2013).

This research has demonstrated one possible way to design civic centres that integrate with ecology for climate change adaptation and has discovered the critical steps for design professionals wanting to achieve similar outcomes. A significant finding from this research is that it is crucial that architects understand the ecology of place in depth. This involves a detailed ecological history analysis of the site and working with ecologists from the project's outset. Furthermore, architects need to understand their projects' cultural effects and collaborate with the community throughout the design phases. In restoration projects such as the integrated landscape/architecture remediation of this research, positive impact on the community would come from engagement with local iwi, whose Indigenous knowledge of place is critical in ecological restoration projects. Therefore architects may need to spend more time at the front end of the design process and allow local iwi to lead the design decisions.

To conclude, it is clear that architects urgently need to change how they design cities and how people live in them in response to climate change and urbanisation effects. The design explorations in this research are a potential contribution to a new civic typology for a world grappling with climate change.

9

CHAPTER

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9.1

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9.2

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