COHABITATION IN SUBURBIA

IMPROVING NEW ZEALAND'S BIODIVERSITY THROUGH SUBURBAN ENVIRONMENTS

BY SOPHIE WHIDDETT

Figure 1. Cover Page Image

COHABITATION IN SUBURBIA;
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01

INTRODUCTION

WHAT IS CO-HABITATION?

This landscape design investigation stems from an understanding of Reconciliation Ecology, a term coined by ecologist and biologist Michael L. Rosenweing in 2003. Reconciliation ecology aims to reconcile the needs of humans and other species in order to crease habitats that provide space for both to live simultaneously.

“For a thousand years, at an accelerated rate, Man has been reducing the are available for most other species. If we use only reservation ecology and restoration ecology, it would seem that we are doomed to lose nearly every species alive today.” (Rosenzweig, 2003b).

Reconciliation ecology offers an alternative way of thinking that approaches landscapes not as separate habitats for humans and non-human but as a single environment that needs to be approached in a unifying way.

Within landscape architecture, this can be most easily thought of as a form of cohabitation.

Cohabitation names that which adapts urban environments to better provide for a wide variety of species, in this case bird species, and their respective needs. This includes both the adaptive species often seen in urban spaces (eg, tui) but also more human-sensitive species that typically reside in more natural areas (eg saddleback). Cohabitation includes opportunities for nesting and reproduction as well as food and water.

Cohabitation also names that which continues to offer a safe residential environment for humans, where the act of co-habiting does not impact the quality of daily life. This environment should be reflective of desirable human living, and as such hold opportunity to become a normalised way of living.

This design investigation is thus driven by its pursuit designing the ideal landscape conditions to support cohabitation in suburban environments.

THE PROBLEM

One of the major crises facing the world today is ever increasing biodiversity loss; the primary cause of which stems from land-use change (Sih et al., 2011). Land-use changes have a wider impact on biotic and abiotic life than what becomes evident in the immediate landscape surroundings. The five main impacts on landscape are habitat loss/ fragmentation and isolation, the spread of exotic species, harvesting, pollution, and climate change (Sih et al., 2011).

In Aotearoa New Zealand, land cover has changed significantly from 80% native forest to only 20% in the 800 years of human settlement (Ministry for the Environment, 2019), leading to a huge loss of habitat for native bird species. With a growing population the demand for land dedicated to new housing continues to transform the New Zealand landscape.

This investigation considers how green-field housing expansion is changing land-use and land-cover, by examining the relationship between bird life and suburban landscapes. It seeks to identify and demonstrate ways landscape architecture can positively intervene in biodiversity loss and its associated environmental degradation, at the local scale. It speculates on how biodiverse communities are achieved or maintained in areas of human inhabitation.

IS IT A QUESTION OF PRESERVATION?

Habitat loss is a major reason for the loss of native bird species in New Zealand. As an attempt to mitigate this, New Zealand's environmental legislation focuses primarily on preserving remnant patches of native vegetation. Around 32% of New Zealand's land area is currently zoned as a protected area[1]. These areas are managed to protect biodiversity and typically allow low level of human activity (eg. walking, biking) but no permanent occupation.

There are also several laws in place to protect native bush and prevent deforestation and between 80-90% of surviving native bush is under management of the Department of Conservation. The Resource Management Act is key to the governance of this protection along with the New Zealand Forest Accord (Ministry of the Environment, 1997). Additionally, individual trees may be identified as significant or heritage trees by individual councils that require consent to remove.

It is evident in New Zealand that conservation methods are deployed to protect rare and vulnerable elements of biodiversity as a priority (Anderson, 1998, as cited in Midler, 2007). This approach creates pockets of native vegetation that can provide habitat for bird species, but such a focus does not address or guide a holistic approach to habitat protection within New Zealand. Whilst protected areas are vital habitat for many human sensitive native species, such as Kiwi, in most cases preservation is not enough to prevent overall species decline. As such, despite preservation efforts an estimated "eighty percent of our bird species are now threatened with extinction" (Forest & Bird, 2018).

Footnotes:
1. Defined as one of the following: national parks; conservation parks; nature reserves; scientific reserves; scenic reserves; historic reserves; other conservation land; recreation (and other) reserves. (Molloy, 2015)

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Figure 2. Forest Loss in New Zealand since Human Settlement.

Ministry for the Environment. (1997). *Pressures on the Land.* Retrieved from https://www.mfe.govt.nz/publications/environmental-reporting/state-new-zealand%E2%80%99s-environment-1997-chapter-eight-state-our-2

WHAT ABOUT COHABITATION?

As preservation areas alone do not allow native bird species to thrive, opportunities to create habitats for wildlife within human-dominated landscapes become necessary (Rosenweig, 2003a).

When considering human-dominated areas, low levels of biodiversity are seen in dense urban areas[1] and rural areas[2], but there is a peak in low residential/ suburban areas. This peak is often attributed the wide variety of plant species occurring within residential homes. Though the use of exotic plant species is generally high, these species are often flowering or fruiting species which can provide year-round food sources for wildlife. The low density and restrictions on site coverage make the areas more easily traversed, with many trees and bushes providing resting points. (Beninde et al, 2015; Donnelly & Marzuff, 2004).

Settlements currently make up less than 10% of New Zealand's land-use, but growing populations are leading to a rapid expansion of urban areas (Falconer, 2015). This expansion is in part vertical, with many city councils supporting increased densification in their central areas; but horizontal sprawl remains prevalent, with continued pursuit of low density residential development on land at urban margins.

The legal protection of state-owned reserve land and native bush remnants means that most land converted to housing in New Zealand is privately owned farmland. Given that suburban density affords higher levels of biodiversity than farmland, this would indicate that within a New Zealand context, suburban expansion actually has the potential to improve national biodiversity. Current New Zealand suburban environments support only a limited number of native bird species and the prevailing suburban design would have to change to support a wider range of native birds.

Footnotes:
1. Due to the high amounts of impermeable surfaces and limited vegetation areas.
2. Due to the monoculture of exotic grasslands.

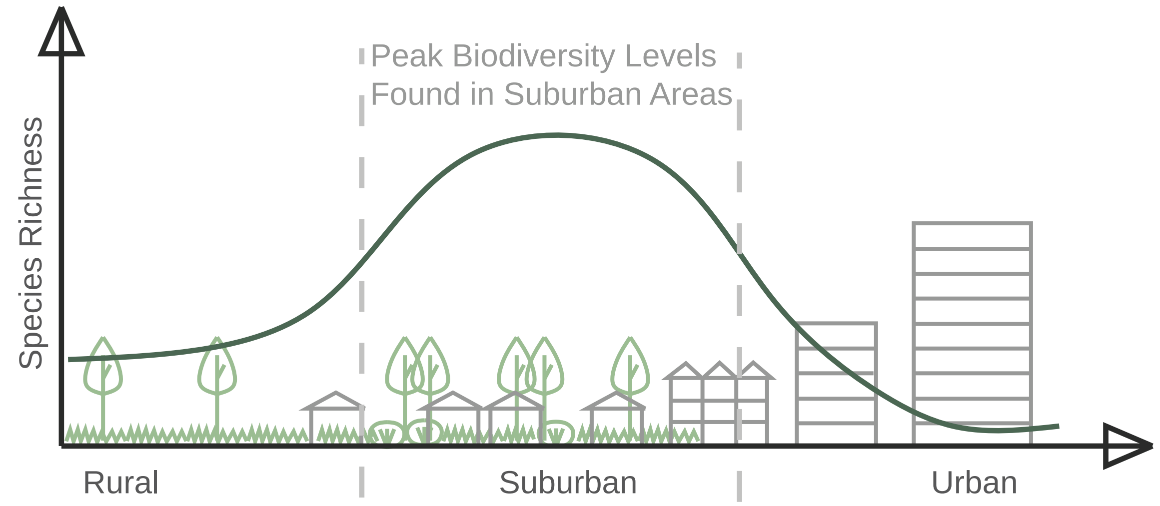

Figure 3. Intra-urban Biodiversity Gradient.

Additionally, surrounding land-use is shown to have an impact on the biodiversity value of reserve lands (Beninde et al, 2015). This research suggests a new suburban landscape could not only provide an expansion of habitable areas for native avian species, but also increase the success of existing local reserve lands, through improving the suburban environment, thus decreasing the negative impacts of habitat fragmentation.

The practice of landscape architecture offers the capacity and responsibility to consider how human occupied areas can begin to accommodate non-human species and direct our urban landscapes towards becoming co-habitable spaces. This research will therefore aim to capitalise on the potential of suburbia as a habitat for native bird species through the method of a design-led research. Using the potential of cohabitation as a driver, it will explore an alternative approach to green-field housing development. Heres ecological principles are placedat the forefront of design, using a 'green-field' case-study site in Plimmerton's designated Northern Growth Area of Porirua.

This research document begins by synthesising the main suburban movements throughout New Zealand history and the relationship between our urban fabric and societal attitude towards nature (chapter 2).

It then undertakes a systematic literature review of ecological texts to determine the impacts of urbanisation on avian communities (chapter 3), followed by a precedent review (chapter 4).

Throughout these chapters, design implications are extracted. These design implications are synthesised into working design principles (chapter 5) that are used to guide the creative design process of the project (chapters 6-11).

The four phases of design development explore and refine these design principles into a final set that can be used as a guide for designing co-habitable green-field developments (chapter 12).

The final chapter (13) reviews and critically reflects on the validity of these principles and designing within them to achieve the goal of cohabitation.

RESEARCH AIM

To generate and evaluate design principles from ecological literature for the landscape design of green-field suburban housing developments that encourage cohabitation between humans and native New Zealand bird species as a way to improve biodiversity.

RESEARCH QUESTION

How can landscape architecture practices approach the development of green-field suburban environments through cohabitation to improve biodiversity.

OBJECTIVES

To undertake an ecological literature review and precedent studies in order to derive design implications that inform design decisions from an ecological perspective.

To use the above design principles to develop, through an iterative design process, a theoretical green-field housing development within Porirua city.

Use the design process to test and refine a final set of design principles to be used as a guideline for improving biodiversity and cohabitation within suburban green-field developments.

SCOPE

This project will develop a schematic masterplan outlining suggested ratios of public reserve land and housing typologies. Storm and wastewater proposals will be developed as a percentage of land mass based of development land size housing number.

As landscape architecture research, this study is limited to a cursory and typological approach to housing so as to determine potential zoning and plot size. Thus the study will not investigate housing design in any detail nor does it include the design of housing frontage to street or public space beyond orientation.

The project will propose a vegetation strategy, including phasing and management of public spaces, but the limitation of this strategy is the ongoing threat of weed species from private gardens.

METHODOLOGY

This thesis takes a design-led research approach. To this end it generates its findings via the practice of the landscape design of a particular site. It integrates creative design practice and the analysis and synthesis of literature and field studies as a form of research to test ideas and produce a contribution to landscape knowledge.

The methodology uses a systematic literature review of ecological studies in relation to urban environments to establish and trial a set of design implications from which design research actions can be reviewed. A number of relevant precedent projects are selected and tested alongside these design implications to refine the design implications into a set of working design principles.

The research works through phases of site analysis, concept design and developmental design to explore the expression of these design principles in a green-field housing development proposal within Porirua City.

Design opportunities are investigated at a variety of scales and detail levels to give a comprehensive overview of how these design principles can inform the suburban housing condition, and its livability from both human and non-human perspectives. At each point of the design process, critical reflection reviews how the design principles are informing the work, and evaluates their potential for species cohabitation. To this end the design principles remain open to adaptation throughout the design process. This creative process will in turn feed back into the success and viability of designing within said principles and pose an alternative landscape led approach to housing developments that considers ecological needs at the forefront of the design processes.

METHODOLOGY DIAGRAM

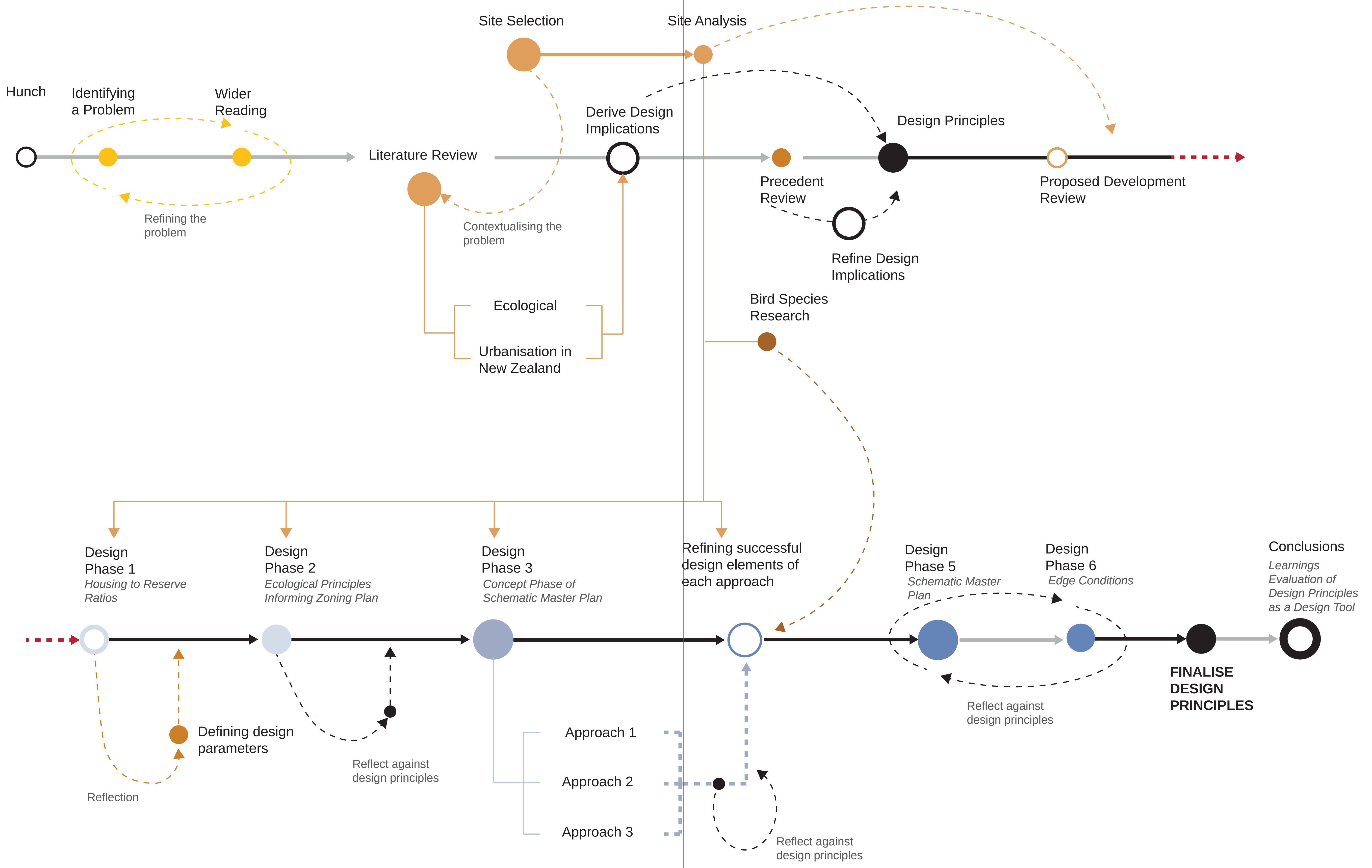

Figure 4. Methodology Diagram.

02

THE URBANISATION OF NEW ZEALAND AND THE ROLE OF COHABITATION

THE REJECTION OF NATURE

Urban growth in New Zealand dates back to the 1800's, when European settlers came to New Zealand, bringing with them different notions of land ownership to tangata whenua Maori, whose settlement culture was based off tribal territories (NZ Ministry for Culture and Heritage, 2017). The current urban fabric has been primarily formed by Europeans land development and architectural trends that reflected the colonial and neocolonial ideals of modern living.

The early settlers established towns on a 'clean-slate' system where all existing vegetation was removed before building. Towns were seen as "the conquering of the wilderness… there was a powerful urge to impose order in the landscape." (Brown as cited in Falconer, 2015, p. 79). These actions also sought to erase the settlement patterns and land use priorities of Maori.

In the 1880's, the New Zealand government recognised the potential profit in tourism and began conserving land in natural areas, protecting the large national parks and scenic reserves now enjoyed today (Falconer, 2015). The preservation of these natural landscapes was profit driven, and did not place value in the ecological significance of these areas at the time. Vegetation was thus valued for its picturesque qualities alone.

This period marks the beginning of New Zealand's preoccupation with the pristine, and the separation of humanity and nature which underlies the modern conservation movement (Western, 2001).

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Figure 5. Painting of Nelson, 1842.

Falconer, G. (2015). *Living in Paradox: A History of Urban Design Across Kainga, Towns and Cities in New Zealand.* China: Blue Acres Press.

THE START OF SUBURBIA

THE GARDEN SUBURB IN NEW ZEALAND

The early 1900's saw a shift from farming to industry and population in urban centres grew, causing congestion and sanitation problems (Schrader, 2014).

At the same time, industrialisation in Britian was causing inner-city slums, and the New Zealand government wanted to avoid making the same mistakes. The garden suburb movement offered an alternative solution that campaigned on the health and social benefits of edge city living (Falconer, 2015).

The Governments response to this movement was to fund low-density state housing outside of the central city through a state loan system (Williams, 1994). Suburban living was also embraced by the middle class, and the 1920's saw huge growth from the private sector in the style of the 'California bungalow' (Falconer, 2015).

The garden suburb[1] is often referenced as a primary influence on New Zealand's suburban model, and while the movement was a catalyst for low density growth, a lack of finance or social demand meant New Zealand suburbs did not include many of the community spaces or aesthetics of the garden suburb movement (Miller, 2004).

Footnote:
1.At this point the concept of natural spaces continued to be heavily influenced by the picturesqueaesthetic, with the garden suburb movement focusing on human orientated design over ecological value.

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Figure 6. California Bungalow.

NZ House Surveys. (n.d.) *The New Zealand Bungalow*. Retrieved from https://www.nzhousesurveys.co.nz/Events/47/The-New-Zealand-Bungalow

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Figure 7. Advertisement for a "Garden Suburb" in Tawa.

Falconer, G. (2015). *Living in Paradox: A History of Urban Design Across Kainga, Towns and Cities in New Zealand.* China: Blue Acres Press.

THE DOMINANT SUBURBAN MODEL

The majority of houses in New Zealand were built after the 1950's, where automobiles were common place. The post-war 'baby boom' increased demand for housing, while a change in government turned growth away from state built housing towards private development (Schrader, 2012). Cars now allowed a freedom that ultimately reinforced the separation of nature from city living. Local communal facilities, including park spaces, were no longer viewed as important for developments, with the newfound ability to drive to recreation activities (Derby, 2010).

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Figure 8. Photo of Street, Porirua, 1960.

Falconer, G. (2015). *Living in Paradox: A History of Urban Design Across Kainga, Towns and Cities in New Zealand.* China: Blue Acres Press.

Most developer-driven housing continues to somewhat reflect the 1950's housing model: low density, single dwellings, wide roads and a car dominant mentality. As territorial authorities have pushed for diverse housing mixes and more walkable environments, numerous developers across the country have shifted their model to accommodate - however in these market-driven times the outdated model remains given is proven profitability. There is growing evidence of the mental and physical health benefits of spending time in natural areas[1], yet the prevailing housing model does little to support this. In fact it reinforces an ideal of detached houses secured by private lots, despite the lot sizes precluding the growth of significant trees.

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Figure 9. Recent Development in Papakowhai, Porirua.

Dando, K. (2016). *A primary school could be a possibility for Aotea in Porirua after all.* Retrieved from https://www.stuff.co.nz/national/education/83805224/a-primary-school-could-be-a-possibility-for-aotea-in-porirua-after-all

Footnotes:
1. The current model of sprawl is linked to an increase in chronic medical problems, due to the drop in physical activity associated with the lifestyle (Sturm and Cohen, 2004).
Evidence shows that spending time in more natural environments, around greenery and water bodies, has a positive effect on human mental health, stress levels and general wellbeing (Dean et al, 2018; Mitchell, 2013 & Liu et al., 2017).

ALTERNATIVE CURRENT TRENDS

MEDIUM DENSITY AND TRANSPORT ORIENTATED DESIGN.

Medium density developments, particularly around transport nodes, are commonly proposed as a way to reduce the impacts of car use and control the continued outward sprawl through central city density[1]. The role of densification is an important tool to deal with growing populations, but it continues to “other” nature and ignores the potential of urban environments for cohabitation.

While medium density’s popularity is increasing, a report for the Centre for Housing Research New Zealand suggests New Zealand’s current approach to medium density has limited its appeal to a small demographic, and if the adoption of medium density housing is to increase, it needs be included in suburban areas, not just central city developments (Dunbar & McDermott, 2011)

Predicted growth in Porirua is in 1-2 person households, as the population of over 50’s is expected to rise and the proportion of childless couples increases nationally. (Cox et al., 2018). Smaller households and an aging population indicate a shifting demographic that may respond positively to medium density developments with their low maintenance outdoor spaces and smaller house size.

This project provides an opportunity to explore alternative approaches to implementing medium density housing within an edge-city suburban context that foster a relationship between people and non-human life. Based on research on which the preceding discussion represents, I have extracted 2 design onbjectives:

Design objective 1: implementation of medium density in suburban context.

Design objective 2: encourage residents’ engagement with local wildlife and natural habitats.

Footnote:
1. See Wellington Regional Public Transport Plan, 2014 and Porirua Transportation Strategy, 2012

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Figure 10. Housing Typologies and Related Amenities.
Kapiti Coast District Council. (n.d.). *Kapiti Coast District Plan; Apendix 5.1 Medium Density Housing Design Guide.* Retrieved from https://www.kapiticoast.govt.nz/media/28599/appendix-51-medium-density-housing-guide.pdf

SUMMARY

Our current urban fabric continues to “other” natural landscapes and the non-human; separating us from other species at the detriment of our physical and mental wellbeing (Serres, 1992).

New Zealand’s suburban development has indicated a long-held desire to connect with nature, which settlement patterns have thus far failed to achieve.

The concept of cohabitation counters the binary approach to land use offering an opportunity to develop an alternative suburban model that prioritises biodiversity and a human connection with nature.

03
ECOLOGICAL LITERATURE REVIEW

The goal of cohabitation requires us to consider how our existing urban environments can be adapted to offer more for non-human species.

While this is a landscape architecture thesis, it is crucial to understand and engage with the ecological sciences, as to best inform how design can come from an ecological perspective. The literature review therefore examines scientific studies and literature to understand the ecological impact of urban environments, with particular focus on bird life.

Conclusions from the literature review will be used to form a set of design implications, which aid the transition of ecological findings into actionable design moves.

It will begin outlining how bird species in New Zealand have evolved in our unique environment and the impact human development has had on their survival. It will then look at how bird species vary in sensitivity to human interaction and how we might consider this gradient sensitivity in designing.

It will then see what impact vegetated reserve size, structure and edge conditions have on bird abundance and the potential design implications. It will investigate the importance of natural succession processes for revegetation and potential issues arising with revegetation and public opinions.

Next it will look at the impacts of lighting on bird life.

Followed by the impact that urbanisation has on water quality and potential mitigation techniques.

Finally, it will show the effects of earthworks on the local environment.

HUMAN SENSITIVITY

Bird species have varied sensitivity to human interaction and environments. Some birds, referred to as urban exploiters, are seen only in urban areas, and rely on humans for survival through exploitation of human resources (eg., food). The other end of the spectrum is sensitive species, who are unable to live in human occupied spaces and require natural reserves for their survival (Price, 2008). For this project, cohabitation means providing for the tolerant and sensitive species as well as the adaptive and exploiters we already see in urban areas.

Species sensitivity depends on several factors, but primarily; their ability to avoid predation; and their ability to find and consume different food sources.

PREDATION

New Zealand's native fauna evolved in a unique environment absent of land mammals. NZ native bird species therefore developed with few natural predators (only the small number of predatory birds), meaning they do not have appropriate behavioural response to predation risks (Guthrie, 2020). This means either an over-reaction, causing loss of energy and avoidance of habitable areas, or an under-reaction, resulting in death.

Many species also exhibit behaviour that leaves them vulnerable to predators, including high numbers of ground foragers and nesting on the ground, in burrows or within low vegetation that is easily accessed by mammals (Duncan & Blackburn, 2004).

Most bird's anti-predator response relates to generalised stimuli, such as fast-movement and noise, of which humans exhibit. This means that despite a limited actual risk, for most birds, the presence of humans incites a similar behavioural response as the presence of a natural predator, with increased heart rate and stress levels triggering the fight/flight response (Price, 2008).

Cars exhibit even more disruptive behaviour, as in the eyes of a bird they are essentially even louder, faster and bigger predators than humans (Price, 2008).

Design Implication 1: minimise car use within the development

Design implication 2: limit car speeds within development

While some species can learn to adapt to predation and other environmental changes, this tends to evolve genetically over a long period of time. Where birds have had a continued exposure to humans in a predictable and repetitive behavioural pattern, some have been seen to habituate to their presence (Ma et al, 2009). This behaviour is seen in common exotic birds, such as sparrows and pigeons, but several New Zealand species have shown partial adaption to human presence (such as tui who are regularly seen within urban environments, or kaka who will allow people to get quite close to them).

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Figure 11. Alert Distances of Birds to Humans.

Botsch, Y., Tablado, Z., Scherl, D., Kéry, M., Graf, R. & Jenni, L. (2018). Effect of Recreational Trails on Forest Birds: Human Presence Matters. *Frontiers in Ecology and Evolution, 6; 175.* DOI=10.3389/fevo.2018.00175

Design Implication 3: Restrict human movement to designated paths within natural areas to help habituate birds to human activity.

FOOD SOURCE

Food source plays a key part in determining how sensitive a bird species is to human activity. Forest species that forage for food (insects) on the ground leave themselves open to risk from predators (and perceived risk from humans). These species are further discouraged from urban areas because high levels of permeability and poor soil quality limit access to food (Parris, 2016).

Wetland birds tend to be sensitive species as they too spend much of their time on the ground or wading in shallow water.

Design implication 4: reduce impermeable surfaces.

Design implication 5: Prioritise rejuvenation of soil and access to insect food sources.

NESTING

Regardless of sensitivity level, most birds will still tend not to nest near areas of high traffic. Nest defence varies within stages of the breeding cycle; with investment in young increasing over time. If humans do approach nests, many species will flee, leaving eggs or young unprotected and vulnerable to predators. Continued disturbance, particularly within early stages of nesting, will have a dramatic impact on the reproductive success of a species (Montgomerie and Weatherhead, 1988, as cited in Price, 2008)

Design implication 6: Provide human-free areas within recreation patches to allow birds to nest undisturbed.

Design objective 3: reduce the impact of housing and urban parks on bird life to allow cohabitation in these areas.

VEGETATION STRUCTURE AND NATURAL SUCCESSION

Porirua was previously dominated by native broadleaf-conifer forest, and most bird species in the area rely on remnant patches of forest for their primary habitat. Cohabitation is in part improving the urban fabric for native birds, but also using development as a method to support the regeneration of natural habitats.

Development of NZ forests occurs over many decades, undergoing several species changes (Dawson, 1988). Current management is often aimed at restoring indigenous forests to a state close to that before either Māori or European settlement (Allen, 2013) however the GWRC acknowledges that;

“It will never be possible to regenerate the ecology of the original forest cover due to the extinctions that have occurred over the past 1000 years and the introductions of new plants and animals that cannot be excluded from [Cannons Creek, Porirua]. …the intention is to restore [Cannons Creek, Porirua] to a complex functioning ecosystem that is dominated by native plants.” (GWRC, 2003)

In NZ, there are as many naturalised exotic plant species as there are indigenous ones with invasion of exotics now being a major problem for the restoration of native forests. (Allen, 2013; Cathcart, 2017).

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Figure 12. Manuka Scrub.

Manuka and Kanuka Forest, Farewell Split. (n.d.). Retrieved from https://mapio.net/pic/p-19461537/

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Figure 13. Gorse Scrub.

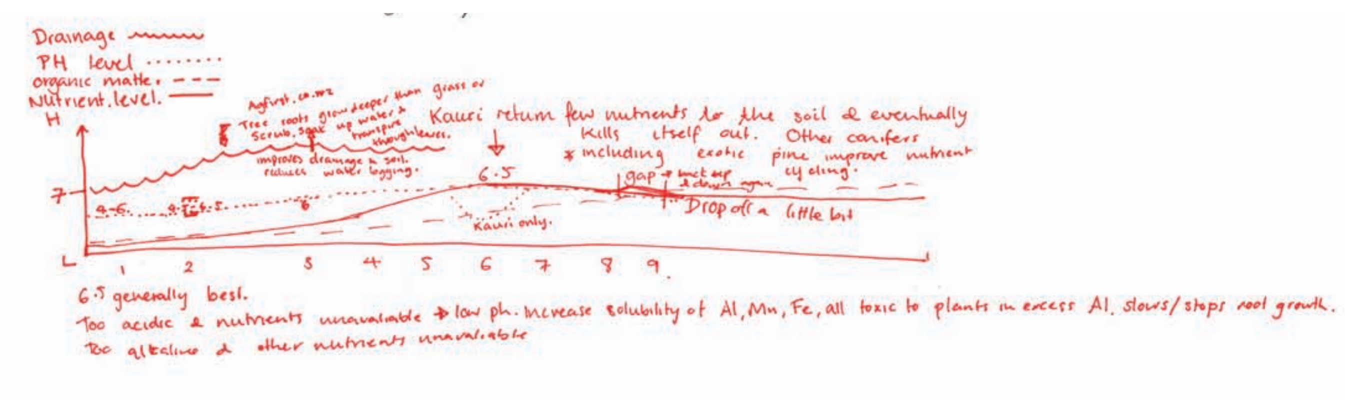
The Wildlife Trust. (n.d.). *Common Gorse.* Retrieved From https://www.wildlifetrusts.org/wildlife-explorer/trees-and-shrubs/common-gorse

BROADLEAF / CONIFER FOREST SUCCESSION

The following diagrams show a timeline of natural succession within the ecosystem types present on site (broadleaf/conifer forest and freshwater wetland - see next page). These diagrams were developed to aid my personal understanding of succession and the role each stage plays in supporting the next through shade conditions, moisture retention and soil nutrient regeneration. This process highlighted that different bird species will be supported at different stages of the suburb development, depending on the stage of succession.

Despite the probable inability to fully recreate native forests, natural progression remains a useful tool to convert large masses of farmland to forest areas with minimal human input and maintenance.

Through these diagrams I was able to identify that parts of the site are reflecting the expected stages of natural succession. These patches have a variety of native species that could provide a natural seed source for further forest regeneration.



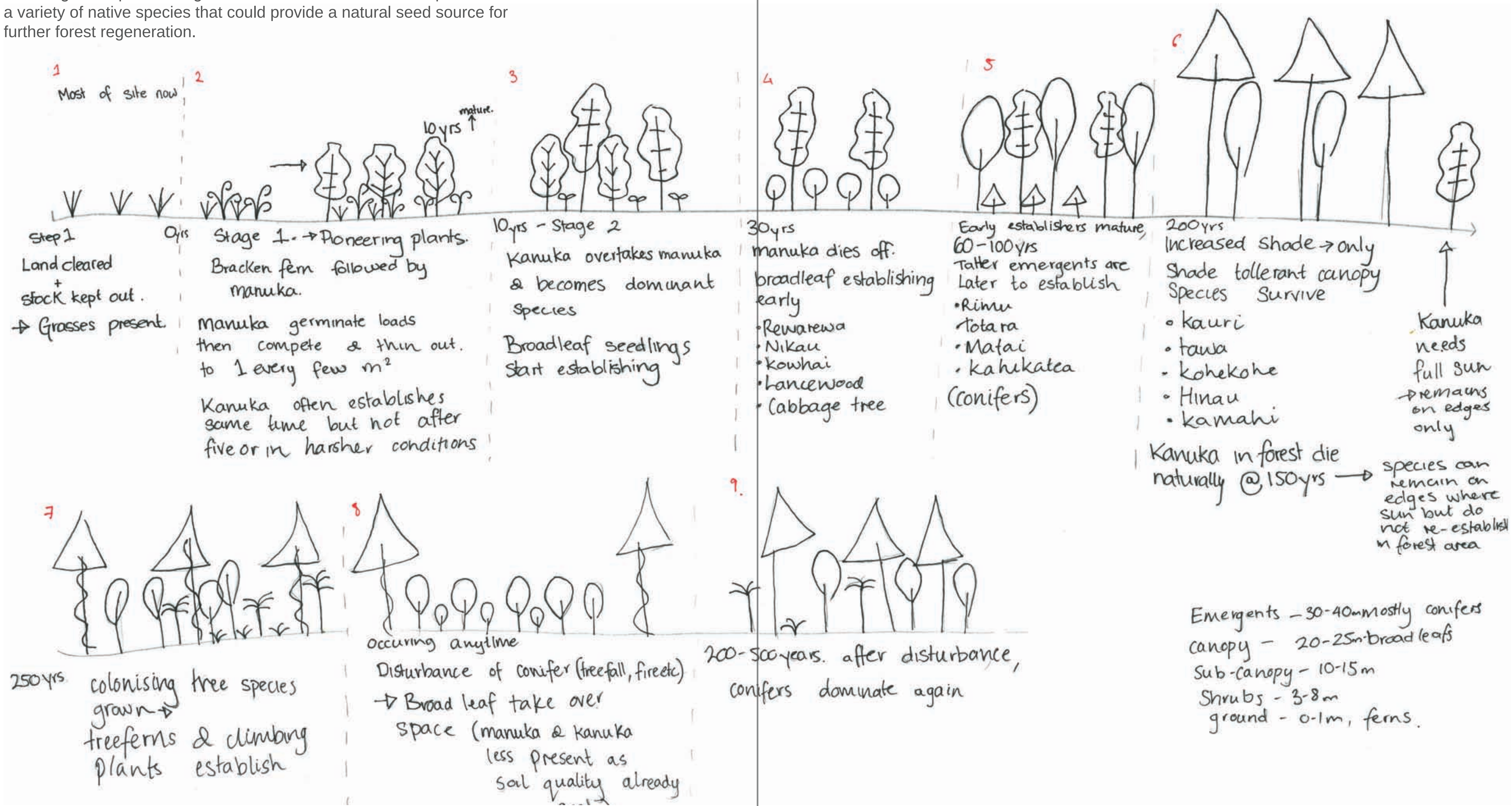


Figure 14. Broadleaf Forest Succession.

FRESHWATER WETLAND SUCCESSION

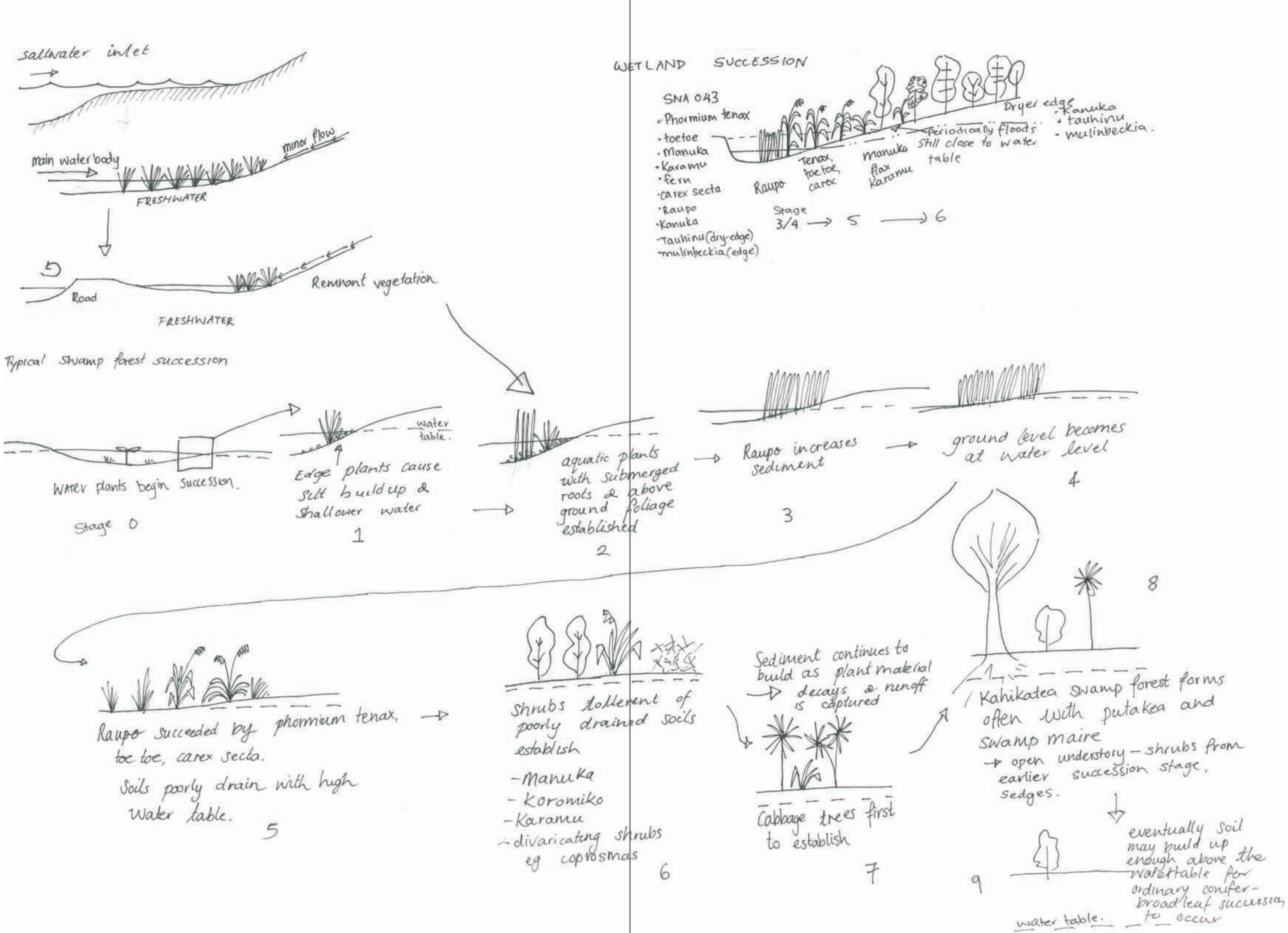


Figure 15. Freshwater Wetland Succession.

Design objective 4: Develop of a re-vegetation outline that compliments residential development.

DESIGN IMPLICATION 7: locate patches to utilise natural succession including seed source and spread.

VEGETATION PATCHES AND BIRD LIFE

We have established the need for providing vegetated natural areas within the development for more sensitive species and activities. The next thing to consider is how best to layout these vegetated areas into the development. The impact of vegetated areas (commonly referred to as patches) on biodiversity has been the topic of many ecological studies.

PATCH SIZE

Patch size has been shown to be the primary influence on the biodiversity value of a patch (Hilty et al. 2006; Parris, 2016).

Donnelly and Marzluff (2004) investigated the relationship between patch size, surrounding land-use and bird species present. They discovered that while the number of different bird species present (species richness) increased with patch size in all landscapes; in suburban environments, bird abundancy was highest in patches sized between 20-40ha.

Patches of this size also had 3-4 times as many nests; with nearly two times as many successful nest cycles (incubation and brooding) as other sizes within suburban environments.
Successful breeding is a primary importance for supporting the increase of native bird species within New Zealand, and needs to be a key factor in patch design within suburban environments.

Their findings highlighting the importance of the surrounding land-use on biodiversity, and indicate that within this development context, several medium sized patches(20-40ha) would be more desirable than a single larger patch.

Design implication 8: Provide several medium sized patches within the development.

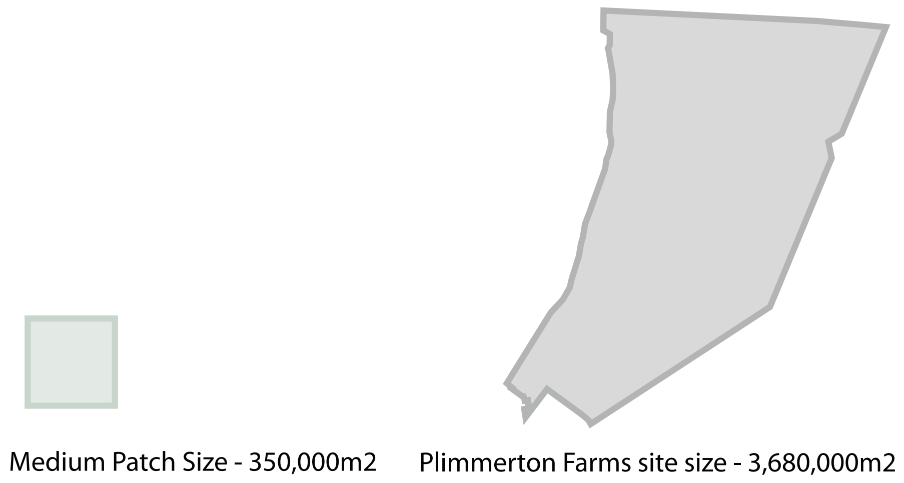


Figure 16. Relative size of Vegetation Patch to Plimmerton Farms Site

CONNECTIVITY

The connectivity of these vegetation patches is another key influence on species richness (Ying et al., 2018; Helzer & Jelinski, 1999). Isolated patches have a limited ability to support self-sustaining populations, with species being “more susceptible to extinction from factors such as inbreeding or environmental fluctuations” (Richter & Weiland, 2011).

Connectivity is typically achieved through vegetated corridors which provide safe passage for animals to travel from one patch to another without needing to traverse the surrounding (in our context – suburban) environments.

When continuous green corridors aren’t suitable, there is the potential to use stepping stone connections. These are where a series of small islands of vegetation provide safe havens and temporary resting spots for animals travelling between two patches.

Hilty et al (2006) and Paris (2016) suggest stepping stone connections can be beneficial for birds, which can traverse urban environments; however the realisation of stepping stones for bees and other insects may be limited.

DESIGN IMPLICATION 9: where possible, provide continuous vegetated corridors between vegetation patches. If Steppingstone connections are being implemented, minimise distance travelled between resting spaces.

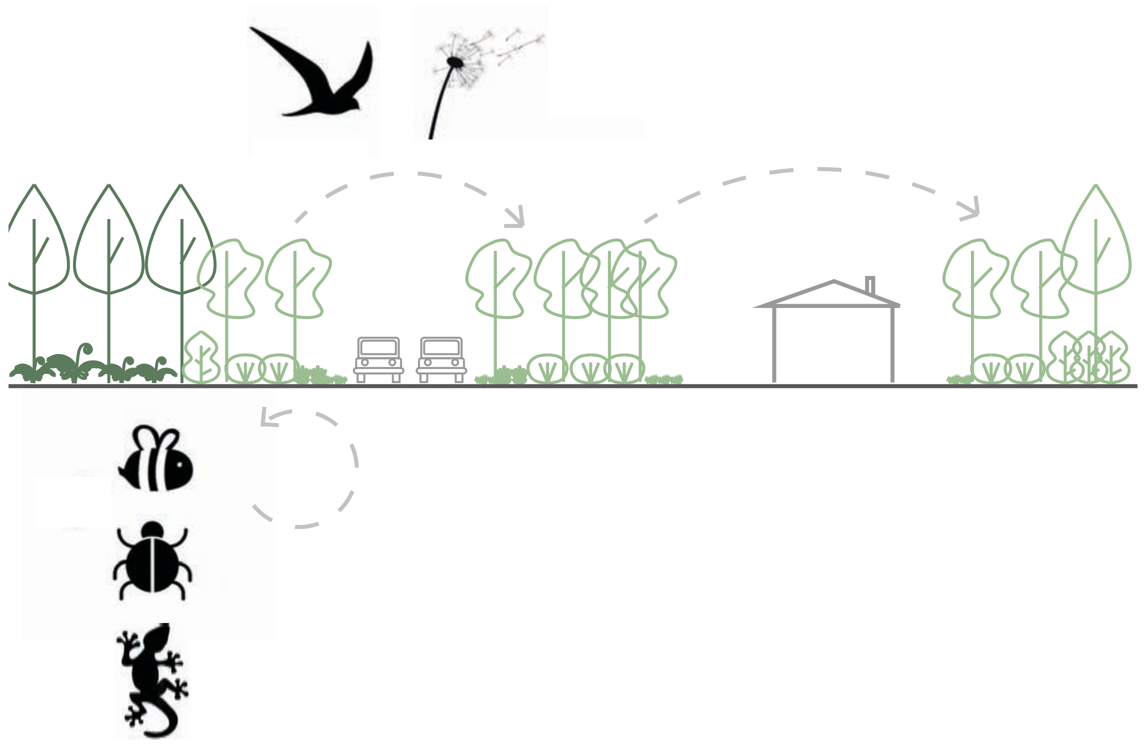


Figure 17. Stepping Stone Connections.

THE EDGE EFFECT

The previous section showed how patch size and bird abundance were influenced by the surrounding land-use. The surrounding land-use can also impact the vegetative composition of a patch and therefore influence ecosystem heath and the bird species it is able to support. Risks from adjacent land include invasive species, pollution and altered disturbance regimes (Hilty et al, 2006). As patch sizes decreases, the amount of exotic vegetation increases. This is because a smaller patch has a larger edge to core ratio, and “wind penetrating into a patch can carry seeds and pollen from the surrounding matrix, influencing composition of species at habitat edges.” (Hamburg et al., 2008).

While edges are the most vulnerable part of a patch, they also hold a greater opportunity for biodiversity as they provide the highest level of interaction with species outside the patch (Terraube et al, 2016). Edges also provide an important food source for patch inhabitants. Both Hawot & Neimi (1996) and Helzer & Jelinski (1999) found that natural edges that provide a gradient of planting can increase patch biodiversity as they provide important habitat for insects, which are a valuable food source for many bird species.

When we look at avian communities, bird abundance is higher in patches with large perimeters with regards to less sensitive natives, however patch shapes that favour the cores are better for more sensitive species (Wilson et al, 2016; Hawot & Neimi, 1996). Helzer & Jelinski (1999) found that birds only nest in core areas regardless of species sensitivity.

Design implication 10 :Patches should be shaped with non-linear edges to increase edge sizes while maintaining a large and healthy core.

Design objective 5: minimise negative impacts of edge conditions.

DESIGN IMPLICATION 11: Edges should reflect a natural gradient of species that would typically occur in each habitat type, including a varied and complex understory planting.

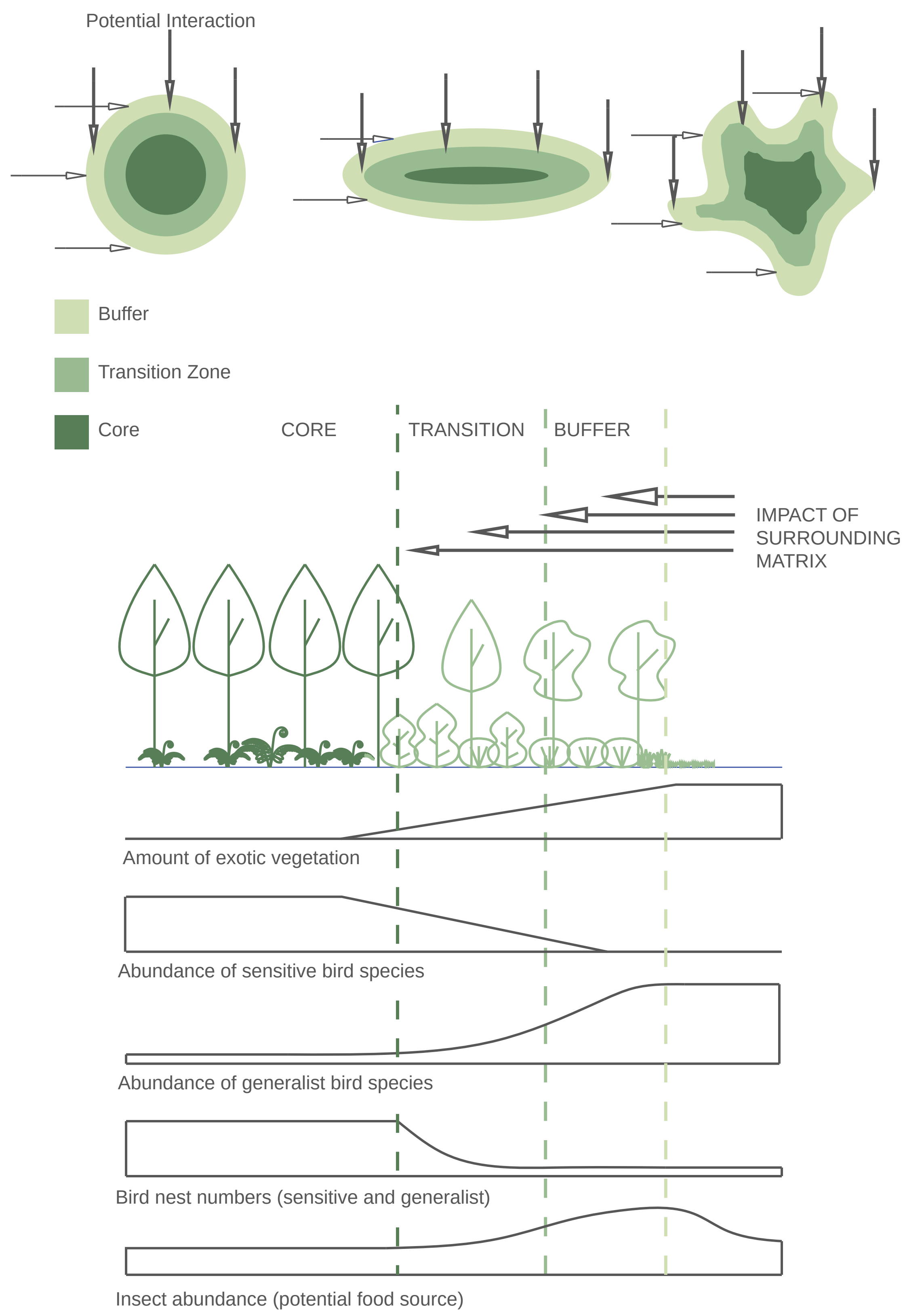


Figure 18. The Edge Effect.

LIGHTING EFFECT ON BIRDS

Birds have much better visual acuity than humans and can perceive both visual light and ultra violet. Birds that are active during the night can capture more light and see better in low light. (Mayntz, 2019)

Most migratory birds will travel at night, using the stars for navigation. Light pollution often distracts migrating birds, making them divert the route to investigate the lit area and hesitate to leave. (Florida Atlantic University.n.d.) (Cabrera-Cruz et al, 2018) Artificial lights can also cause birds to migrate at the wrong time of year, meaning they miss-time nesting, foraging and other behaviours. (International Darksky Association, n.d.).

While some birds actively move towards these lit areas, nocturnal species will stay away. According to Dr Theresa Jones, “One of the reasons they’re probably in the night is they’re trying to avoid visual predators, so by putting lights up you’re essentially allowing those visual predators a much more extended daytime.” (Jones, 2018)

While eliminating all artificial night light is a human safety issue, there are ways to lessen the impacts. Poot et al (2008) found that “nocturnally migrating birds were disoriented and attracted by red and white light (containing visible long-wavelength radiation), whereas they were clearly less disoriented by blue and green light (containing less or no visible long wavelength radiation). This was especially the case on overcast nights”

Another option is to design lighting to reduce wider light pollution, through using lights projecting down rather than up, minimising strong flood lights and reducing the amount of amenity lighting in trees and other possible sites where birds are likely to be nesting or sleeping (Poot et al, 2008).

DESIGN IMPLICATION 12: Only light up trees where birds will not be nesting (eg street trees and key residential trees only). Limit lighting in forested areas.

DESIGN IMPLICATION 13: design public lighting to limit skyward projection and select hues that interfere the least with sleeping patterns (blue and green light).

DESIGN IMPLICATION 14: Additional mitigation: ask residents to buy UV reflective collars for pets to make them easy to see by native birds.

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Figure 19. Porirua Harbour.
Pilkinton-Ching, L. (2016). Retrieved from https://visionphotography.co.nz/photographer-blog/63-porirua-harbour-photography

WATER RUNOFF AND POLLUTION

Urbanisation has had huge impacts on hydrological systems.

Rainfall from roofs and concrete surfaces are transported through storm water systems and deposited into waterways. This stormwater can harbour many pollutants, and large amounts of runoff can degrade the health of waterways resulting in a loss of aquatic habitat. The increase in impervious surfaces also raises the amount of peak runoff during storm events increasing the risk of flooding. Runoff can have a high temperature due to the high heat absorbency of concrete and metal (Parris, 2016). This is combined with a loss of shading riparian vegetation, significantly increasing water temperatures in streams, making them uninhabitable to many fish and insect species.

These negative effects can be largely offset with implementation of riparian buffers. A study by Moore and Palmer (2005) found that urban streams with high amounts of intact riparian forest exhibited biodiversity levels similar to less urban areas, despite high amounts of impervious cover in their catchments.

Dr Richard Death (n.d.) suggests 20m buffers will capture 90% of sediment particles, and 50m buffers are required for biodiversity gains.

There are also impacts of channelling and urbanising waterways, including the diversion into underground pipes and creation of dams. The increased speed can affect fish passage and reduce appropriate spawning grounds (Parris, 2016).

Residential water usage in New Zealand is extremely high, with irrigation being the highest consumption at 58% of total water use. High water use combined with the increased impervious cover in urban areas reduces infiltration and percolation, reducing groundwater flow and causing stream baseflows to be reduced[1].

Footnotes:
1. Baseflows are critical in controlling stream temperatures (due to the cooler temperature of groundwater) and maintaining stream health between rainfall events. With reduced baseflow, streams rely more on stormwater runoff and therefore experience higher concentrations of pollution. (The Urban Engineers, 2019)

Design implication 15: 50m buffers to main waterways, 20m buffers to headwaters where possible.

Design implication 16: Minimise channelling of waterways and maintain a naturalised stream bed where possible.

Design implication 17: Manage water use through rainwater harvesting and grey water recycling.

EARTHWORKS

Soil plays a pivotal role in ecosystems and the food chain. For species to survive, they need adequate food source. This is either through consuming vegetation or consuming other animals that rely on vegetation. Soil health hugely impacts the ability for a diversity of vegetation to grow and maintain a healthy ecosystem. Earthworks disturb the soil through vegetation loss and removing the nutrient rich topsoil. Low-nutrient soils limit what species will grow, with increased risk of invasive species (Potočnik, 2010).

A reduction in plant cover means soil is more affected by erosion from wind and rain. Soil not protected by vegetation can be eroded up to 100x faster than vegetated soils, and this sediment runoff enters local waterways damaging wildlife (Potočnik, 2010).

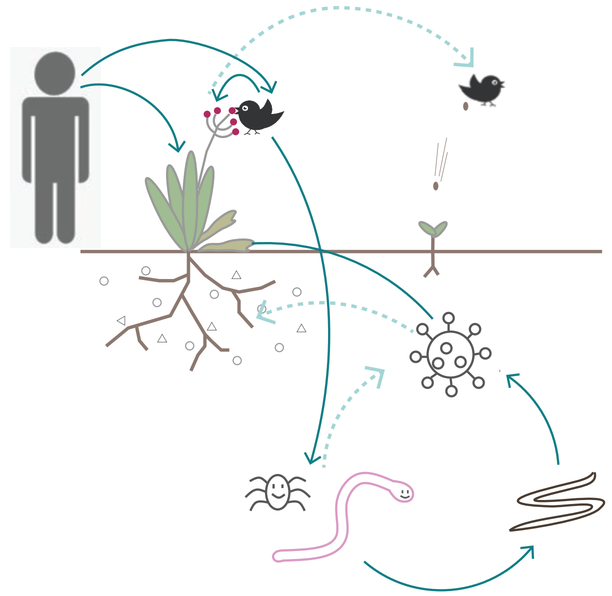

Figure 20. Food Chain.

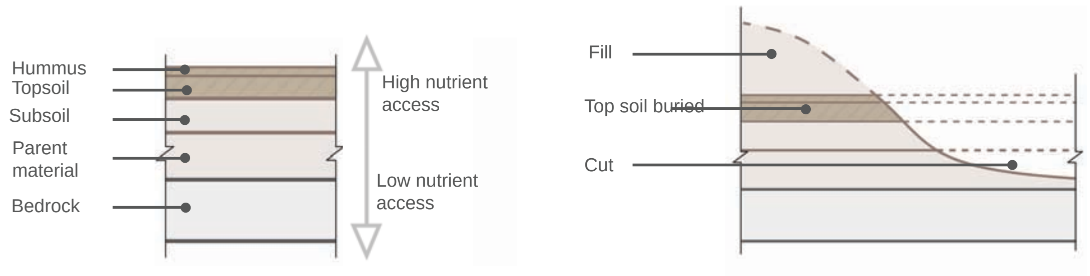

Figure 21. Cut and Fill Earthworks

DESIGN IMPLICATION 18: Minimise earthworks.

DESIGN IMPLICATION 19: Vegetate steep slopes for soil stability.

DESIGN IMPLICATIONS AND OBJECTIVES

Below is a summary of the design implications and design objectives extracted throughout the literature review. This table will be used to record how these implications and objectives inform the design process and how they might change throughout the research to inform a final set of design principles that refelct the finding of this project.

Transportation	Design Implication 1	minimise car use within the development
	Design implication 2	limit car speeds within development
Vegetation	Design implication 6	Provide human-free areas within recreation patches to allow birds to nest undisturbed.
	Design Implication 3	Restrict human movement to designated paths within natural areas to help habituate birds to human activity.
	Design Implication 7	locate patches to utilise natural succession including seed source and spread.
	Design implication 8	provide several medium sized patches within the development.
	Design implication 9	where possible, provide continuous vegetated corridors between vegetation patches. If Steppingstone connections are being implemented, minimise distance travelled between resting spaces.
	Design implication 10	Patches should be shaped with non-linear edges to increase edge sizes while maintaining a large and healthy core.
	Design implication 11	Edges should reflect a natural gradient of species that would typically occur in each habitat type, including a varied and complex understory planting.
	Design objective 4	Develop of a re-vegetation outline that compliments residential development.
	Design objective 5	minimise negative impacts of edge conditions
Housing	**Design objective 1**	implementation of medium density in suburban context
	Design objective 3	reduce the impact of housing and urban parks on birdlife to allow co-habitation in these areas.
	Design objective 2	encourage residents' engagement with local wildlife and natural habitats.
Lighting	Design implication 12	Only light up trees where birds will not be nesting (eg street trees and key residential trees only). Limit lighting in forested areas.
	Design implication 13	design public lighting to limit skyward projection and select hues that interfere the least with sleeping patterns (blue and green light).
	Design implication 14	Additional mitigation: ask residents to buy UV reflective collars for pets to make them easy to see by native birds.
Water systems	Design implication 15	50m buffers to main waterways, 20m buffers to headwaters where possible
	Design implication 16	Minimise channelling of waterways and maintain a naturalised stream bed where possible.
	Design implication 17	Manage water use through rainwater harvesting and grey water recycling.
Earthworks	Design implication 18	minimise earthworks
	Design implication 19	vegetate steep slopes for soil stability
	Design implication 4	reduce impermeable surfaces.
	Design implication 5	Prioritise rejuvenation of soil and access to insect food sources.

04
PRECEDENT REVIEW

Three precedents will be reviewed against the design principles to establish how existing projects address the various aspects of cohabitation.

EARTHSONG ECO-NEIGHBOURHOOD

RANUI, AUCKLAND, NEW ZEALAND

Earthsong is New Zealand's first co-housing development. Co-housing is a community-focused way of living, where private homes are clustered around a car-free shared garden space.

The co-housing model allows residents to have independent incomes, but houses are owned by a homeowner association or housing cooperative that residents have a share in (as oppose to owning their own property).

Earthsong has comparatively high levels of surface permeability to a typical suburban neighbourhood while also managing to fit more residents onto the site.

Rainwater is harvested to reduce reliance on city supply and reduce stormwater runoff. The remaining stormwater is directed through topographical manipulation to enter a pond at the bottom of the site, providing habitat to local wildlife. Example of how to action (Earthsong, 2021).

Design implication 4: reduce impermeable surfaces.

Design implication 17: Manage water use through rainwater harvesting and grey water recycling.

NEW Design Implication 20: Use housing orientation to create small communities through a mix of street frontage and internally facing housing groups.

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Figure 22. Figure 23. Figure 24. Earthsong Eco-neighbourhood.
Retrieved from https://www.earthsong.org.nz/resources/photographs

KURWALDPARK

BAD LIPPSPRINGE, PADERBORN, GERMANY

Kurwaldpark in Germany is a series of designed open space situated within a dense existing forest. The spaces introduce light, air and space into the forest, allowing people to become immersed in the forest environment while enjoying a variety of different activities and play structures. The space acts as a transition between the forest and neighbouring settlement, making nature more accessible to local residents through its wide paths, activities and ample seating areas.

The park was designed to align and improve existing walking tracks, incorporating open spaces at intersections to increase activity in these areas (Forest Park in Bad Lippspringe, n.d.).

Design implication 21: Nodes of open space used to encourage walking and engagement with forested areas.

Design implication 22: Open spaces to include understory plantings with thinning trees to create view shafts encourages biodiversity and allows sunlight into space.

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Figure 25. Figure 26. Figure 27. Kurwalkpark.

Forest Park in Bad Lippspringe. (n.d.). Retrieved from http://landezine.com/index.php/2020/09/forest-park-in-bad-lippspringe/

ARO VALLEY

WELLINGTON, NEW ZEALAND

Aro Valley is one of Wellingtons inner-city suburbs. It was one of the first settlements in Wellington with most houses built between 1900-1920's. Aro Valley residents enjoy a high number of native birds occupying and visiting the area, and while the number of birds is still low compared to pre-human days, there is more bird life than most other central city suburbs.

The main reason is Zealandia. A fenced wildlife sanctuary that provides a predator free space for native wildlife to live and breed (Birds of Zealandia, n.d.). Next to Zealandia is Polhill Reserve. A space of bush and walking tracks at the edge of the valley. The success of Zealandia has led to species branching out into Polhill Reserve and further into the Aro Valley for food.

Zealandia is local example of the success of

Design implication 6: Provide human-free areas within recreation patches to allow birds to nest undisturbed.

Design Implication 3: Restrict human movement to designated paths within natural areas to help habituate birds to human activity.

The relationship between Zelandia and the Aro Valley indicates a new design implication, that the design should transitional levels of human interaction with patches to reflects species sensitivity.

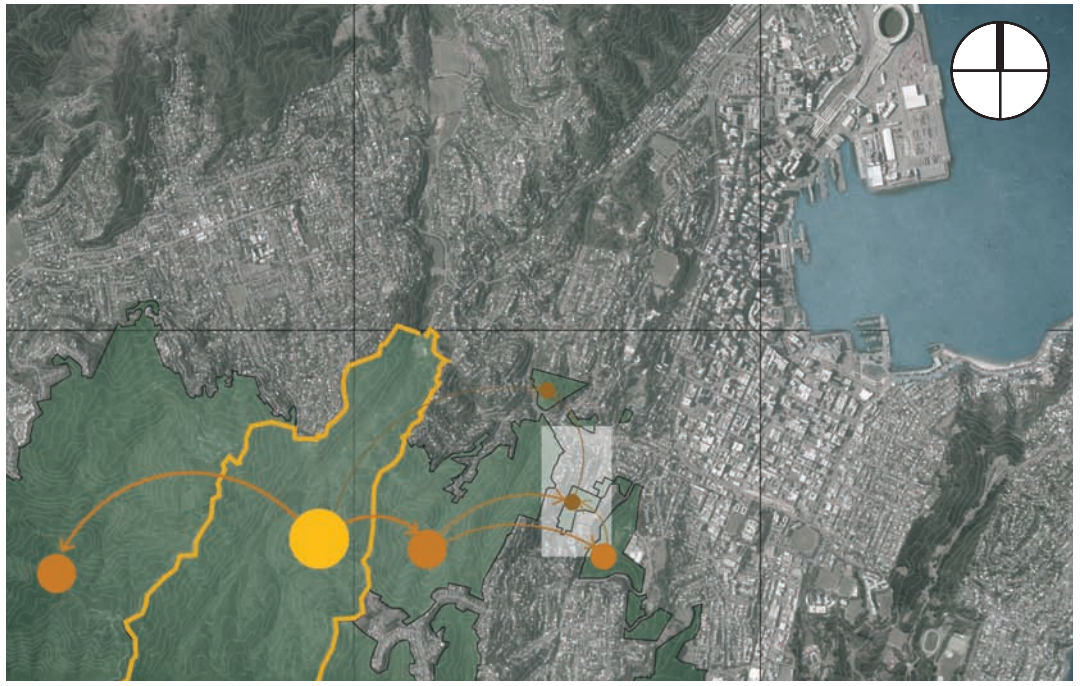


Figure 28. Zealandia Location Map. NOT TO SCALE

ZEALANDIA - A predator free sanctuary with breeding program. Many species of bird life present including highly sensitive and at-risk species. Some previously lost from the area re-introduced through relocation and breeding programs.

LARGE PATCH - These large patches are close to Zealandia and see a fair amount of medium to low sensitive species. Many species are now nesting in these areas as well as searching for food

URBAN PATCHES - larger birds and less sensitive species are seen in relatively high abundance compared to the city centre.

Over 40 different species are supported, including many that were previously extinct in the area. Key species include:

Saddle back
Hihi
Tui
Shag (little, pied and black)
Bellbird
Kakariki
Kaka
Little spotted Kiwi
North Island Robin
Titipoinamu
Takahe
Patake
Kereru
Whitehead
Morepork
Fantail

Many birds have started nesting outside of the perimeter fence and search for food within the larger region including:

Kaka
Kereru
Tui
Silver Eye
Kakariki
Fantail

Urban areas support the less sensitive species including:

Morepork
Tui
Fantail

and other urban adaptive species including
Sparrows
Blackbirds
Starlings
Pigeons
Seagulls

Since lockdown and a reduction in human activity there has also been a noticeable increase in Tui as well as an introduction of Kaka and Kereru not often seen in these spaces before.

The steep slopes have left large parts of the valley full of vegetation and the narrow, winding roads slow cars while a lack of personal or street parking encourage residents to walk over owning a car Aside from Aro Street, most roads are either cul-de-sacs or closed loops. There is little reason for through traffic so any cars or pedestrians are likely to be from the area.

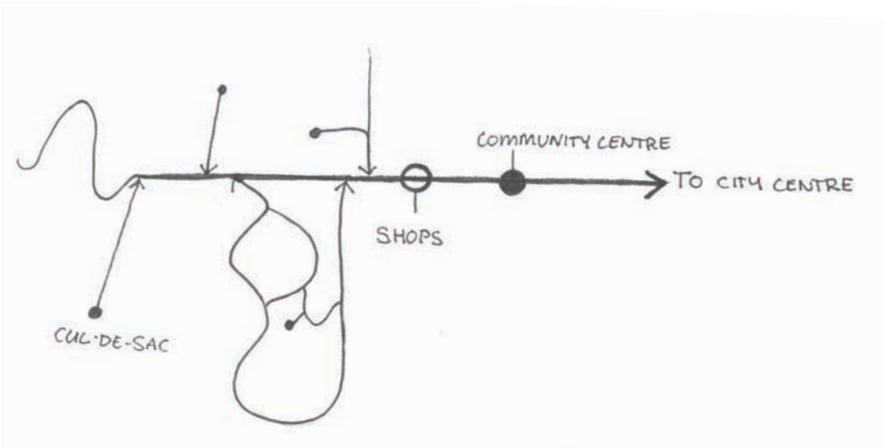


Figure 29. Diagram of Street Layout in Aro Valley.

These show design examples of how to achieve

Design implication 2: limit car speeds within development

Design Implication 1: minimise car use within the development through encouraging / accommodating public transport links

Figure 30. Invasive Weed Species

Figure 31. Slopes Difficult to Maintain.

Figure 32. Soil Erosion.

Figure 33. Vegetation in Valley Centres.

PUBLIC / PRIVATE CONFLICT

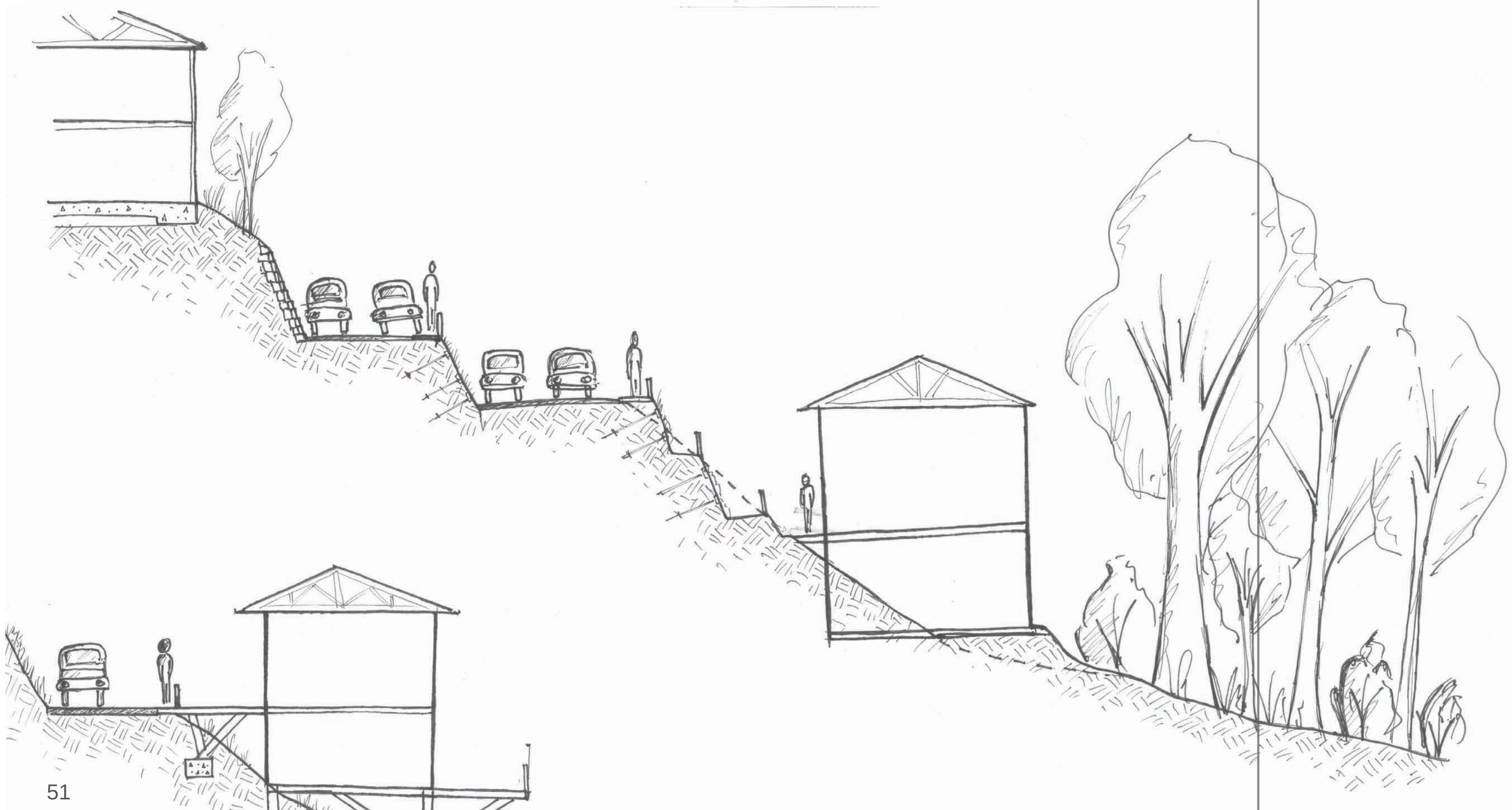
Much of the Valley is situated on hills so residents get a fair amount of privacy. However, this does lead to residential streets having little frontage and feeling unsafe to be a pedestrian on at night.

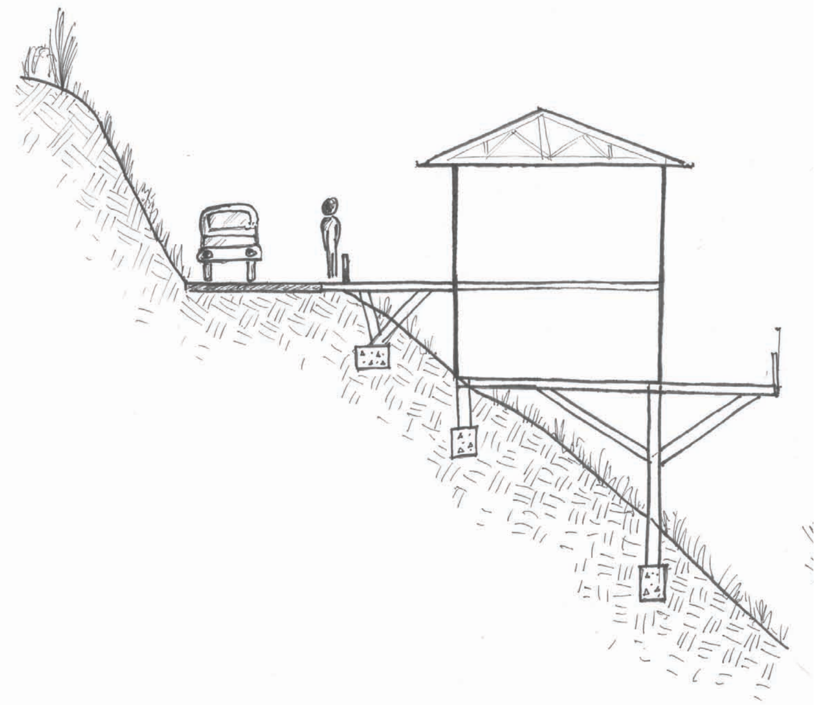
Figure 34. Lack of Housing Frontage.

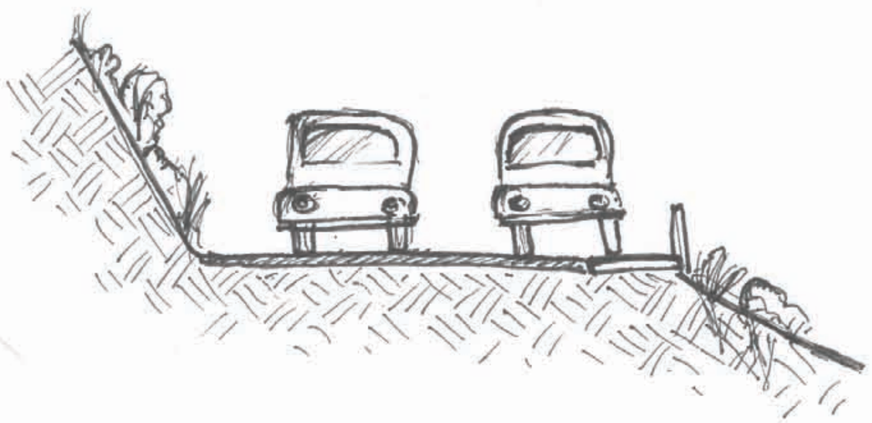
In contrast, the main street has building frontages right on the footpath or only a metre or so back. The benefit of this is that you feel quite safe - you feel as if people can see you. The downside of this is that every house has their curtains closed constantly - because you can see them.

Figure 35. Housing on Main Road with Curtains Closed.

Observations in relation to
Design objective 1: implementation of medium density in suburban context







Steep cuts into the side of cliffs means there has been many localised slips in the area, however many of the slopes are supported by weedy vegetation that although typically not liked, does hold the hill in place.

Reinforcement of
DESIGN IMPLICATION 18: minimise earthworks through stilt housing

Figure 36. Construction Techniques that Minimise Earthworks.

REFLECTION

The precedents gave design examples for several existing design implications, as well as the development of four new design implications:

Design Implication 20: Use housing orientation to create small communities through a mix of street frontage and internally facing housing groups

Design implication 21: Nodes of open space used to encourage walking and engagement with forested areas

Design implication 22: Open spaces to include understory planting with thinning trees to create view shafts encourages biodiversity and allows sunlight into space.

Design implication 23: Transitional levels of human interaction with patches to reflects species sensitivity.

And the expansion of Design Implication 1: minimise car use within the development **through encouraging / accommodating public transport links.**

The table is updated to show how precedents have informed or adressed the findings from the literature review. These will be synthesised into a set of design principles from which to start designing in the next chapter,

Implication groupings		Literature Review	Precedent Review
Transportation	Design Implication 1	minimise car use within the development	Example of how to action - Design to accommodate public transport routes. Make parking difficult.
	Design implication 2	limit car speeds within development	Example of how to action - narrow roads
Vegetation	Design implication 6	Provide human-free areas within recreation patches to allow birds to nest undisturbed.	Example of how to action - Zealandia
	Design Implication 3	Restrict human movement to designated paths within natural areas to help habituate birds to human activity.	Example of how to action - Zealandia
	Design Implication 23		**Transitional levels of human interaction with patches to reflect species sensitivity**
	Design Implication 7	locate patches to utilise natural succession including seed source and spread.	
	Design implication 8	provide several medium sized patches within the development.	
	Design implication 9	where possible, provide continuous vegetated corridors between vegetation patches. If Steppingstone connections are being implemented, minimise distance travelled between resting spaces.	
	Design implication 10	Patches should be shaped with non-linear edges to increase edge sizes while maintaining a large and healthy core.	
	Design implication 11	Edges should reflect a natural gradient of species that would typically occur in each habitat type, including a varied and complex understory planting.	
	Design objective 4	Develop of a re-vegetation outline that compliments residential development.	
	Design objective 5	minimise negative impacts of edge conditions	
Housing	**Design objective 1**	implementation of medium density in suburban context	observations: public private conflict.
	Design objective 3	reduce the impact of housing and urban parks on birdlife to allow co-habitation in these areas.	
	Design objective 2	encourage residents' engagement with local wildlife and natural habitats.	Design objective 3 turns into design implications 25 & 26
	Design implication 21		Use nodes of open space to encourage walking and engagement with forested areas
	Design implication 22		Open spaces to include understory plantings with thinning trees to create view shafts encourages biodiversity and allows sunlight into space.
	Design implication 20		Use housing orientation to create small communities
Lighting	Design implication 12	Only light up trees where birds will not be nesting (eg street trees and key residential trees only). Limit lighting in forested areas.	
	Design implication 13	design public lighting to limit skyward projection and select hues that interfere the least with sleeping patterns (blue and green light).	
	Design implication 14	Additional mitigation: ask residents to buy UV reflective collars for pets to make them easy to see by native birds.	
Water systems	Design implication 15	50m buffers to main waterways, 20m buffers to headwaters where possible	
	Design implication 16	Minimise channelling of waterways and maintain a naturalised stream bed where possible.	
	Design implication 17	Manage water use through rainwater harvesting and grey water recycling.	Example of how to action
Earthworks	Design implication 18	minimise earthworks	Example of how to action - stilt housing
	Design implication 19	vegetate steep slopes for soil stability	
	Design implication 4	reduce impermeable surfaces.	Example of how to action
	Design implication 5	Prioritise rejuvenation of soil and access to insect food sources.	

05

DESIGN PRINCIPLES

Throughout the literature review, several design implications were pulled out that reflect the key aspects of designing for cohabitation.

These implications begin to form a ‘brief’ from which to begin the design process, both by informing initial design decisions and subsequently investigating the soundness/applicability of these implications within a practical setting. To this end, they are open to change as the design investigation furthers an understanding of cohabitation within suburbia.

DESIGN PRINCIPLE 1 – MINIMISE CAR USE, MAXIMISE WALKABILITY

Design Implication 1: Minimise car use within the development through encouraging / accommodating public transport links.

Design Implication 2: Limit car speeds within the development

Design Implication 21: Use nodes of open space to encourage walking and engagement with forested areas

Design Implication 22: Open spaces to include understory plantings with thinning trees to create view shafts encourages biodiversity and allows sunlight into space.

DESIGN PRINCIPLE 2 – PROVIDE WELL CONNECTED NATIVE VEGETATED PATCHES

Design Implication 7: Locate patches to utilise natural succession including seed source and spread.

Design Implication 8: Provide several medium sized patches within the development.

Design Implication 9: Where possible, provide continuous vegetated corridors between vegetation patches. If Steppingstone connections are being implemented, minimise distance travelled between resting spaces

Design Objective 4: Develop of a re-vegetation outline that compliments residential development

DESIGN PRINCIPLE 3 – DESIGN EDGES TO MINIMISE IMPACT

Design Implication 10: Patches should be shaped with non-linear edges to increase edge sizes while maintaining a large and healthy core.

Design Implication 11: Edges should reflect a natural gradient of species that would typically occur in each habitat type, including a varied and complex understory planting

DESIGN PRINCIPLE 4 – TRANSITION LEVELS OF HUMAN INTERACTION RELATING TO BIRD ACTIVITY

Design Implication 6: Provide human-free areas within recreation patches to allow birds to nest undisturbed.

Design Implication 3: Restrict human movement to designated paths within natural areas to help habituate birds to human activity.

Design Implication 23: Transition levels of human interaction with patches to reflect species sensitivity.

DESIGN PRINCIPLE 5 – PROVIDE STRONG VISUAL AND PHYSICAL CONNECTIONS BETWEEN HOUSING AND NATURAL SPACES

Design Objective 1: Implementation of medium density in suburban context

Design Objective 3: Reduce the impact of housing and urban parks on bird life to allow cohabitation in these areas.

DESIGN PRINCIPLE 6 –CREATE SMALL, LOCAL COMMUNITIES

Design Implication 20: Use housing orientation to create small communities

DESIGN PRINCIPLE 7 – MINIMISE LIGHTING IMPACT

Design Implication 12: Only light up trees where birds will not be nesting (eg street trees and key residential trees only). Limit lighting in forested areas.

Design Implication 13: Design public lighting to limit skyward projection and select hues that interfere the least with sleeping patterns (blue and green light).

Design Implication 14: Additional mitigation: ask residents to buy UV reflective collars for pets to make them easy to see by native birds

DESIGN PRINCIPLE 8 – IMPROVE WATER QUALITY

Design Implication 15: 50m buffers to main waterways, 20m buffers to headwaters where possible

Design Implication 16: Minimise channelling of waterways and maintain a naturalised stream bed where possible.

Design Implication 17: Manage water use through rainwater harvesting and grey water recycling.

DESIGN PRINCIPLE 9 –MINIMISE EARTHWORKS AND INCREASE SLOPE STABILITY

Design Implication 18: Minimise earthworks

Design Implication 19: Vegetate steep slopes for soil stability

Design Implication 4: Reduce impermeable surfaces

Design Implication 5: Prioritise rejuvenation of soil and access to insect food sources

06

CASE STUDY
PLIMMERTON FARMS
PORIRUA

Plimmerton Farms is a 365ha agricultural farm identified as a future growth area for Porirua. The Porirua City Council undertook a Streamline Plan Change to rezone the area from ‘Rural’ under the Porirua District Plan to a new ‘Special Purpose Zone’ that allows residential development.

The site is North of the city along the main highway with steep typography providing views of Porirua Harbour, Plimmerton Township and further out to sea.

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Figure 37. View from Plimmerton Farms.

Winter, C. (2016). *Plimmerton Farm may become Wellington's next suburb.* Retrieved from https://www.stuff.co.nz/business/industries/76062103/plimmerton-farm-may-become-wellingtons-next-suburb

Figure 38. Lower North Island
NOT TO SCALE

KEY

TRAIN LINE

PORIRUA REGION

REGIONAL BOUNDARIES

Figure 39. Wellington Region
NOT TO SCALE

DENSITY

Porirua City is an example of classic New Zealand suburban growth. The city has been continually expanding since the 1940's, in part due to its close location to Wellington City, with over half the working residents commuting out of Porirua city (Idcommumity, n.d.). Despite growing trends towards densification, it was only in the 2019 GrowthStrategy that Porirua City Council amended zoning laws to allow residential housingwithin the city centre and medium density within residential areas. Thus, nearly allhousing in Porirua is currently suburban lots[1].

Footnote:
Standard residential density is considered to be "8-10 dwellings per hectare" (Boffa Miskell Limited, 2014, p.33) With suburban zoning rules stating a maximum site coverage of 35% of the net site area (Porirua City Council, 1999, p.21)

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Figure 40. Aotea, Porirua.
(n.d.). Retrieved from https://carrus.co.nz/developments/aotea/

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Figure 41. State Housing in Cannons Creek.
Mitchel. M. (n.d.). *Porirua Housing Development.* Retrieved from https://www.nzherald.co.nz

SCALE 1:100,000

Figure 40. Porirua Density.

OPEN SPACE

SUBURBAN LOTS

MULTI-UNIT STATE HOUSING

PORIRUA GROWTH STRATEGY

Porirua City Council is expecting an increase of 10,000 people by 2050 (Cox et al., 2018), and whilst it is now allowing density within the centre, the council continues to encourage low density sprawl, with a recent zoning change allowing Plimmerton Farms (a 365ha site) to be converted to residential housing.

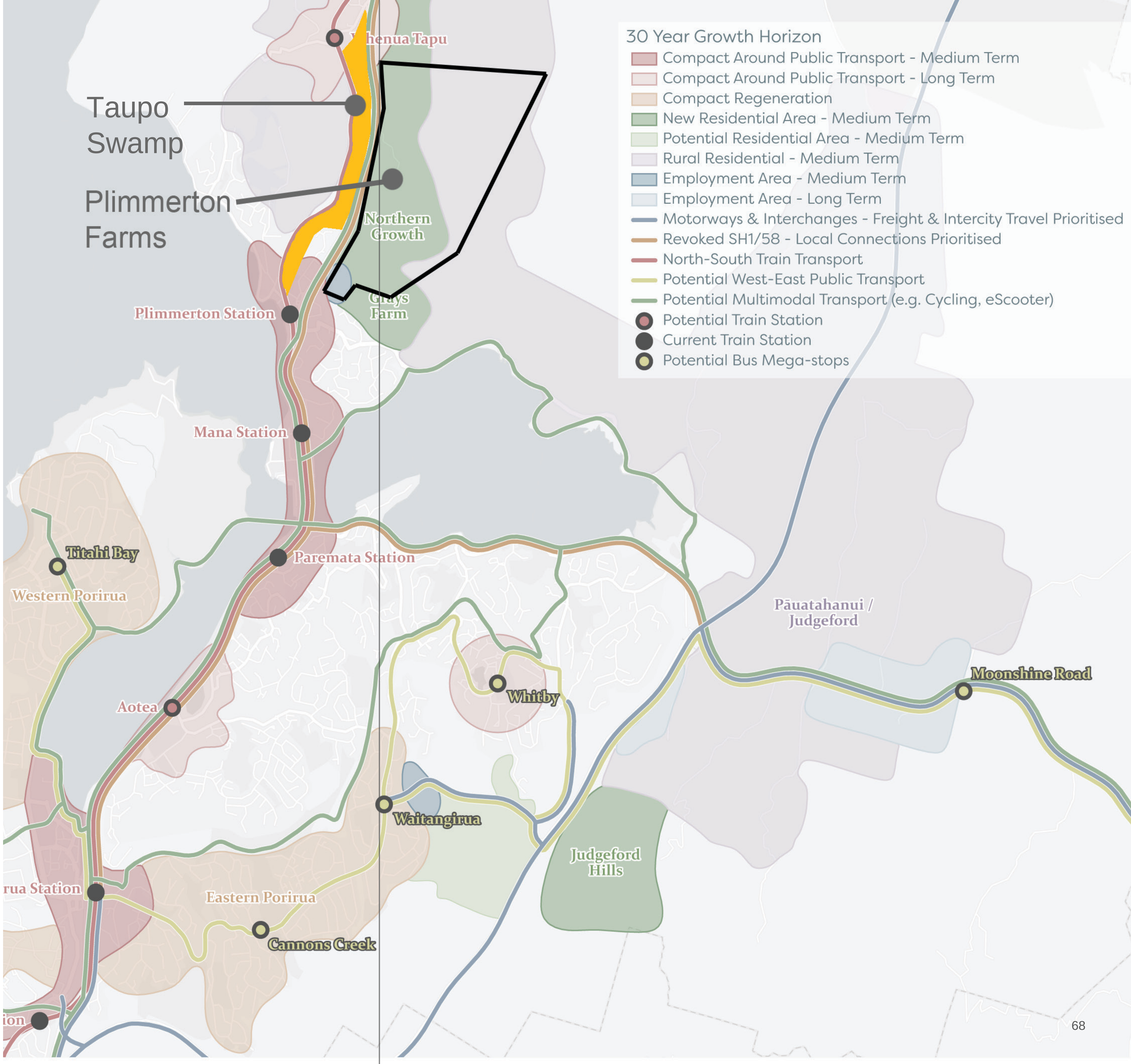


Figure 41. Porirua Growth Strategy 2048.

Porirua City Council. (2019). *Porirua Growth Strategy 2048.* Retrieved from poriruacity.govt.nz

SCALE 1:40,000

TRAIN CONNECTIONS

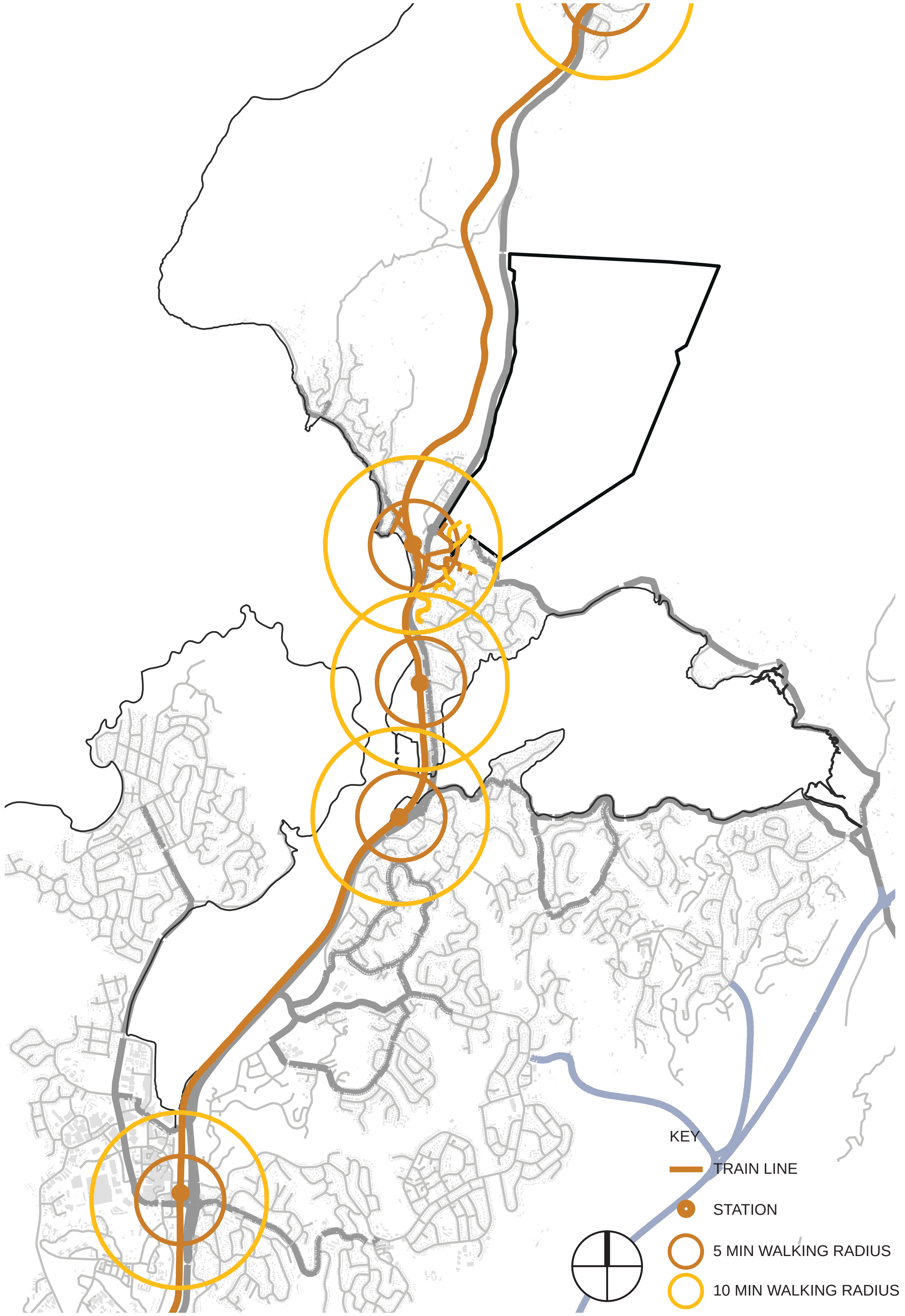


Figure 42. Porirua Train Line.

SCALE 1:50,000

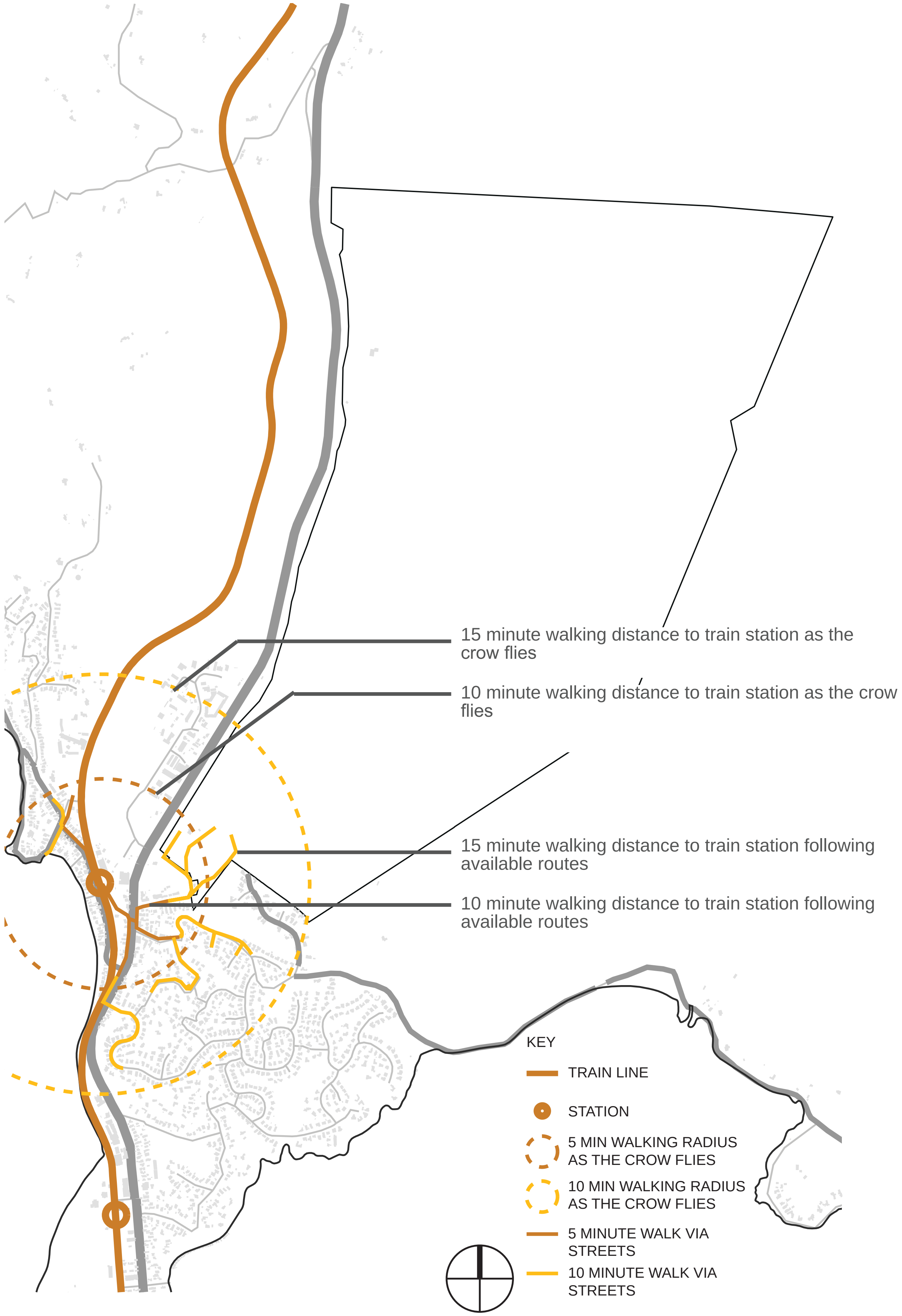


Figure 43. Plimmerton Train Station.

SCALE 1:20,000

TRANSMISSION GULLY

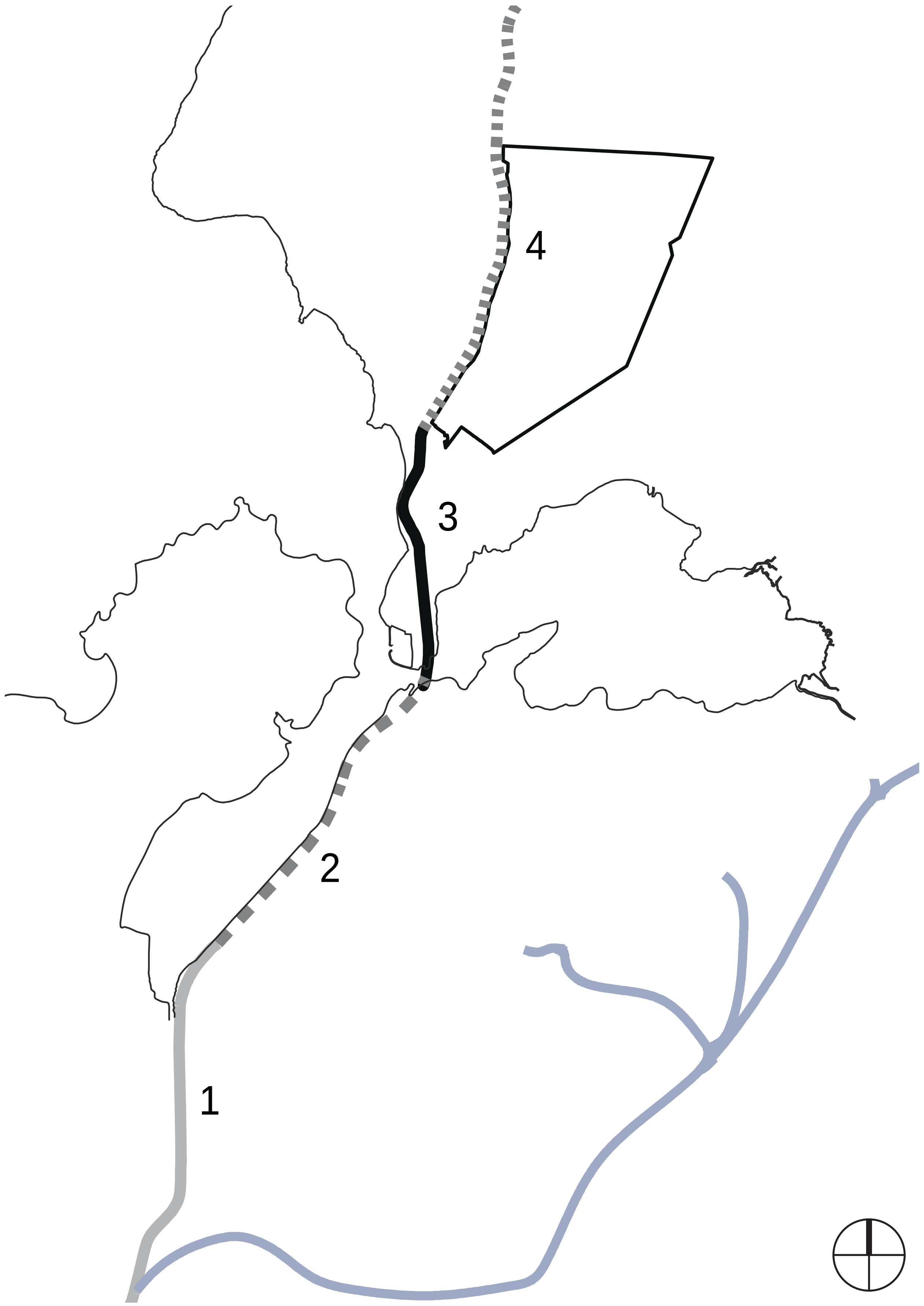
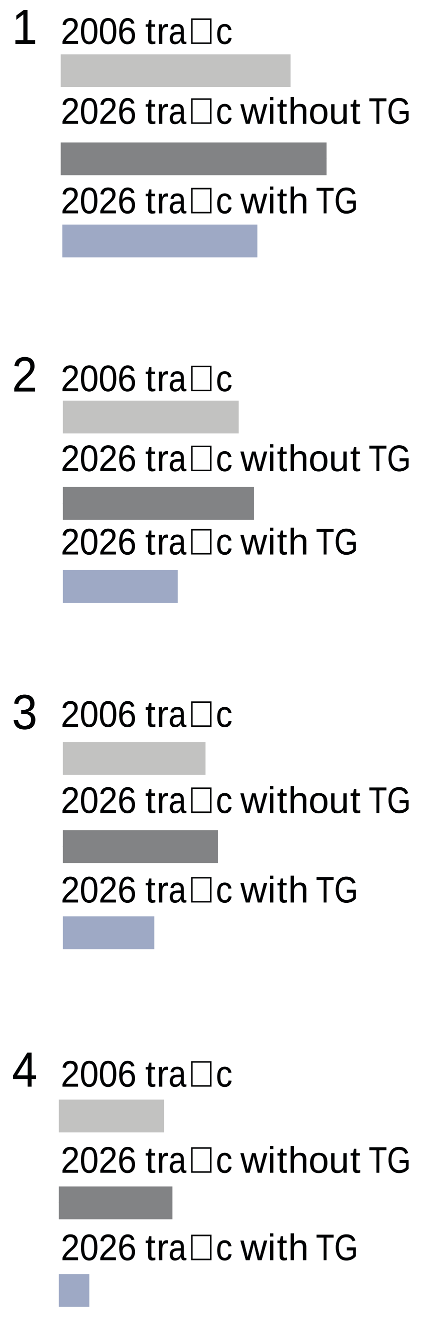


Figure 44. Transmission Gully.

SCALE 1:50,000



Transmission gully, a new road link, is currently under construction to allow long-distance travellers to by-pass Porirua City.

LAND COVER

Plimmerton Farms is located north of the city beside the main train and highway route. There are several points of ecological interest near the site, to which this development could positively impact with ecological design. This means the site is also at high risk of negatively impacting these areas should it be designed in similar ways to current market trends.

KEY

- URBAN
- EXOTIC FOREST
- EXOTIC GRASSLAND
- GREY SCRUB
- MANUKA AND/OR KANUKA
- INDIGENOUS FOREST
- URBAN PARK / OPEN SPACE
- SALTMARSH
- WETLAND
- POND

GRID = MEDIUM PATCH SIZE FOR REFERENCE

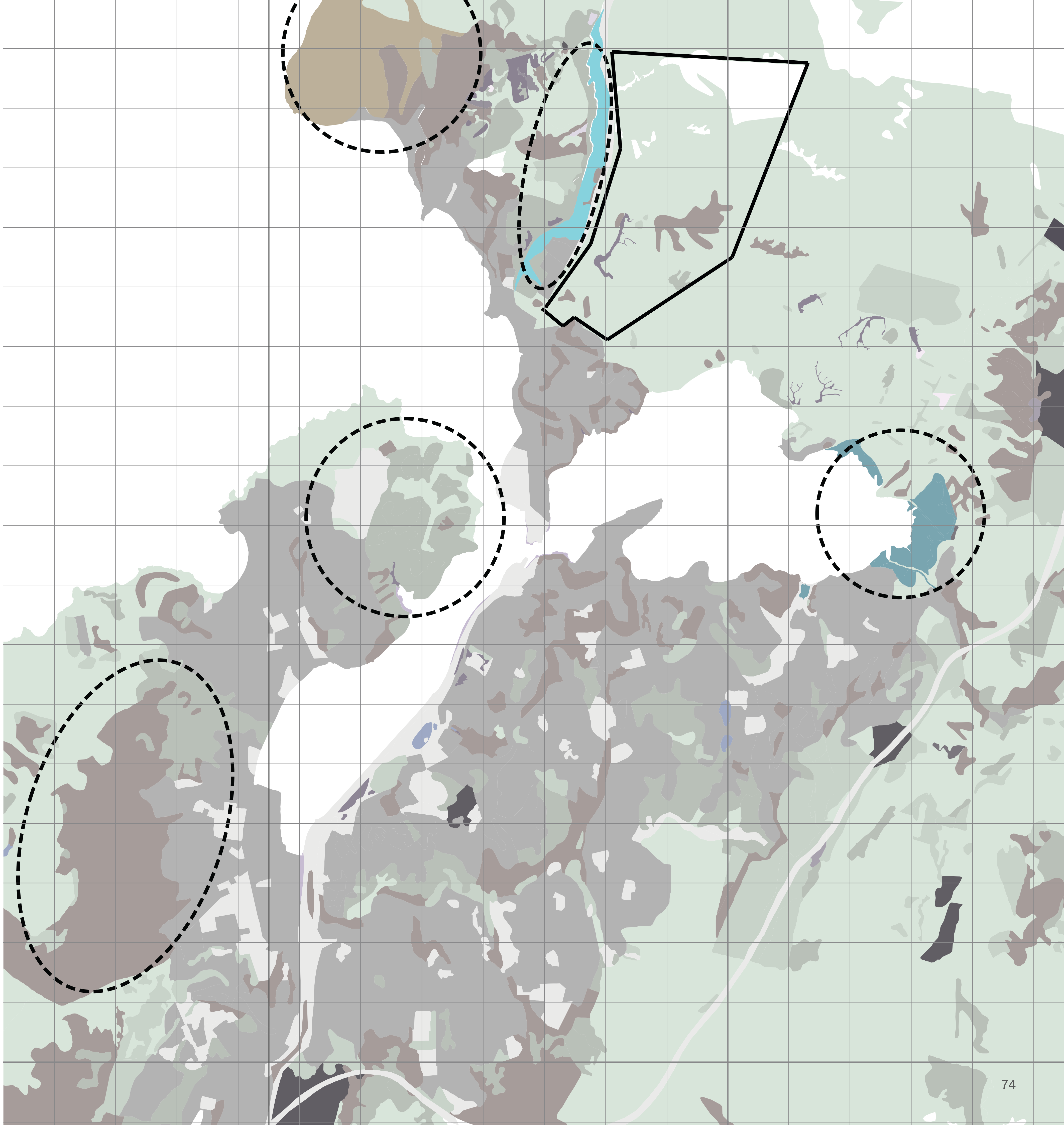


Figure 45. Regional Land Cover.

SCALE 1:35,000

TAUPO SWAMP

Development of the site was opposed by local groups due to its proximity to Taupo Swamp, a wetland next to the site identified as a Key Native Ecosystem. The Plimmerton Farms site catchment primarily drains into this swamp and locals are concerned that the earthworks, increased impermeable surfaces and increased pollution associated with residential development will have detrimental effects on water quality of the swamp; disturbing an ecosystem that supports many rare plant, fish, bird and frog species (Friends of Taupo Swamp & Catchment, n.d.)

Figure 46. Aerial View of Taupo Swamp.

QE II National Trust. (2008). *Taupo Swamp:A Wetland of National Importance.* Retrieved from https://qeiinationaltrust.org.nz/wp-content/uploads/2018/01/Taupo_Swamp.pdf

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TAUPO PA

Maori settlement of Porirua dates back to 1450, with a several tribes occupying the area, culminating in Ngati Toa in the 1820's. Taupo swamp was once an integral part of daily life for Maori living at Taupo Pa. The stream provided a rich source of food, and flax were harvested for garments, baskets and other implements.

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Figure 47. Settler Painting of Taupo Pa. 1847.
Figure 48. Settler Painting of Taupo Pa. 1848.
Plimmerton Residents Association. (2016). *Early Paintings of Taupo Pa.* Retrieved from https://www.plimmerton.nz/early-maori/early-paintings-of-taupo-pa/

The cohabitation goal of this project reflects the Maori value of Kaitiakitanga, which is the management and conservation of the environment in a reciprocal relationship whereby humans are a part of the natural world.

The Plimmerton Farms development will have a direct impact on Taupo Swamp, and as such offers an opportunity to development from an ecological point of view that is more aligned with manawhenua than common development trends.

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07

SITE ANALYSIS

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Figure 49. Plimmerton Farms

Winter, C. (2016). *Plimmerton Farm may become Wellington's next suburb.* Retrieved from https://www.stuff.co.nz/business/industries/76062103/plimmerton-farm-may-become-wellingtons-next-suburb

SOIL CLASS

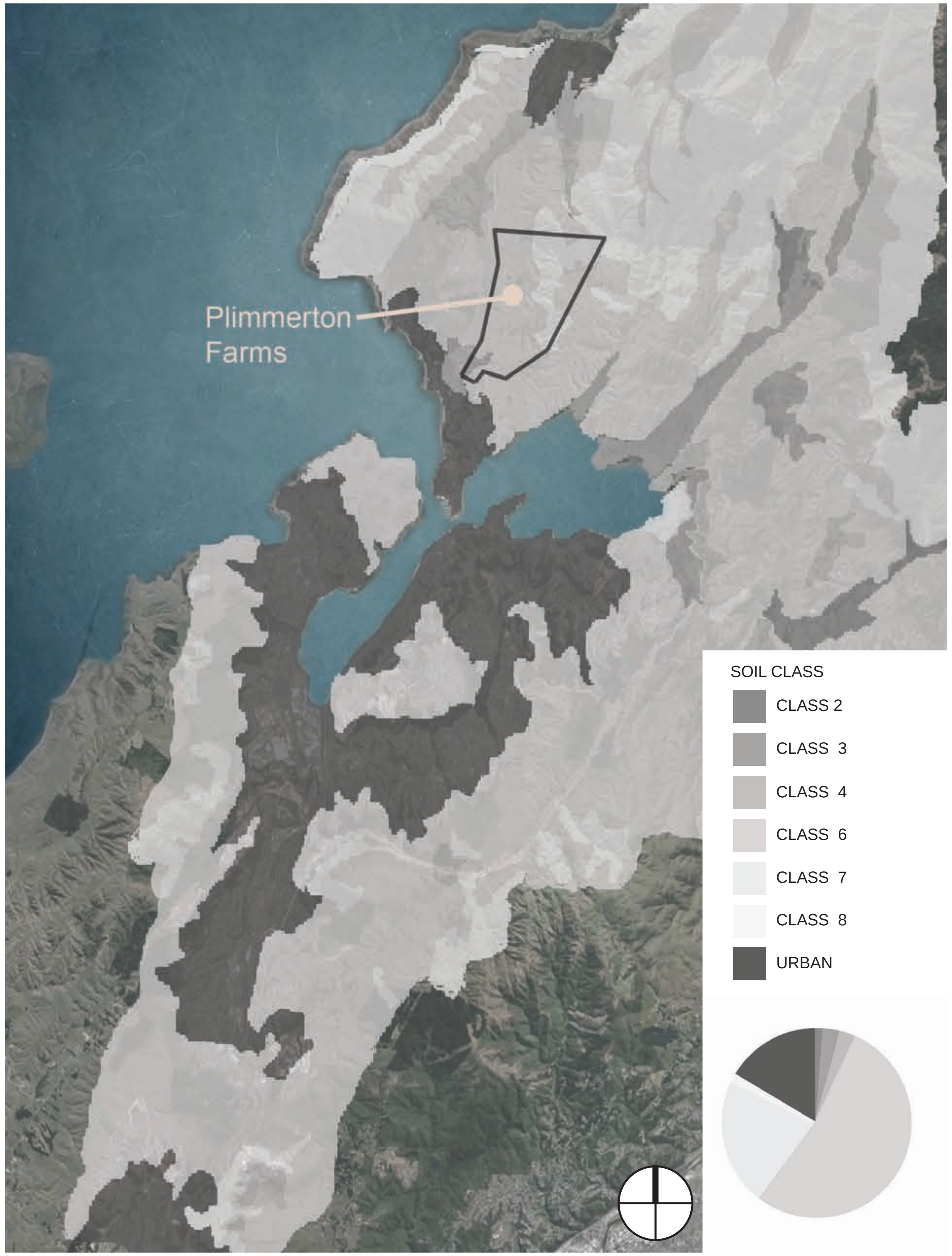

Figure 50. Porirua Regional Soil Class. SCALE 1:100,000

Following soil classifications, only 1% of the wider Porirua region is recommended for conservation, highlighting the need for integrating conservation into other land uses (GWRC, n.d.). The Plimmerton Farms site has poor production value for agriculture, but some potential for forestry. This indicates a potential land mix of native re-vegetation and low residential building would be suitable here.

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Figure 51. Soil Classifications.

Greater Wellington Regional Council. (n.d.) *Land use capability classification.* Land use capability classification. Retrieved from http://www.gw.govt.nz/assets/HANDOUT-Land-use-capability-classification.pdf

REGIONAL SLOPE

Most of the site is between 16 and 25 degree slopes

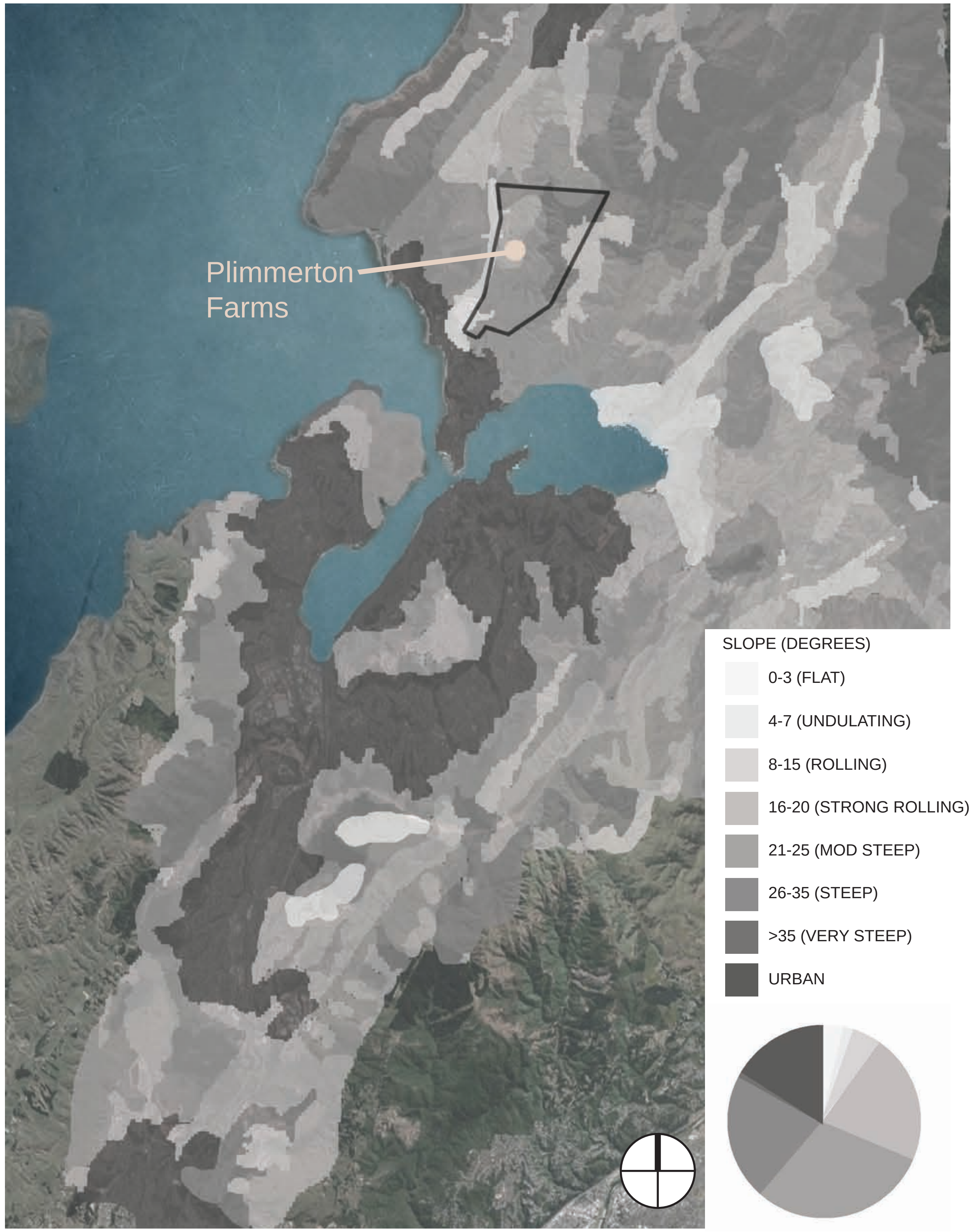

Figure 52. Porirua Regional Slope SCALE 1:100,000

EROSION SUSCEPTIBILITY

The north east corner of the site has moderate erosion susceptibility.
Lower density with more vegetation might be more suited for this part of the site.
Design principle of Minimising earthworks will need to be considered early in the process.

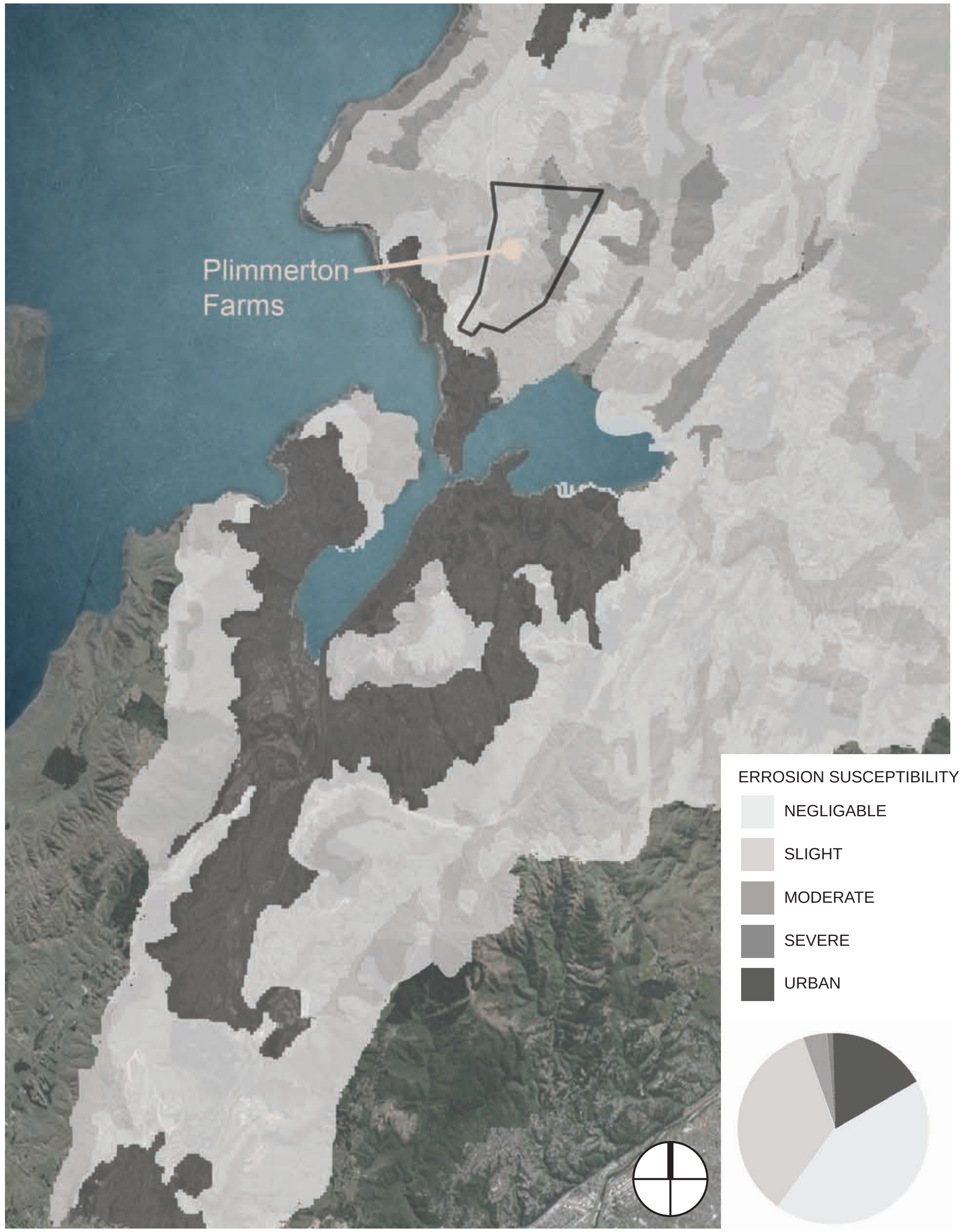

Figure 53. Porirua Regional Erosion Susceptibility. SCALE 1:100,000

TYPOGRAPHY

The site falls predominantly to the west, with the major ridgeline running along the eastern edge. The elevation ranges from 5m to 230m asl. Visual connections with Taupo swamp and Porirua harbour are a key attraction.

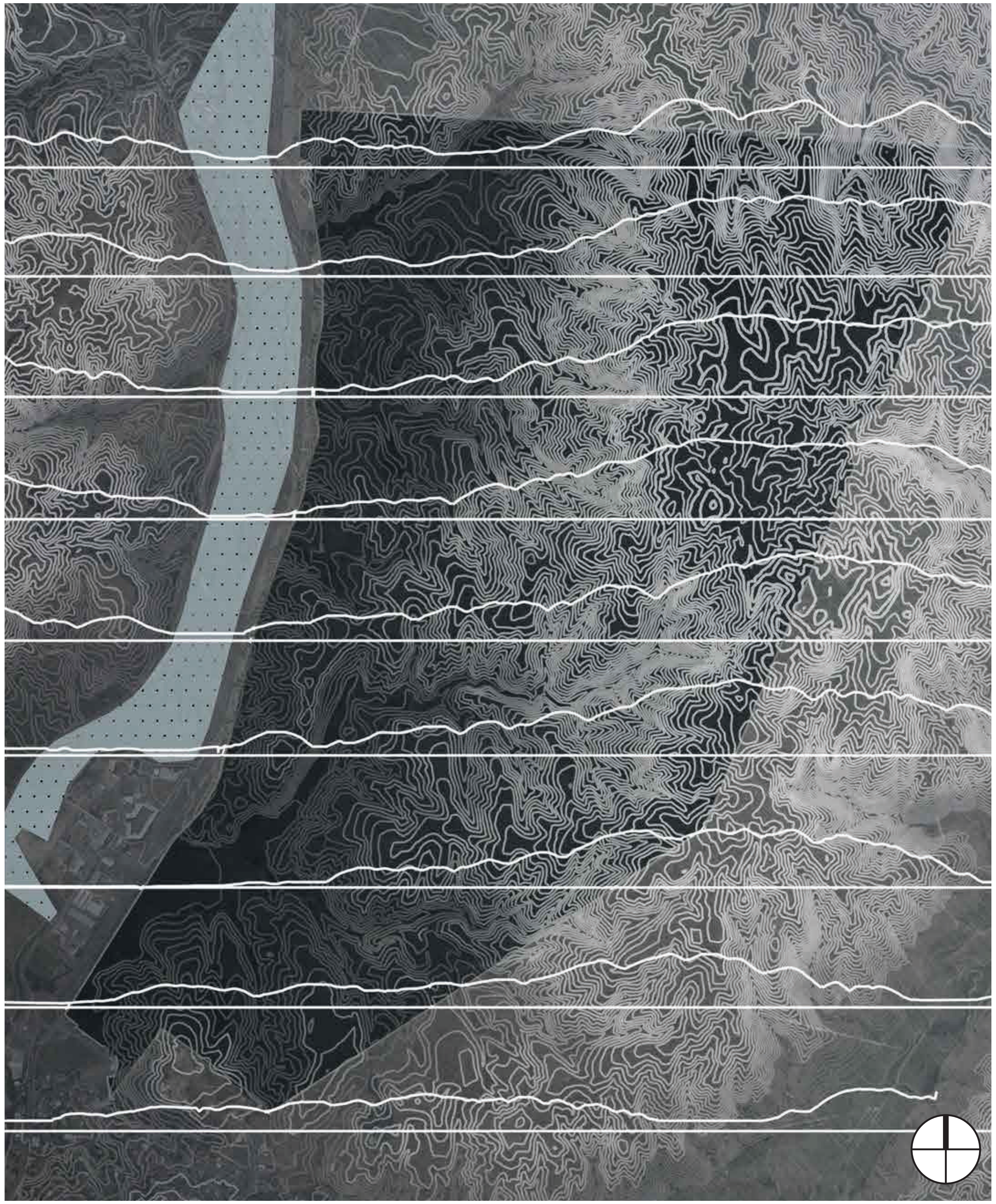

Figure 54. Site Typography SCALE 1:15,000

SLOPES

The steepest areas are the stream gullies, with the western side and ridgelines providing the gentlest slopes.

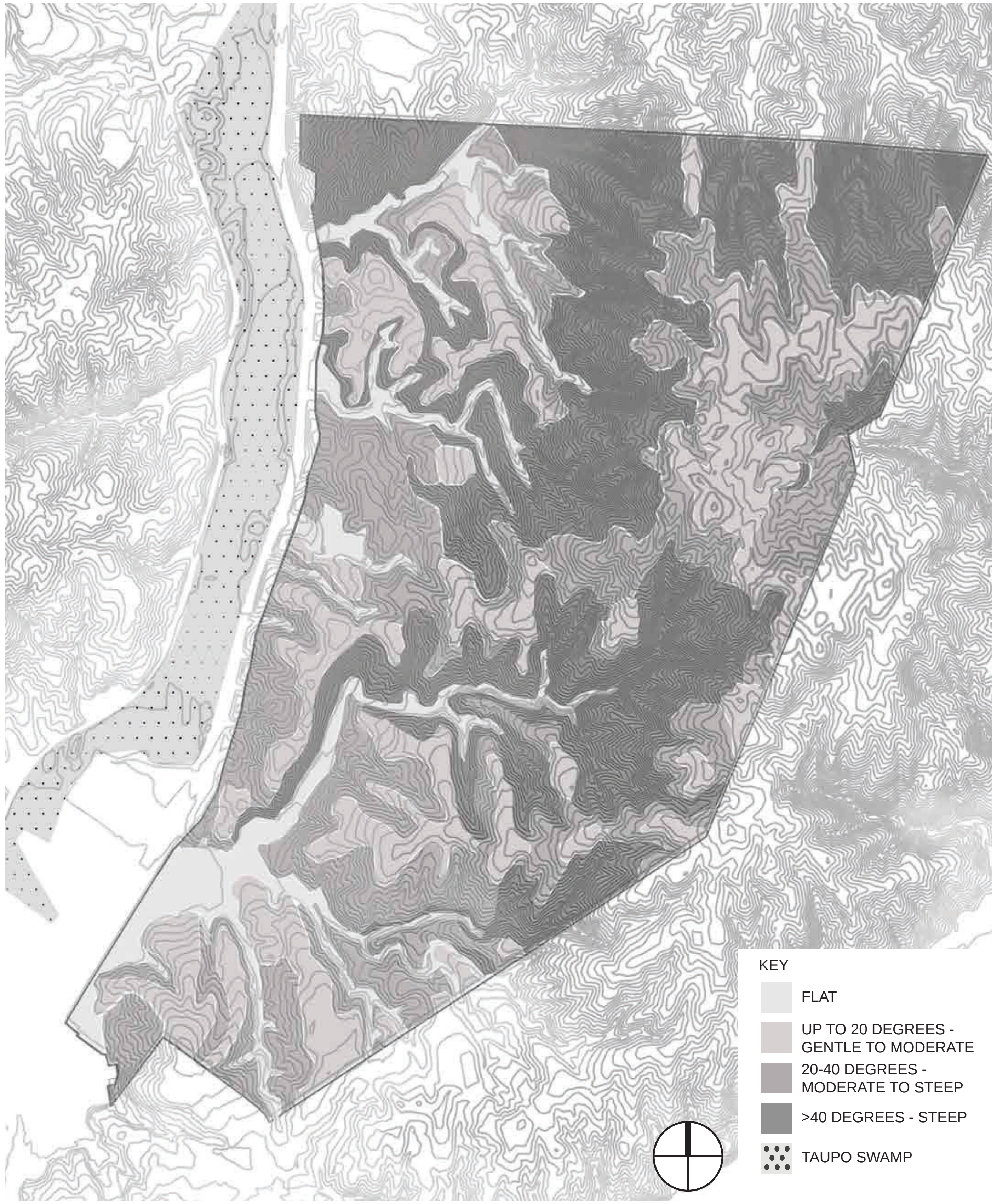

Figure 55. Site Slope SCALE 1:15,000

Figure 56. View of Site Looking North.

Figure 57. Typographical Panorama of Water Course Leading to Field at South-West of Site

SOIL FAILURE

Soil type is a greywacke base with Alluvium, silt, peat, loess and colluvial material (typically a Gravelly Silt) on top. Geotech report indicates that loess soils on site create a high risk tunnelling from water erosion.
Rain gardens and other stormwater treatments are therefore unlikely to be suitable at higher elevations and alternative locations will need to be identified (Engeo, 2018).

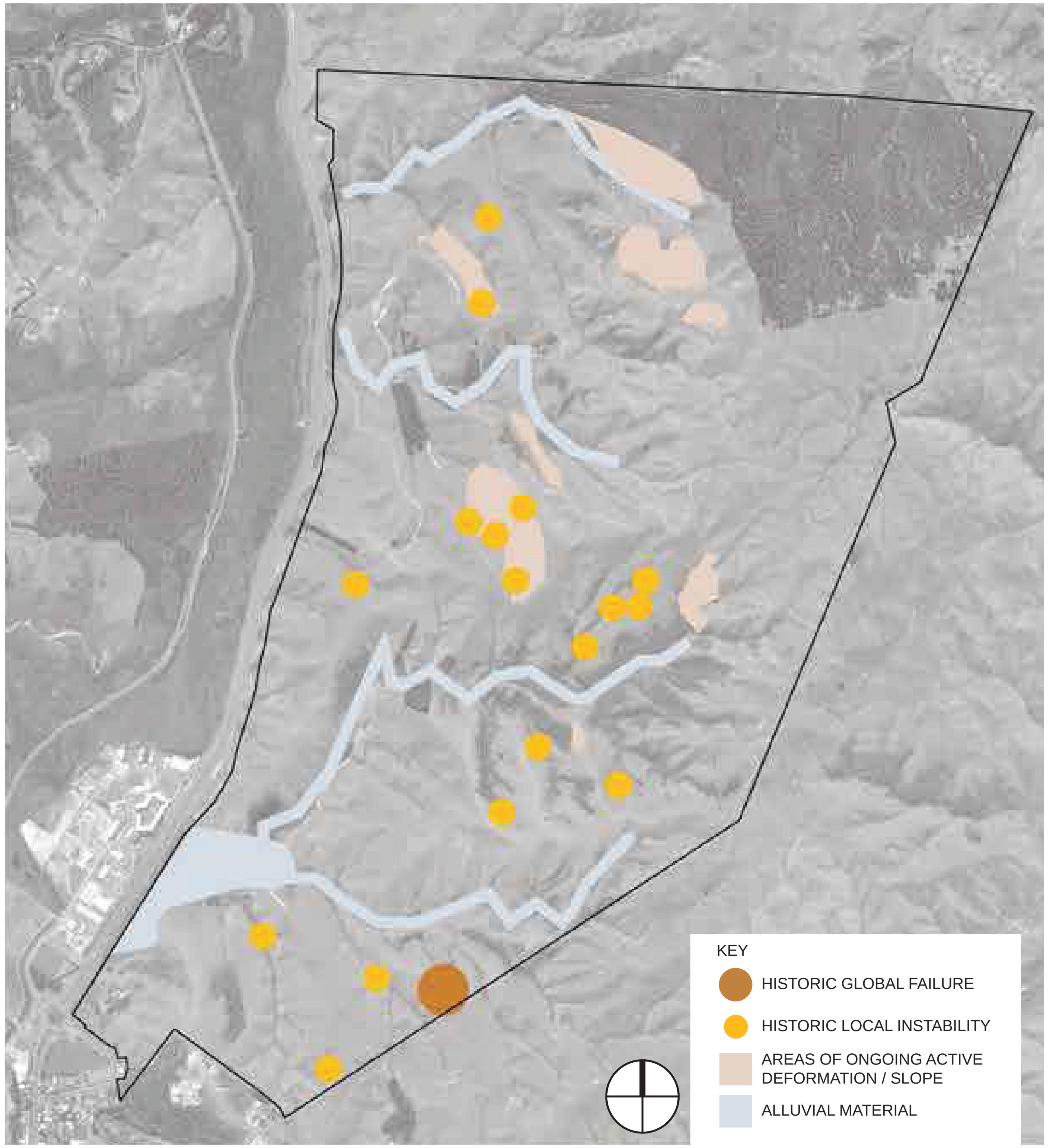

Figure 58. Soil Failure on Site

SCALE 1:15,000

Evidence of slope failure is present on site. Sites with historic slope failure may be unsuitable to build on and more suited to park spaces.

Figure 59. Evidence of Slope Failure

WATER CATCHMENT

The whole of the Porirua catchment area ultimately feeds into the two inlets of the Porirua Harbour. Most runoff from the Plimmerton Farms site will flow into Taupo Swamp and then into the Pauatahanui arm. A small percentage will flow East into Kakaho Stream before also entering the Pauatahanui arm.

KEY

- PORIRUA CATCHMENT
- SUB-CATCHMENTS
- MAIN WATER COURSE
- SECONDARY WATER COURSE
- ROAD

Figure 60. Porirua Water Catchment

SCALE 1:100,000

1921 SWAMP EXTENTS

This map of the Poruria Harbour from 1921 shows Taupo swamp once occupied a much larger area before the construction of State highway 1.

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Figure 61. 1921 Taupo Swamp Extents. [Adapted]

Eiby, G. (1990). Changes to Porirua Harbour in about 1855 : historical tradition and geological evidence. *Journal of the Royal Society of New Zealand. 20(2),* 233-248, DOI: 10.1080/03036758.1990.10426727

SCALE 1:35,000

100 YEAR FLOOD ZONE

The blue flood extents appear to be of a similar expanse to the 1921 Taupo Swamp area, suggesting the land won't be suitable for building on. Swamp wants to expand back into the site.

Figure 62. 100 Year Flood Zone

SCALE 1:35,000

SITE HYDROLOGY

There are four primary water courses on site, fed by dozens of secondary waterways and overland stream paths. Two of the low-lying areas are remnant swamp wetlands, identified as Significant Natural Areas in the Ecological assessment report, maintaining dense wetland planting and supporting some local fish species (Blaschke, 2018).

The main flat area of the site is the south-west corner, where a high water table leaves the ground damp year-round. It is not identified as an area for protection, but is a high liquefaction risk and not suitable to build on.

Figure 63. Taupo Swamp

Figure 64. Secondary Water Course

Figure 65. Flat Land at SW of Site (Previous Taupo Swamp Extents)

Figure 66. Primary Water Course. Wetland Plant Establishing, Self-seeded.

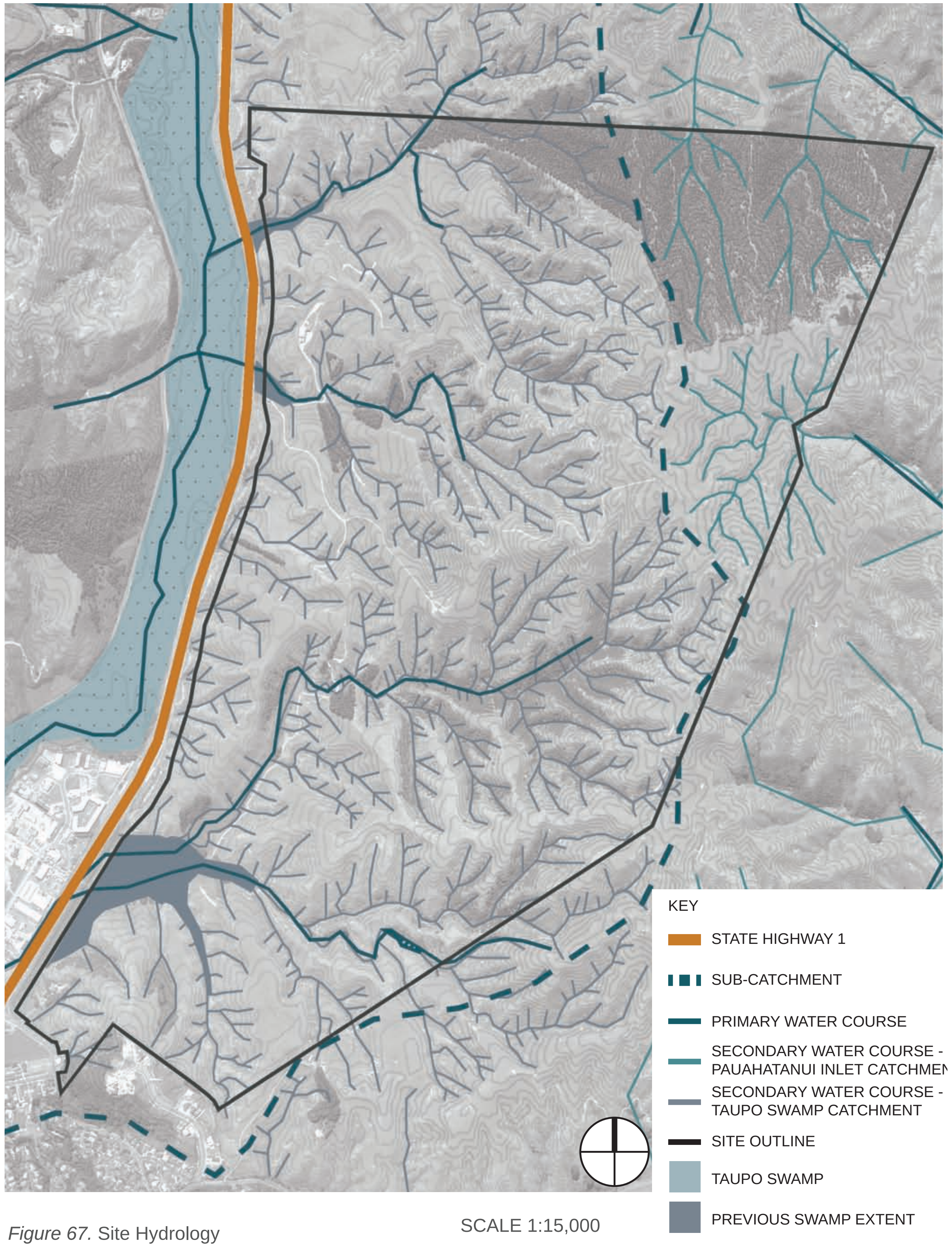

Figure 67. Site Hydrology

SCALE 1:15,000

Figure 68. South West corner of Plimmerton Farms During Height of Summer (No Recent Rainfall)

Figure 69. Flooding on the Plimmerton Domain After Moderately Heavy Rain.
Hopewell, H. (2020).

VEGETATION

The site itself is reflective of the most common land-use trend New Zealand history; the culling of forest and draining of wetlands to use for agriculture.

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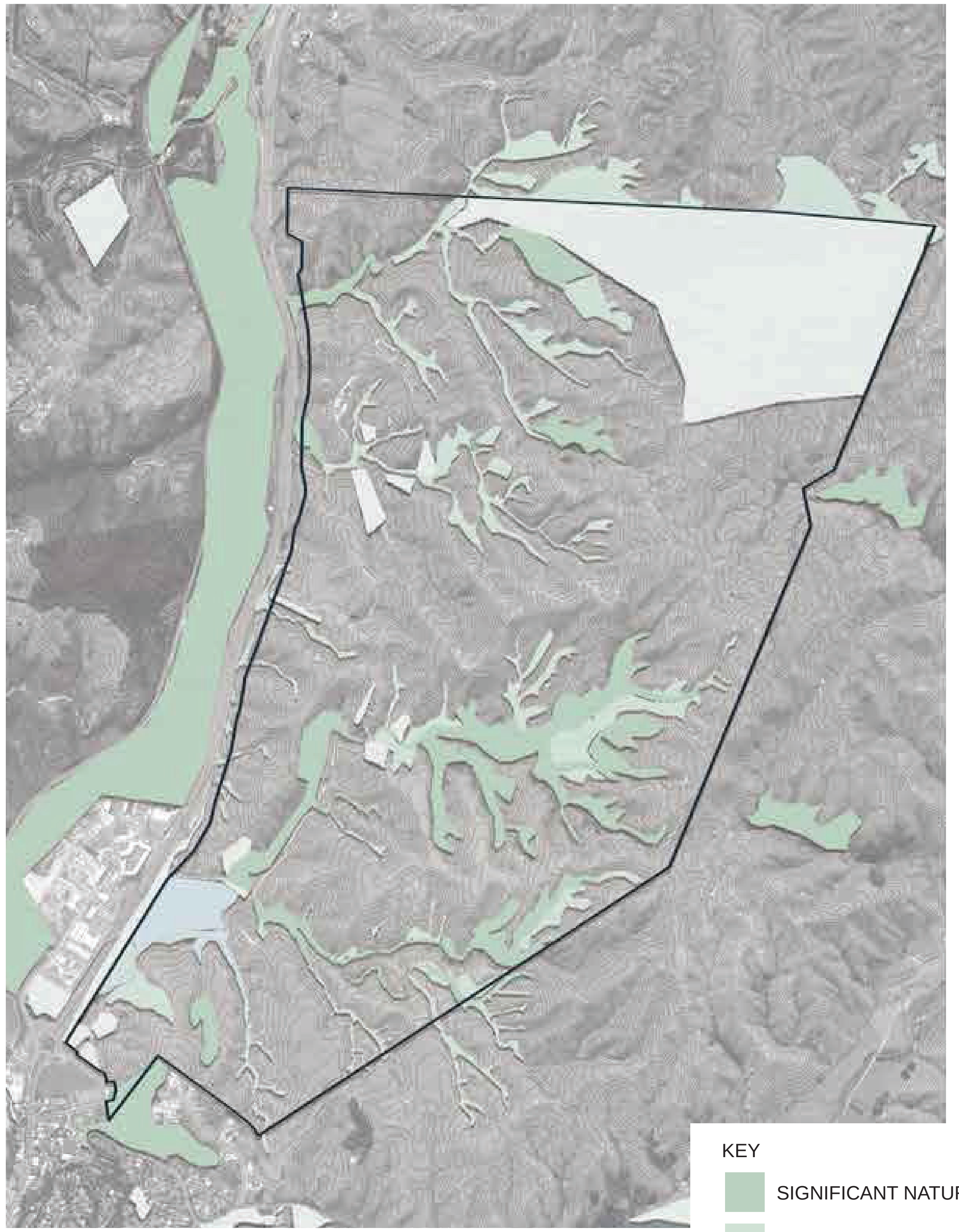
Figure 70. Angus, G. (1844). *Scene in a New Zealand forest near Porirua.*
Retrieved from https://collections.tepapa.govt.nz/object/137549

EXISTING SITE VEGETATION

Most of the site is exotic grasslands, but small areas are regenerating within the gullies, with Manuka and Kanuka bush and native wetlands lining the water courses. The ecological report outlines several areas as Significant Natural Areas (SNA) and protection of these areas will need to be considered in the development plan.



KEY
SIGNIFICANT NATURAL AREA
NATIVE VEGETATION
EXOTIC VEGETATION
WETLAND GRASS SPECIES

Figure 71. Existing Vegetation.

SCALE 1:20,000

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Figure 72. View of Revegetating Gully on Site.

Blaschke, P. (2018). *Ecological Site Assessment Summary for Draft Precinct Plan.* https://poriruacity.govt.nz/your-council/getting-involved/public-consultation/proposed-plan-change-18-plimmerton-farm/

PLANT SPECIES PRESENT ON SITE

Figure 73. Plant Species Present on Site.

PLANT SPECIES PRESENT ON SITE

Figure 74. Plant Species Present on Site.

SNA PLANT SPECIES

The flowering and seeding time of existing plant species on site indicate a clear dip in plant-based food sources over winter months. A decrease in availability is common, and many birds supplement their diets with bugs during winter months; however some species rely on seeds and berries year round. The addition of winter flowering or seeding plants will be important to include into the design to sustain bird life throughout the year.

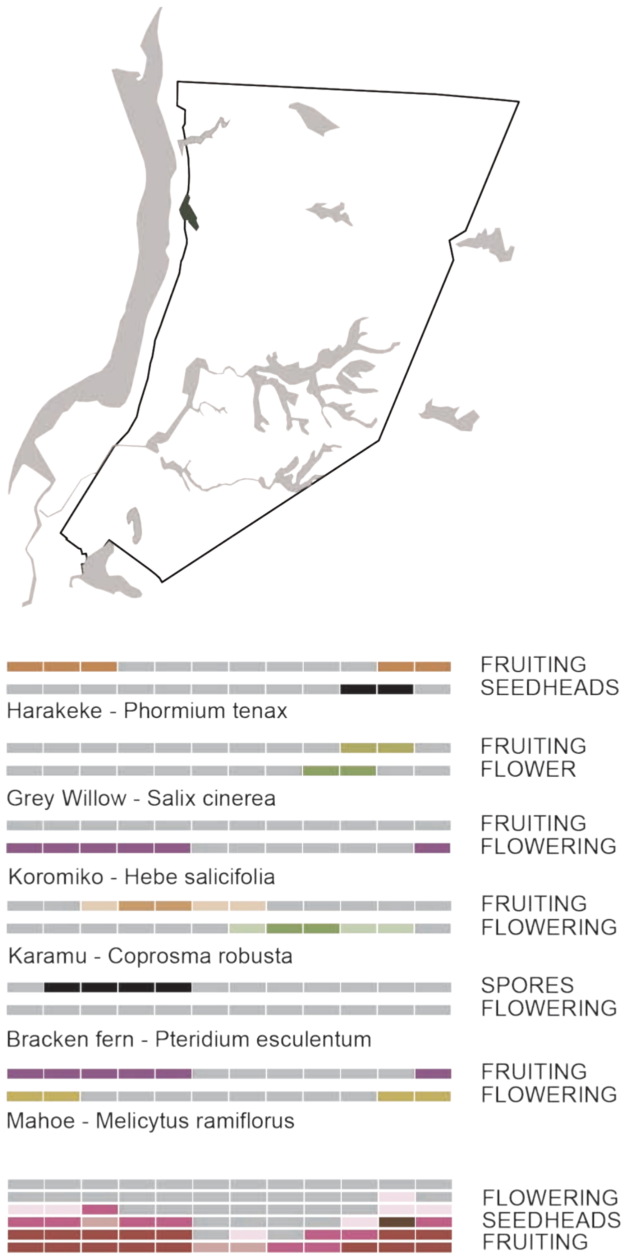

Figure 75. SNA 044

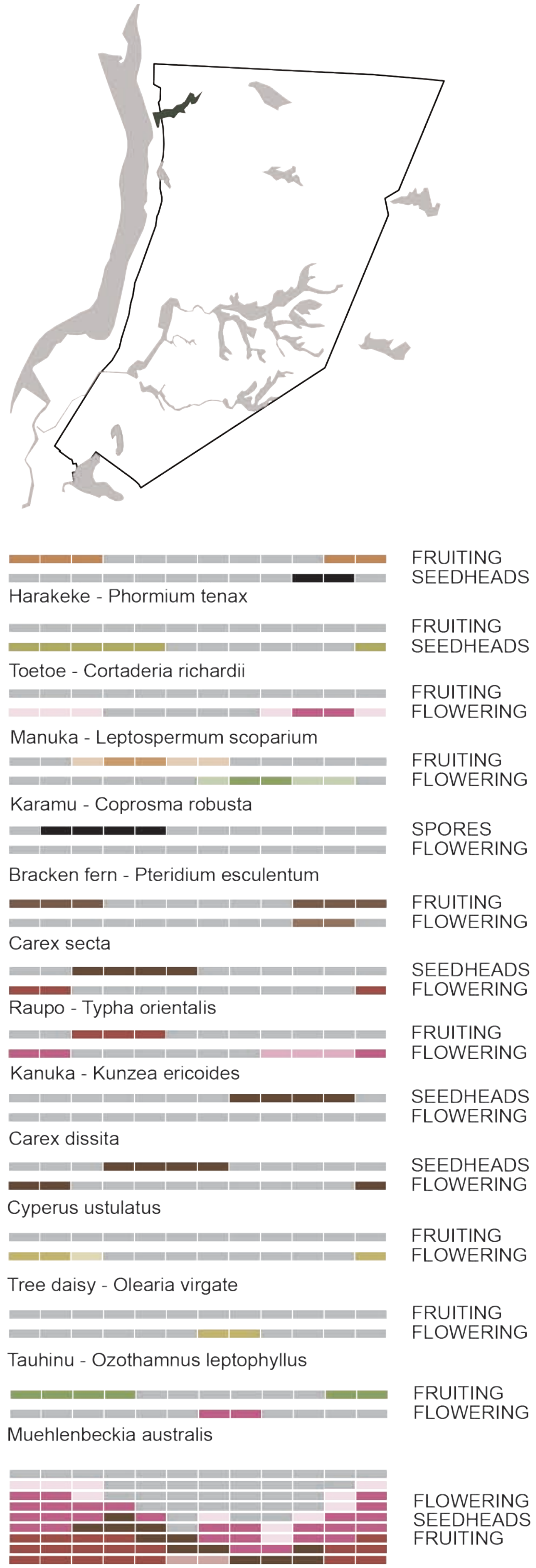

Figure 76. SNA 043

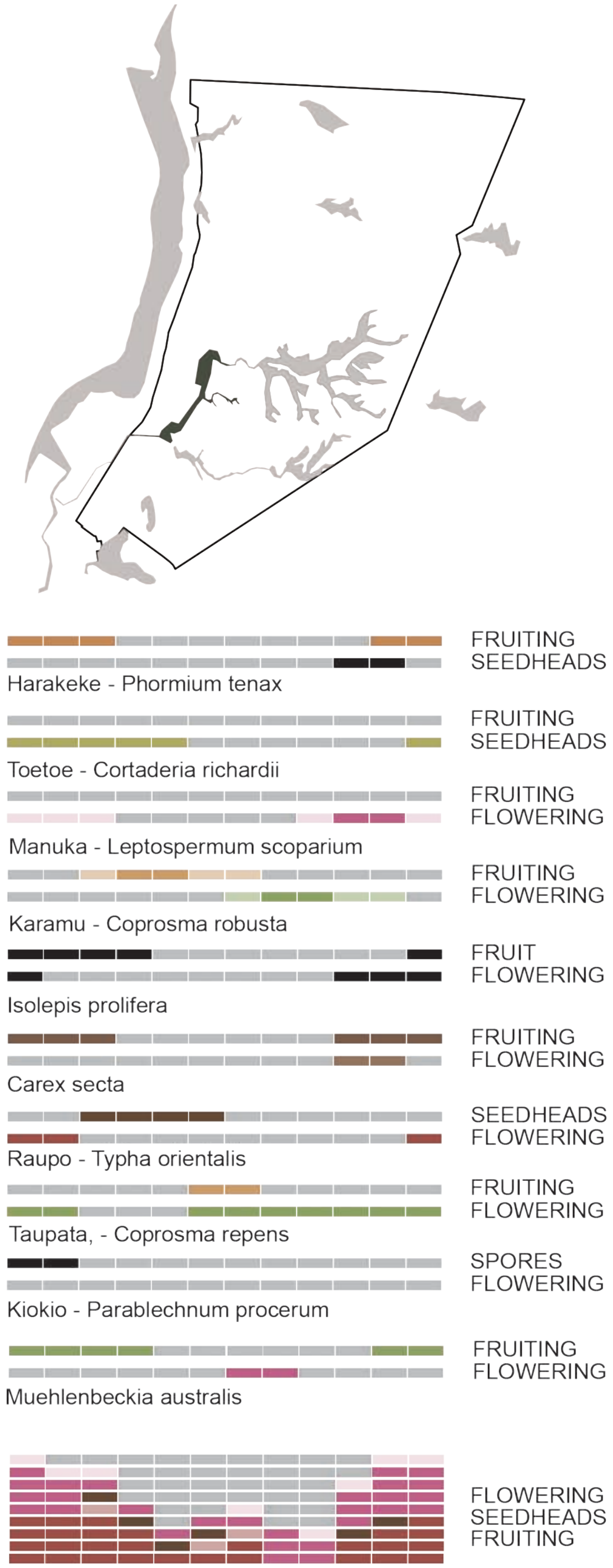

Figure 77. SNA 048

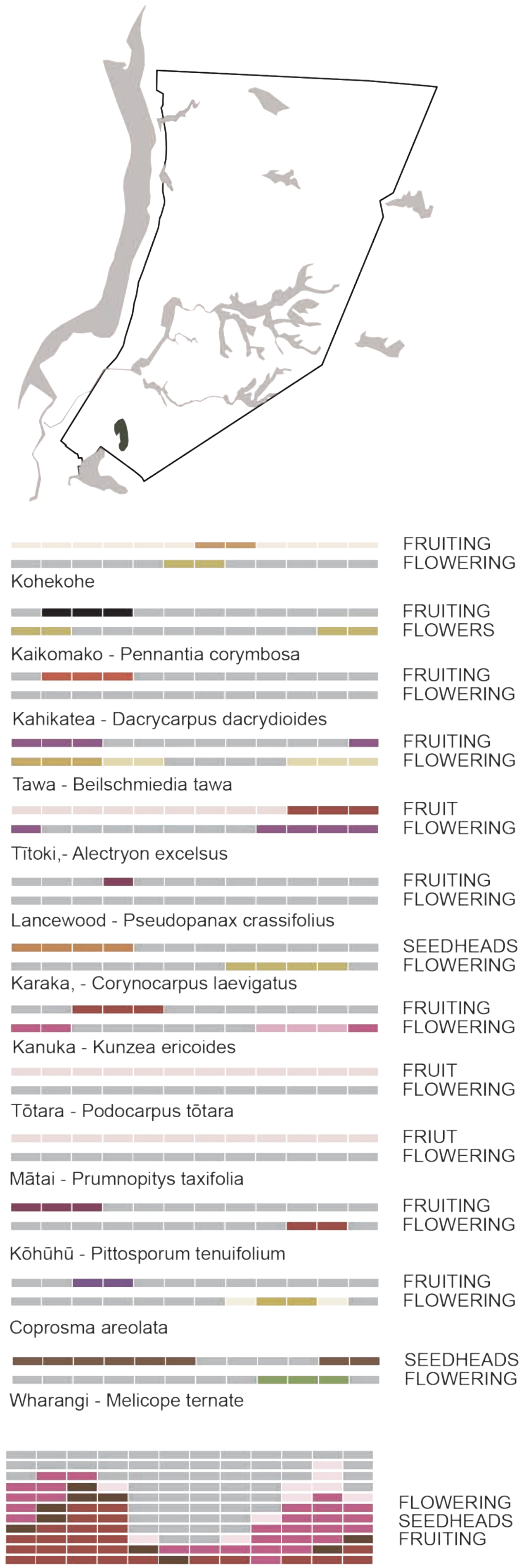

Figure 78. SNA 049

SNA PLANT SPECIES

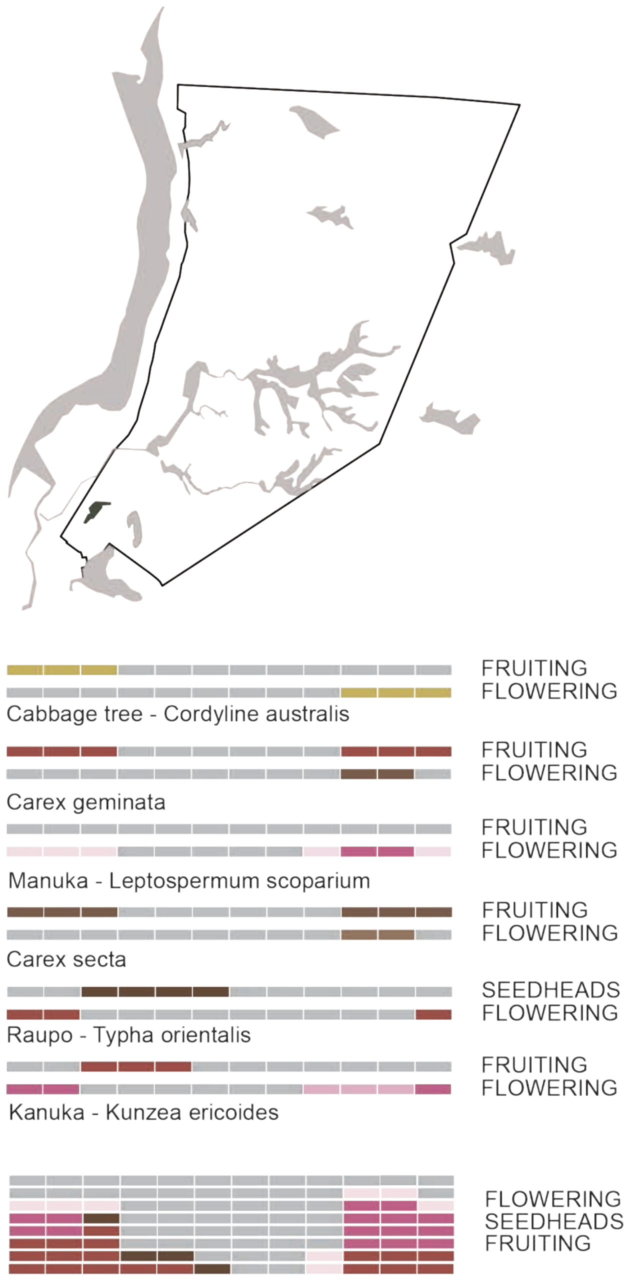

Figure 79. SNA 050

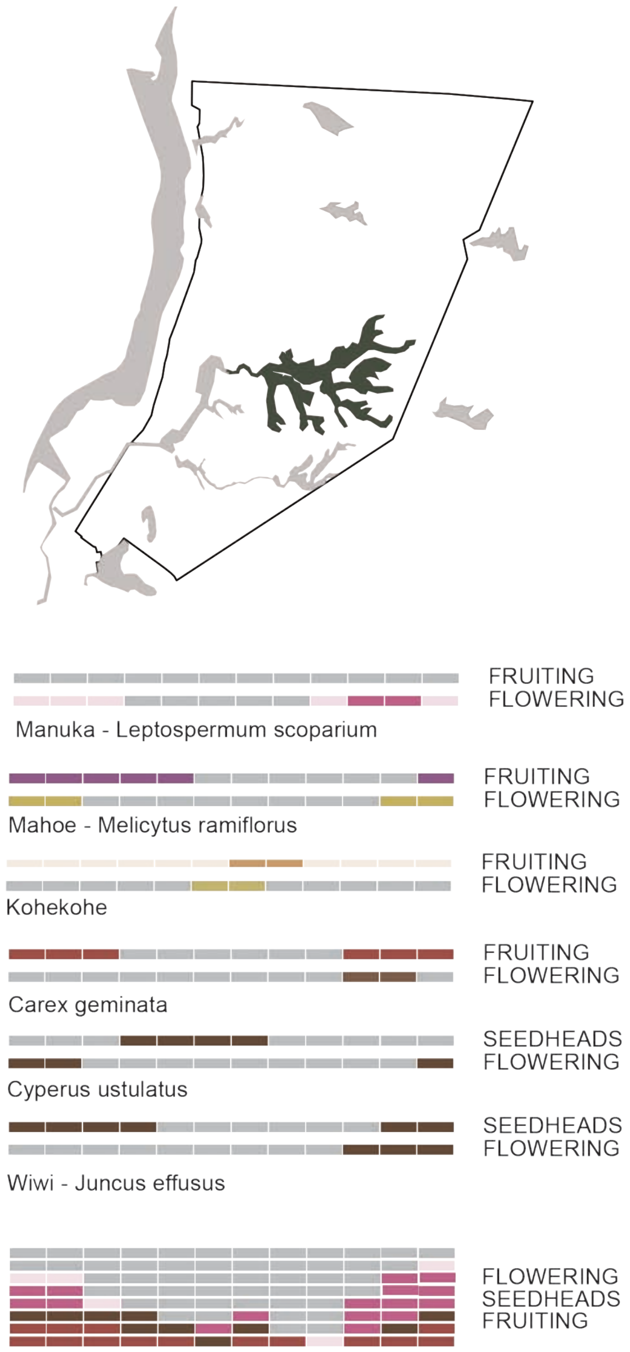

Figure 80. SNA 196

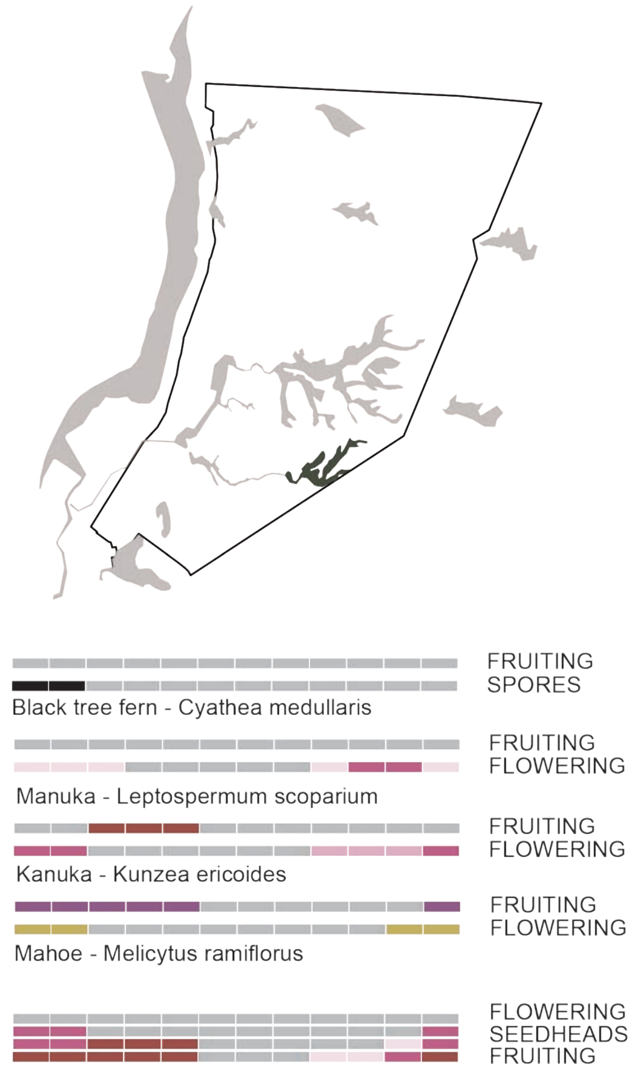

Figure 81. SNA 195

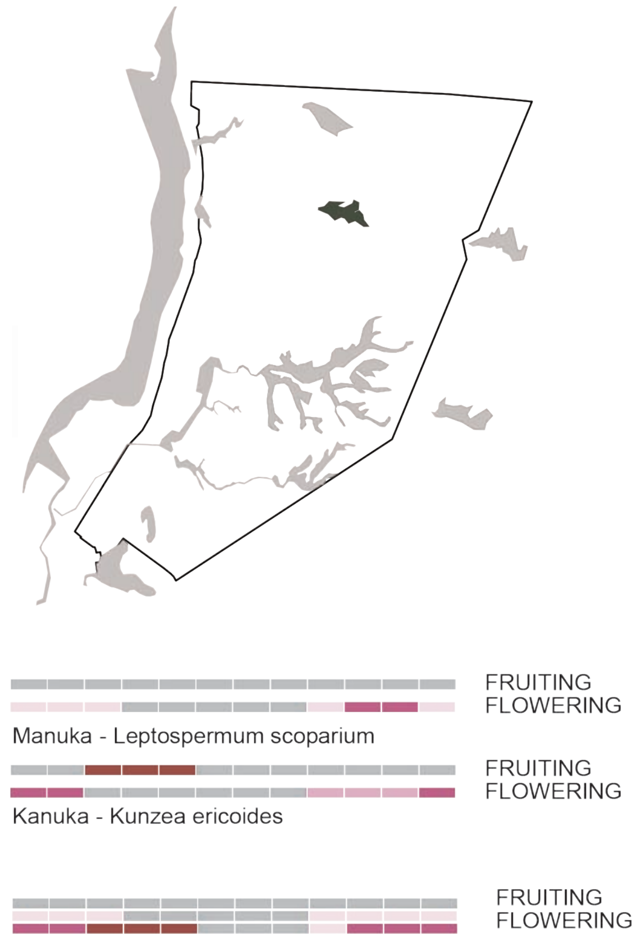

Figure 82. SNA 197

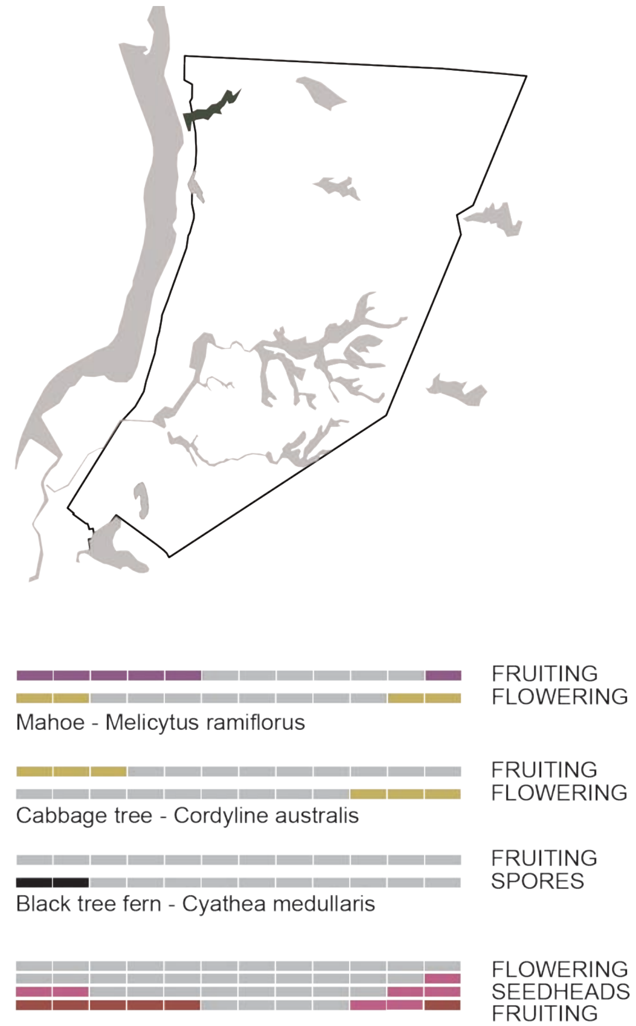

Figure 83. SNA 198

SUNLIGHT MODELING

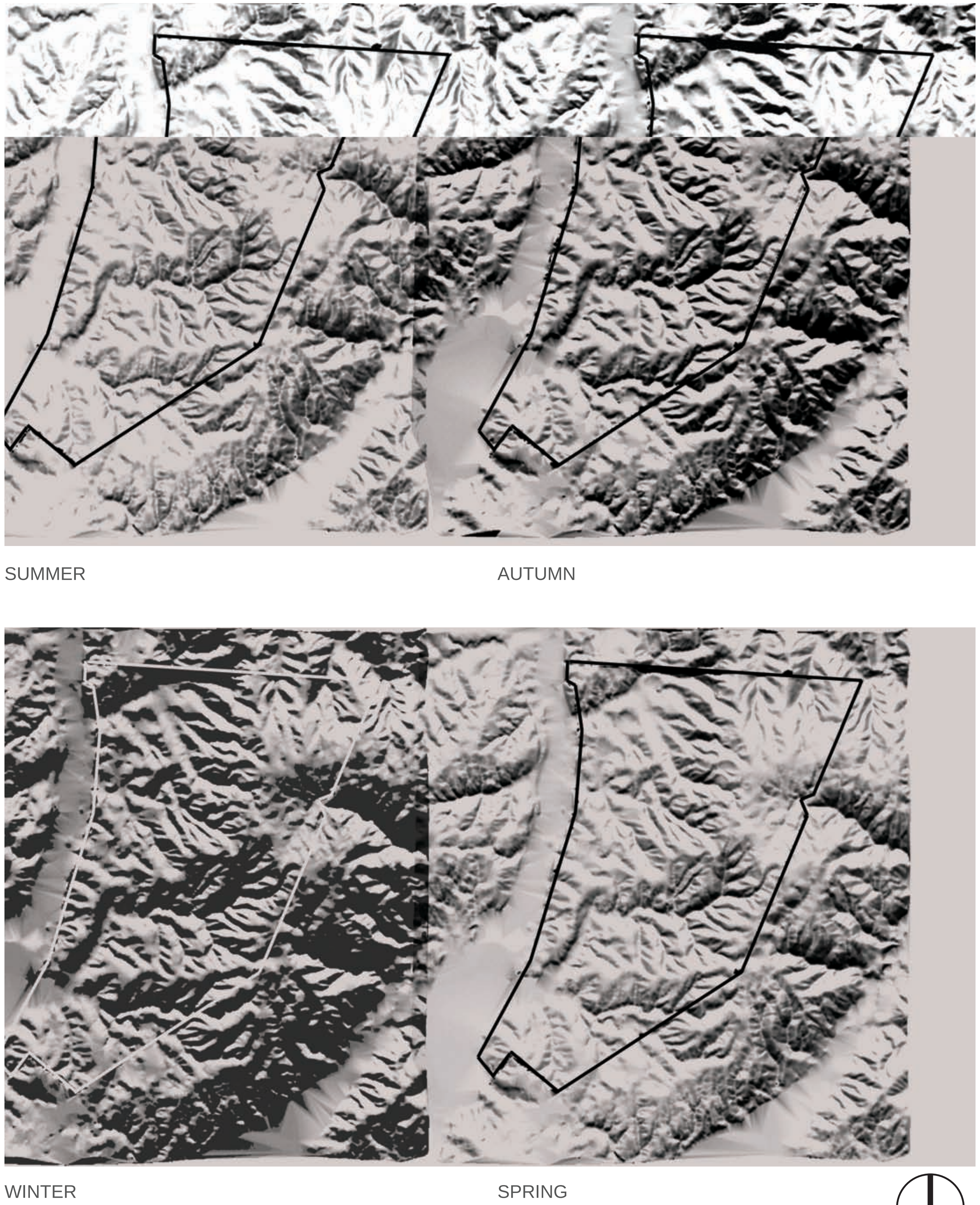

Figure 84. Sunlight Modelling – Midday

NOT TO SCALE

YEARLY SHADE

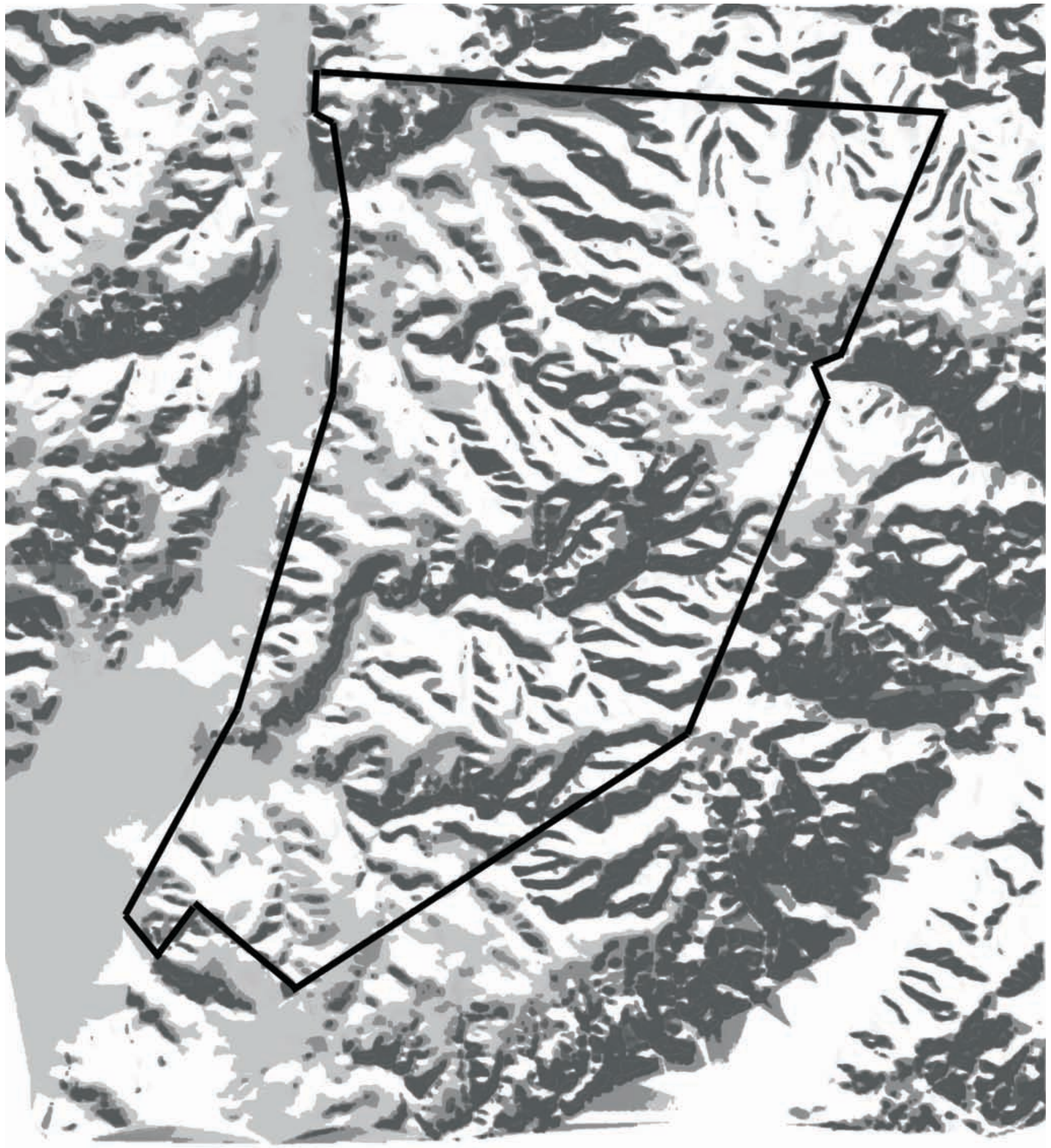

Figure 85. Yearly Shade.

NOT TO SCALE

SITE CONDITIONS

Sunlight modelling and water locations inform the different site conditions. Building locations and planting palette will need to reflect the site conditions during the design phase.

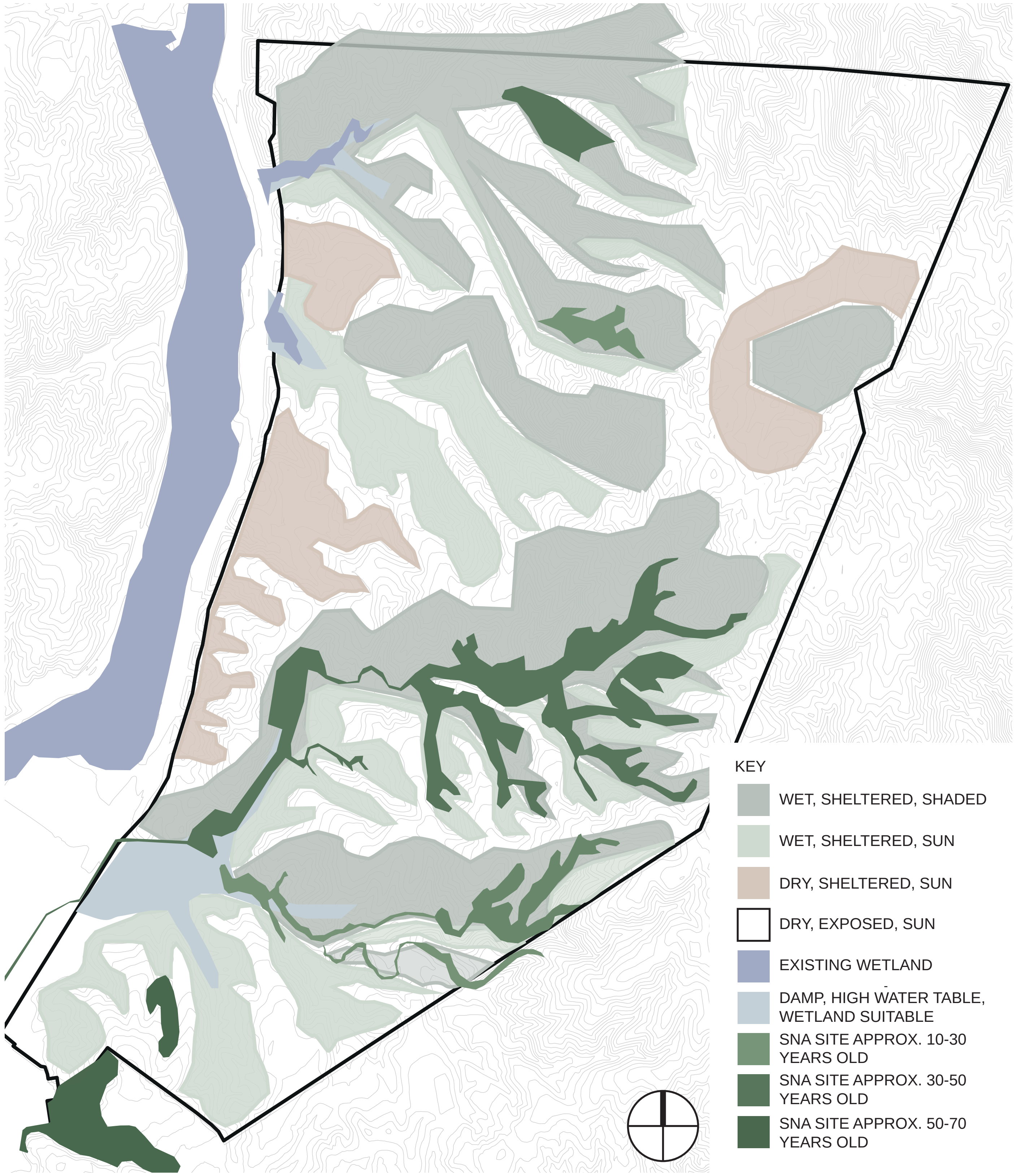

Figure 86. Site Conditions.

SCALE 1:15,000

REFLECTION

The open rolling grasslands are far divorced from its forested past, yet the site holds onto parts of its history, through the powerful typography, slowly regenerating ecosystems and seasonal flooding. It seems the site is eager to return to how it use to be.

The potential impact of development on Taupo Swamp and the Pauahatanui inlet means it should not be left to transform into another suburb that prioritises cars and housing yield. Development should help re-build ecosystems as well as provide a place for people to live.

The natural regeneration already occurring shows the site will support re-vegetation as part of a co-habitation design. Focusing wildlife habitat around stream locations will provide a water source for local species as well as revegetate the steepest areas of the site for erosion control.

The site analysis highlighted potential challenges of earthworks on the steep and potentially unstable site, as well as the difficulty implementing common Water Sensitive Urban Design solutions such as raingardens. This means the flat topography at the bottom of the site will need to be utilised for larger storm water wetlands. The liquefaction risk and high water table make these areas unsuitable for building, and so non-human habitats should be prioritised.

Implementation of these findings will be considered further in the design phases, where a more detailed consideration of habitat location will be explored, as well as investigating how to place housing and roads to minimise earthworks and how these changes to the landscape impact storm water size and location.

7.1
BIRD STUDIES

Designing for cohabitation requires an understanding of the feeding, habitat and nesting preferences of potential bird inhabitants so to best provide for their needs.
The following section examines bird species already present in the wider Porirua area, which may be suited to the potential habitat types Plimmerton Farms development may provide[1].

Future inhabitants can only be guessed; therefore this project will attempt to provide generalised and varied design solutions that support a range of species.

Footnotes
1. See references page 331 for list of websites from which bird species lists were compiled from.

FOREST SPECIES LIST

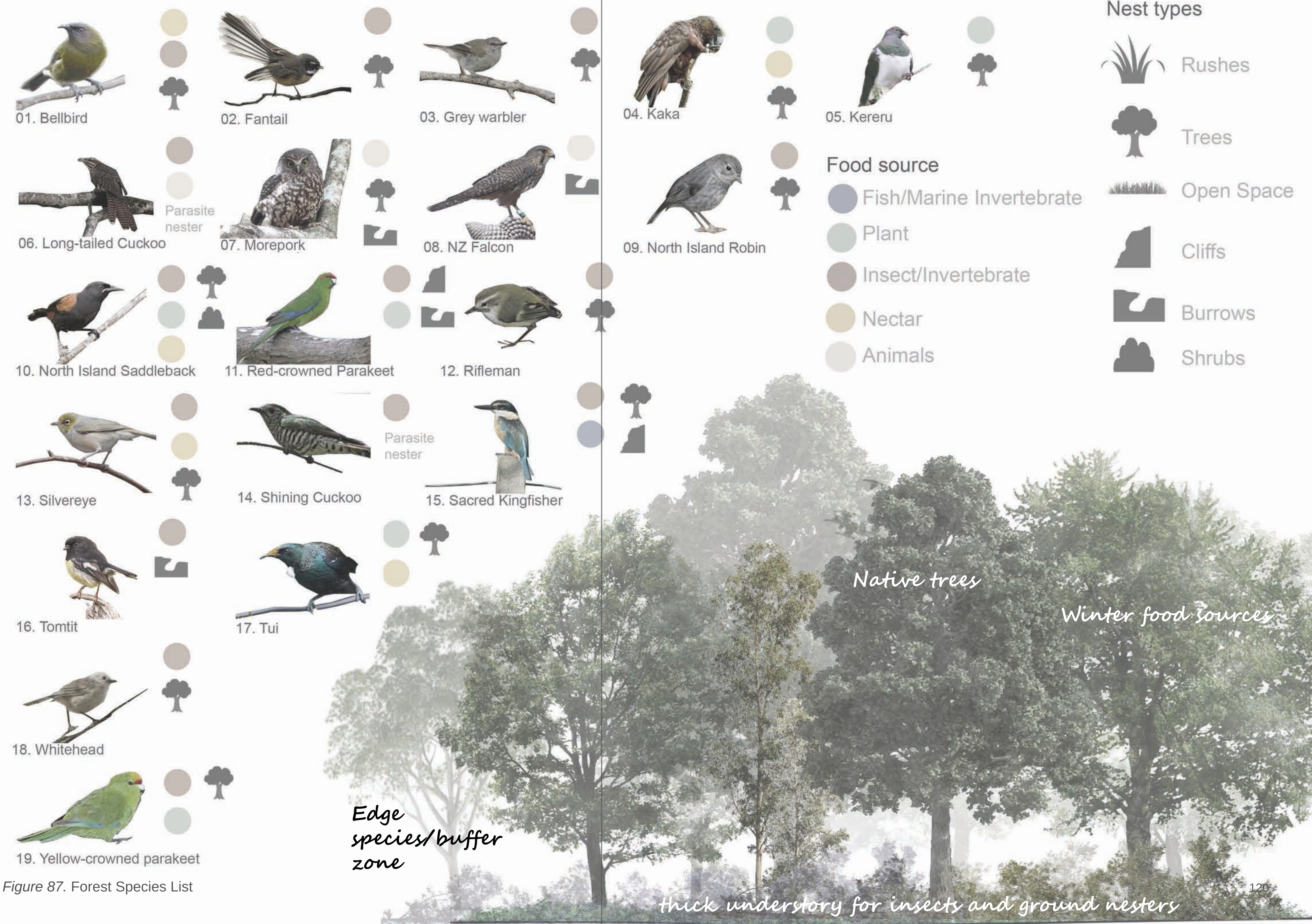

Figure 87. Forest Species List

SCRUBLAND SPECIES LIST

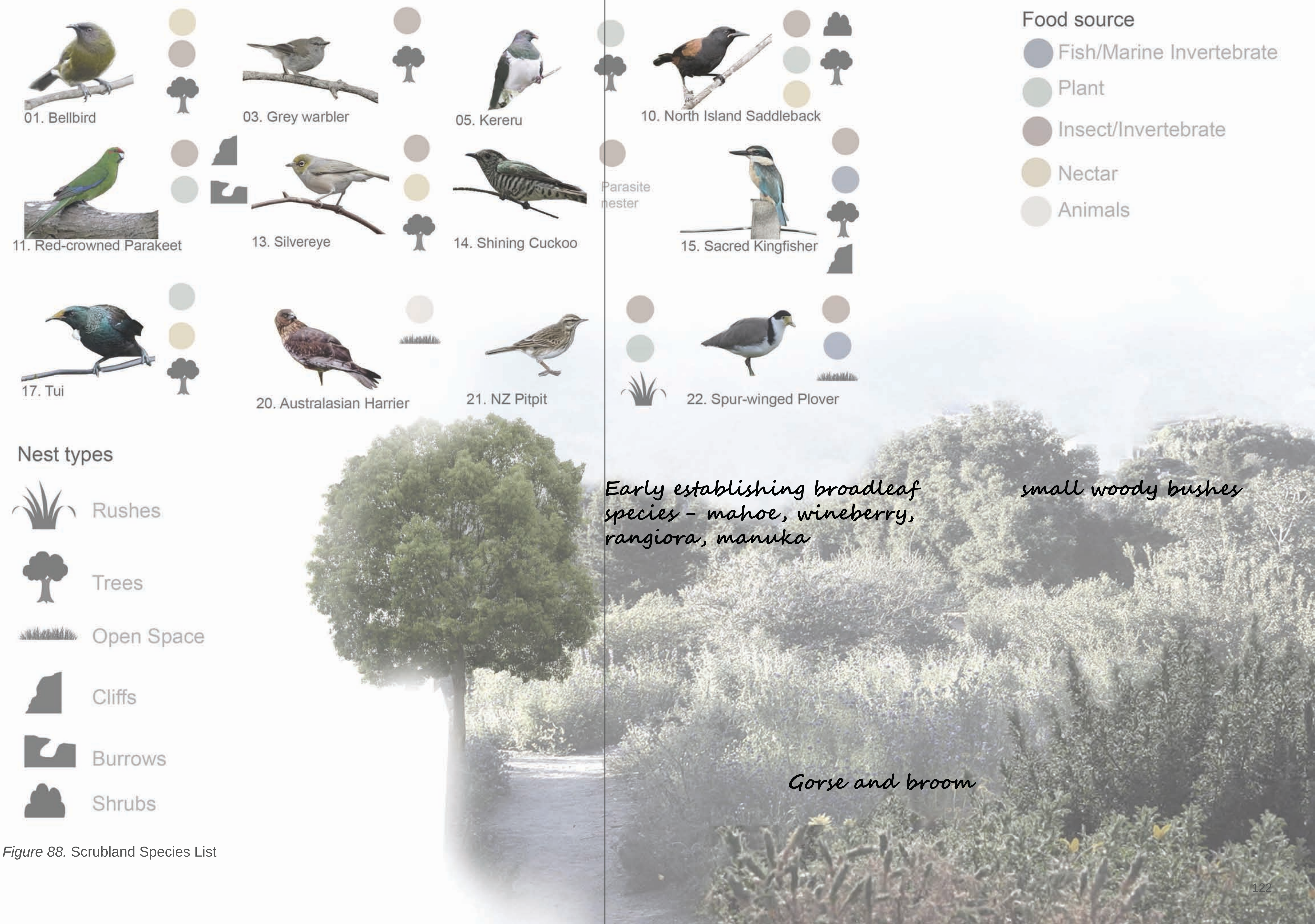

Figure 88. Scrubland Species List

RIVERINE SPECIES LIST

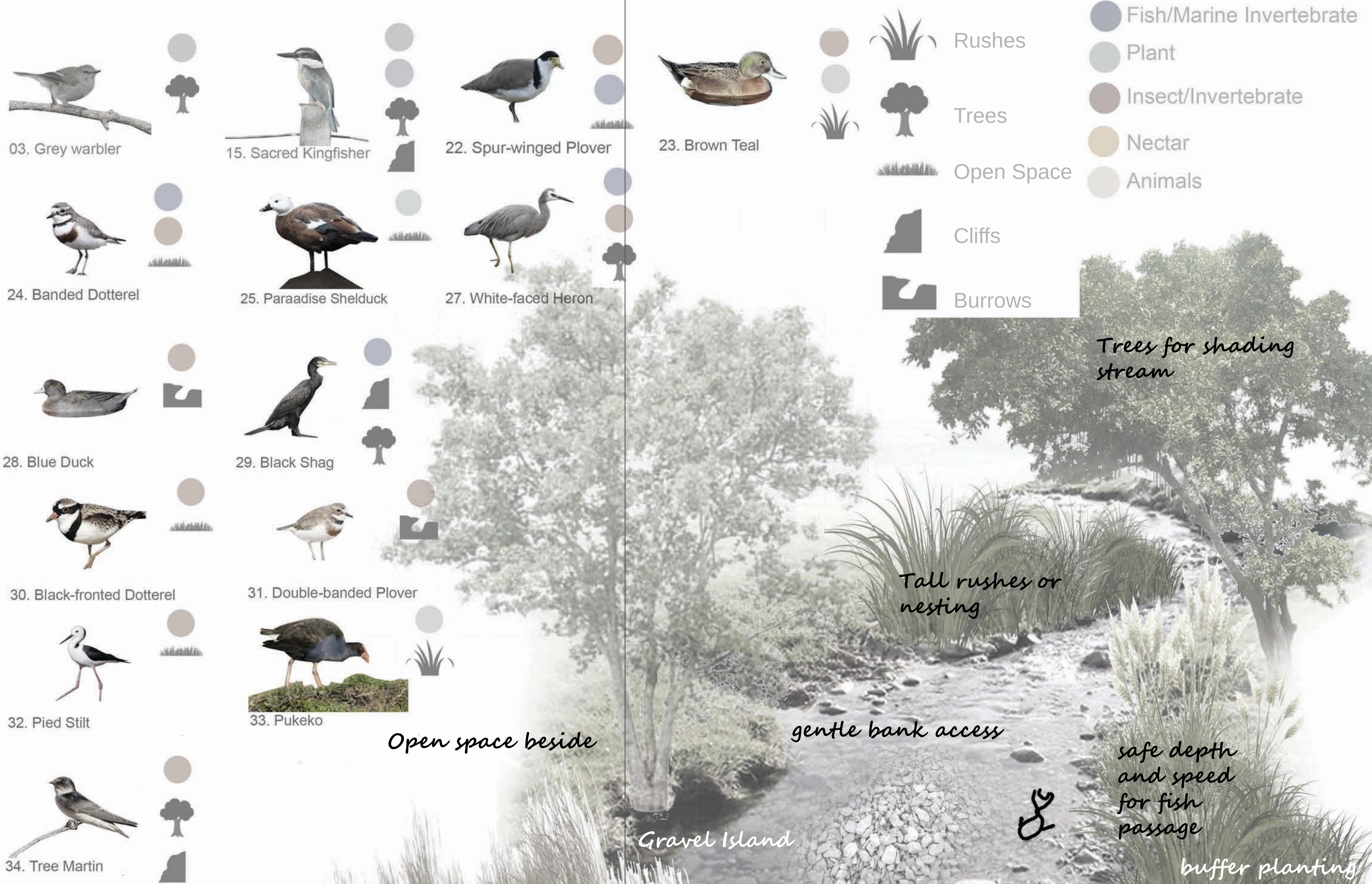

Figure 89. Riverine Species List

GRASSLAND SPECIES LIST

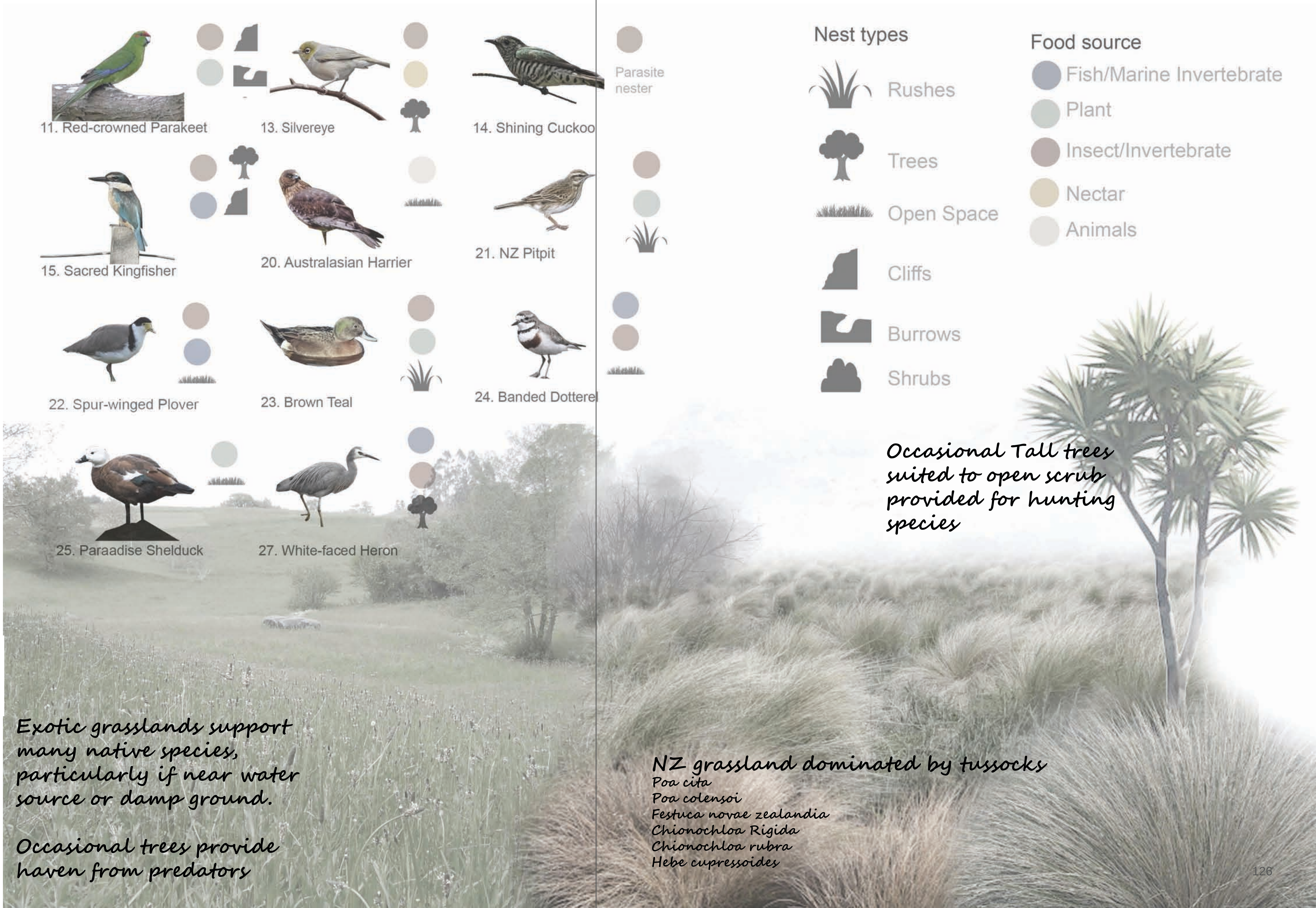

Figure 90.
Grassland
Species List

WETLAND SPECIES LIST

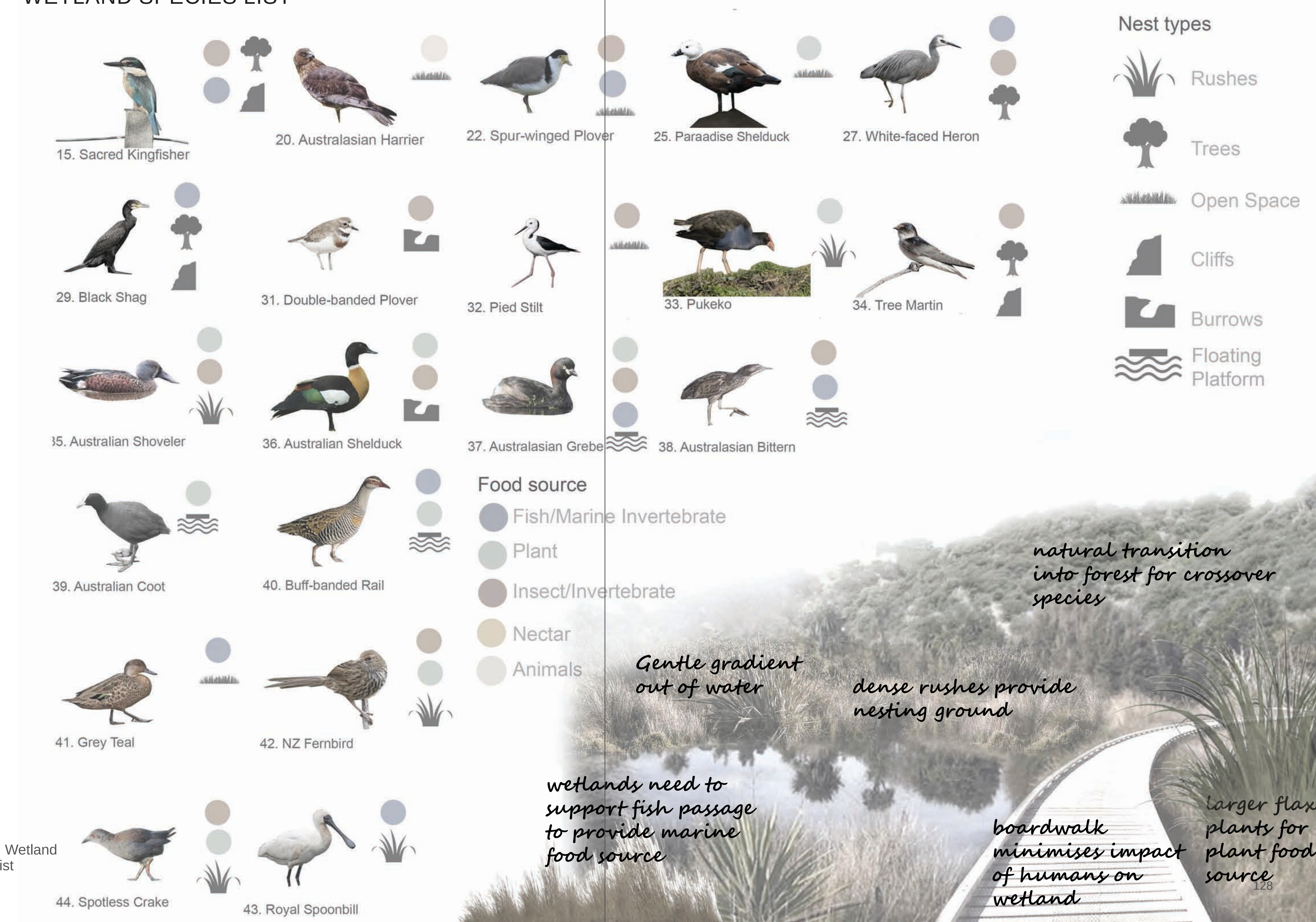

Figure 91. Wetland Species List

URBAN SPECIES LIST

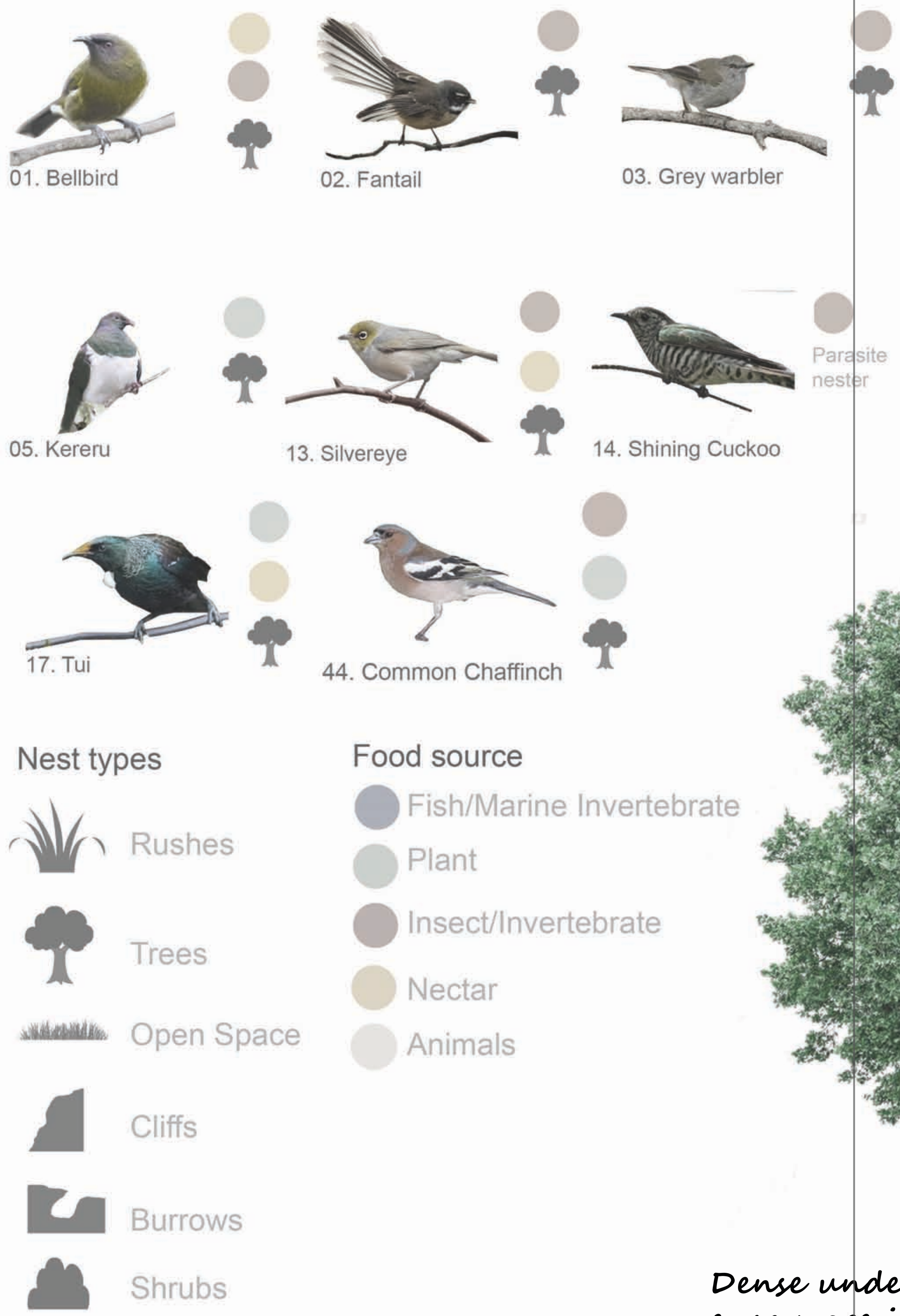

Figure 92. Urban Species List

7.2

DEVELOPER SITE PLAN

As discussed, this site has been selected because it is part of Poriruas Growth Plan. The following chapter will review the developer's proposal for how they currently intend to build on the site. This chapter highlights what a current market approach to suburban development would look like on this site, and can act as a comparison for identifying whether my own design process is able to provide a more ecologically friendly response.

Figure 93. Figure 95. Developers Proposed Site Plan

Draft Precinct Plan Document. (2018). Retrieved from https://poriruacity.govt.nz

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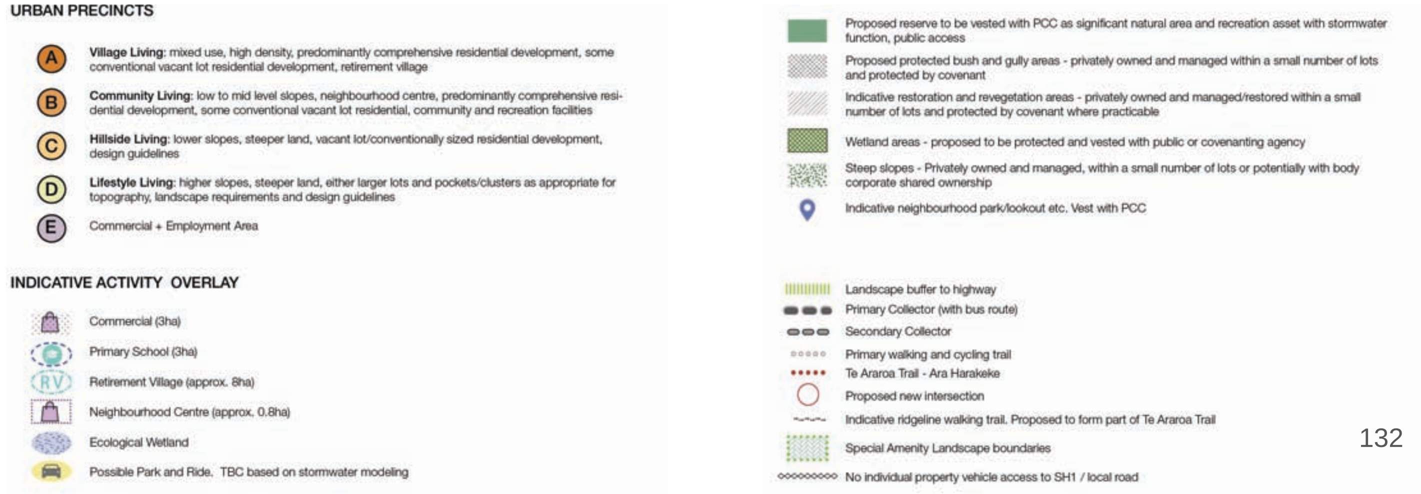

The developer’s proposal divides the site into four main precincts, each with a unique visual theme and building density. This strategy gives a sense of place to each precinct. However, this strategy also creates a risk of homogenous housing and limited diversity of residents.

The developer’s proposal suggests raingardens and other water sensitive design solutions will be included where possible; however the geological assessment indicated that much of the site is unsuitable for ground infiltration methods due to the high levels of loeses soils.

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Figure 94. Site Slopes.
Harrison Grierson. (2018). *Urban Design Assessment.* Retrieved from https://poriruacity.govt.nz

NOT TO SCALE

These restrictions indicate that the low lying, flat area of the site is the only suitable location for storm water wetland systems without the need for major earthworks. Boreholes show the water table at this point is at or just below ground level, and the area supports mostly wetland species.

Yet this is proposed as a location of high density commercial building, a move that requires high levels of soil compression and stabilisation to mitigate liquidation risks. Furthermore, this area is frequently flooded and building here will likely require some form of stop banks of additional soil to raise the ground level above flood risk – putting further pressure on Taupo swamp and worsening the flooding risk for Plimmerton township.

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Figure 95. Developers Proposed Site Plan

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Figure 96. Figure 97. Flat Land SW Corner of Site

08

DESIGN PHASE 1
HOUSING TO RESERVE RATIOS

Putting aside the developer's proposal; the first stage in my own design process was a quick exercise to establish how different housing densities could be positioned on site as a way into the design process. The process narrowed the scope in three ways:

1. Highlighted that a focus too much on reserve land without prioritising housing will just result in further sprawl. To this end, the final design should attempt to provide at least 2000 houses, same as the proposed design by the developers, in order to investigate how biodiversity levels might theoretically be improved without lessening the housing yield.

2. The development should provide a mix of suburban and medium density typologies to offer the most diverse space for residents and their needs. Lifestyle blocks will not be included in the design as they use large amounts of space and offer little biodiversity benefits.

3. The expansion of Taupo Swamp into the site seemed a significant ecological move worth exploring. This expansion will need to be supported through significant natural buffers and protection of the streams flowing into the water course.

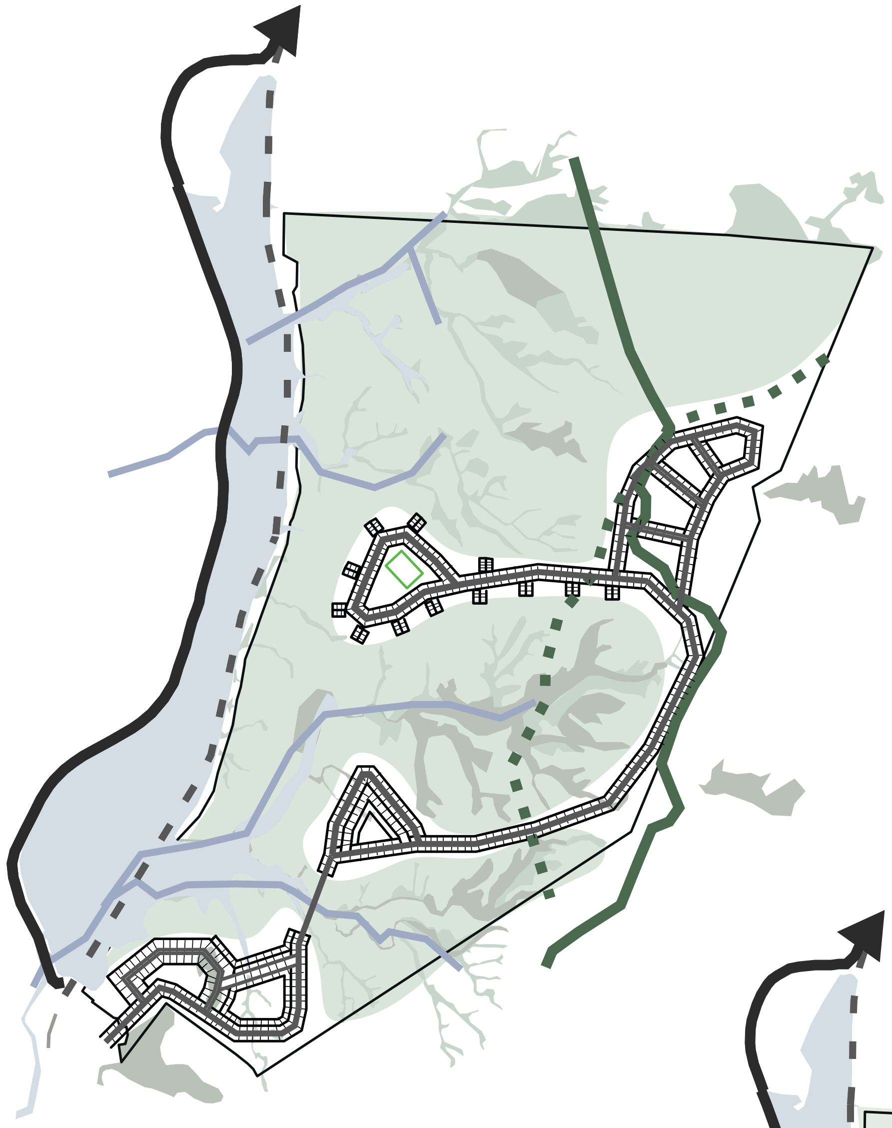
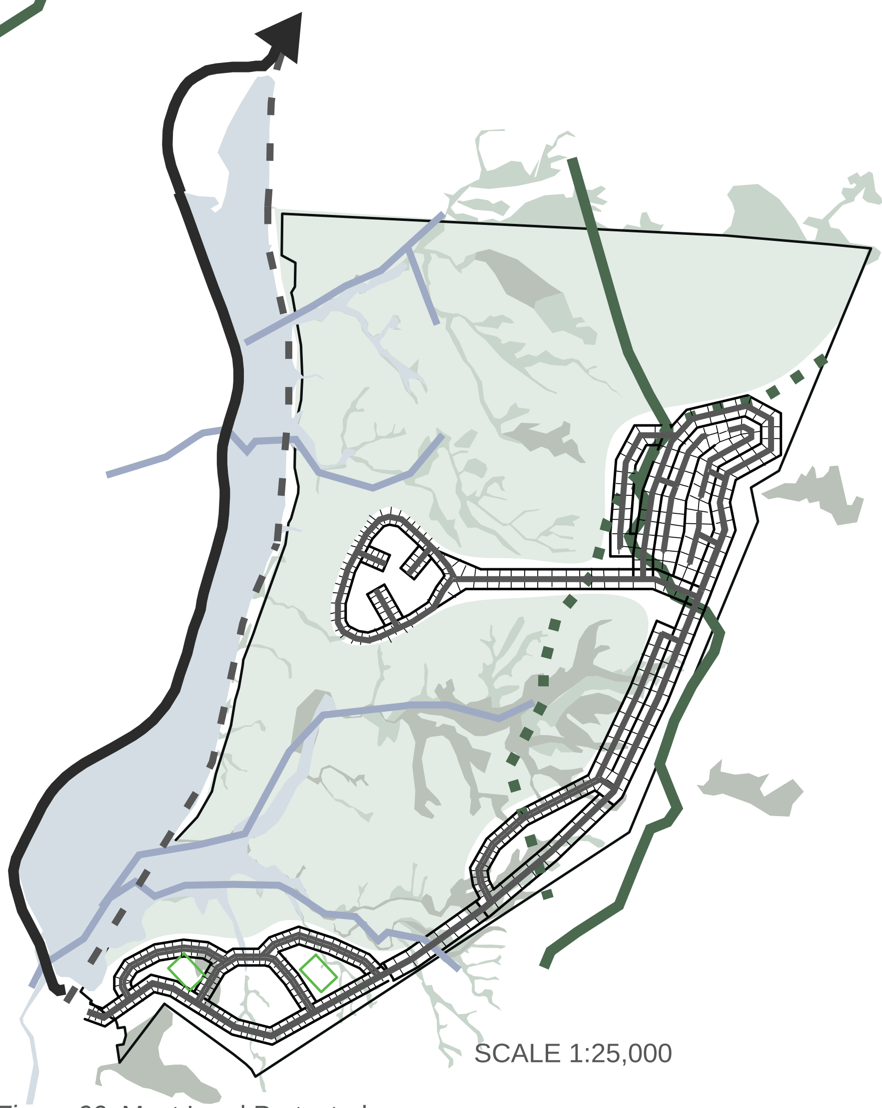


Figure 98. Most Land Protected - Medium Density



SCALE 1:25,000

Figure 99. Most Land Protected - Medium and Suburban Density

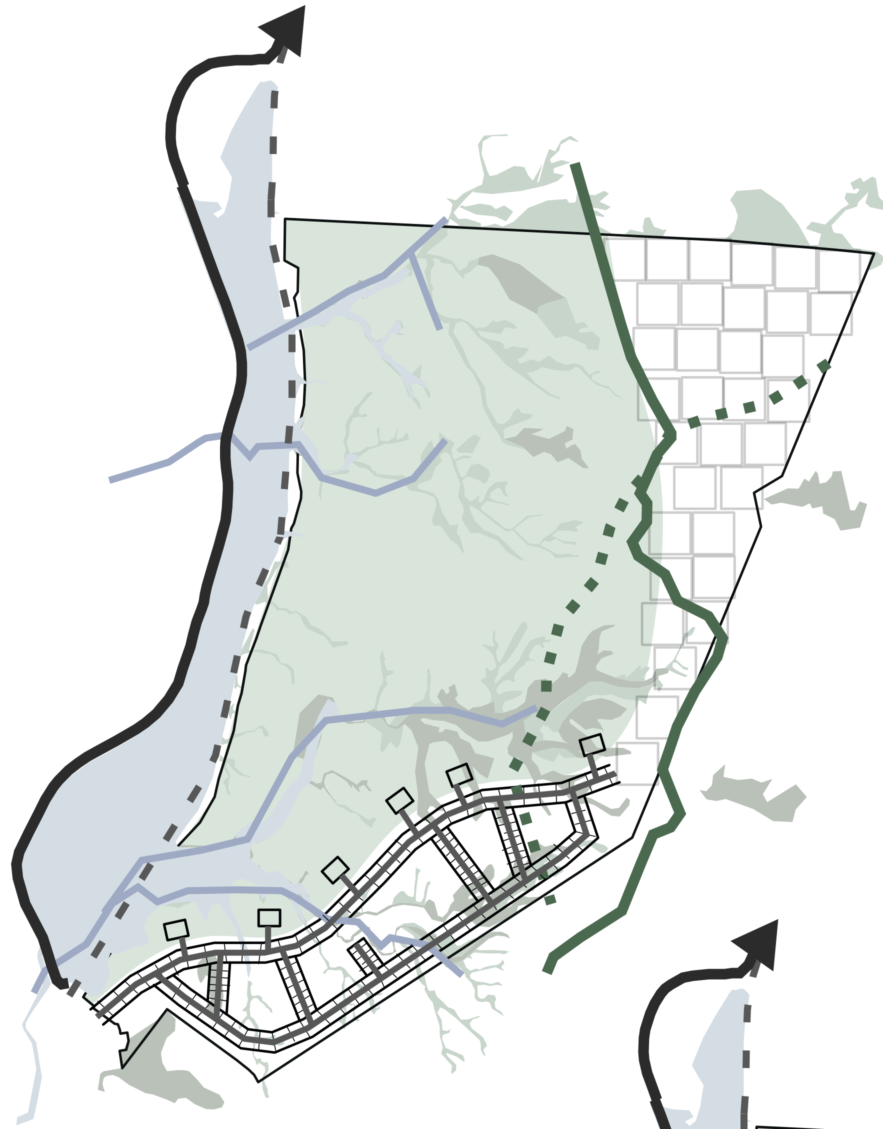


Figure 100. Most Land Protected - Medium, Suburban and Rural Density

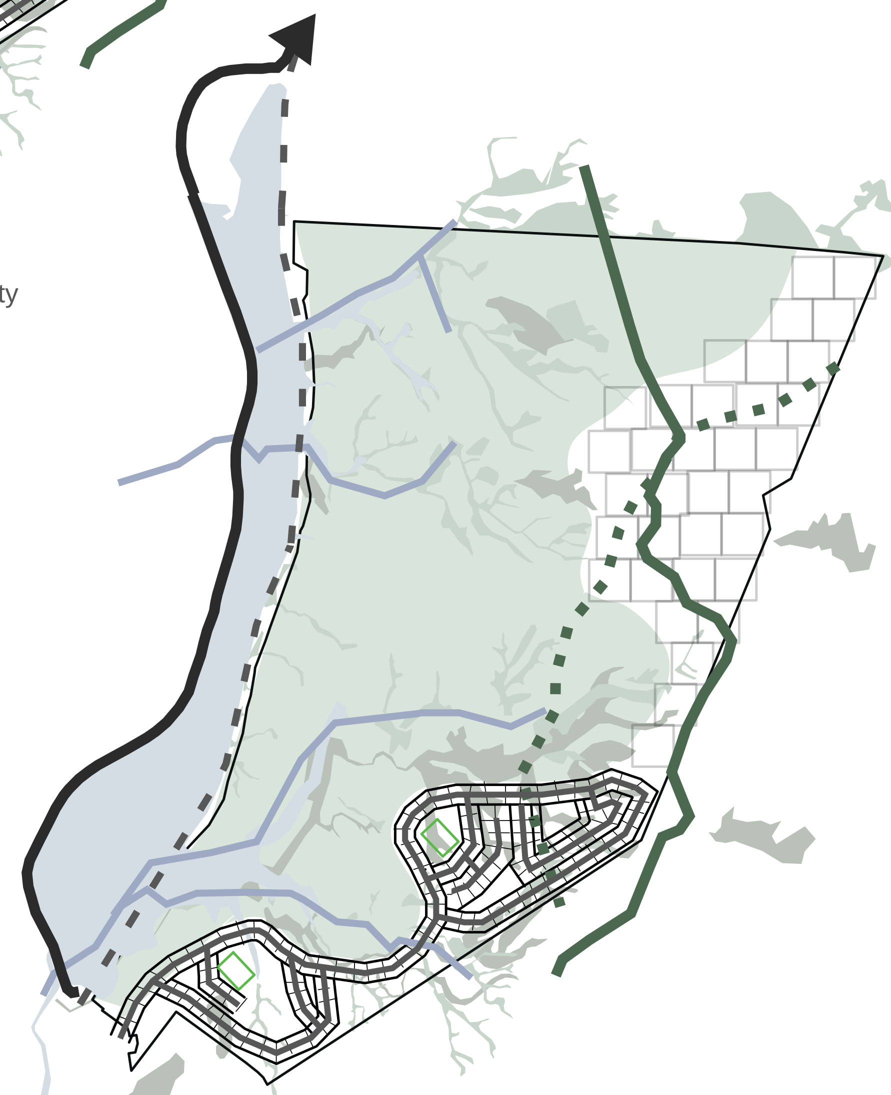


Figure 101. Most Land Protected – Suburban and Rural Density

SCALE 1:25,000

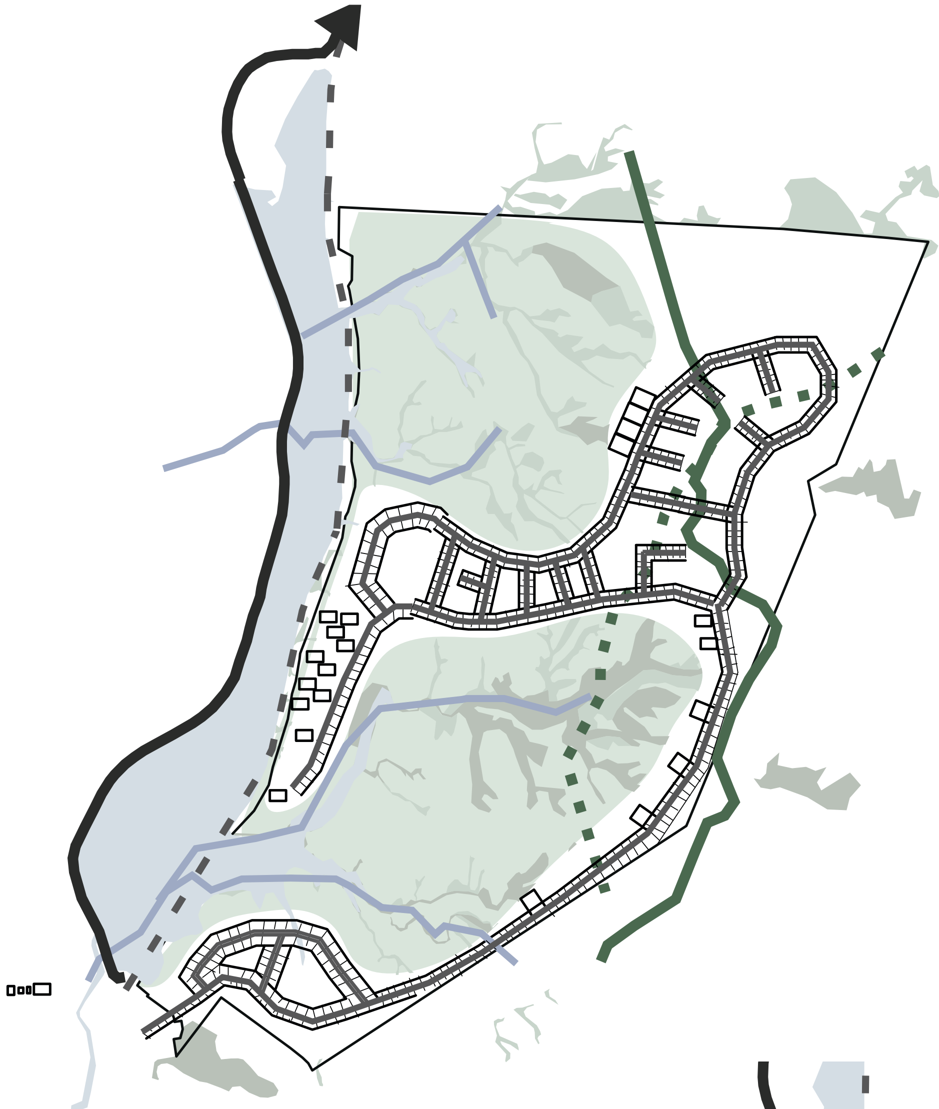


Figure 102. 2/3 Land Protected – Medium Density

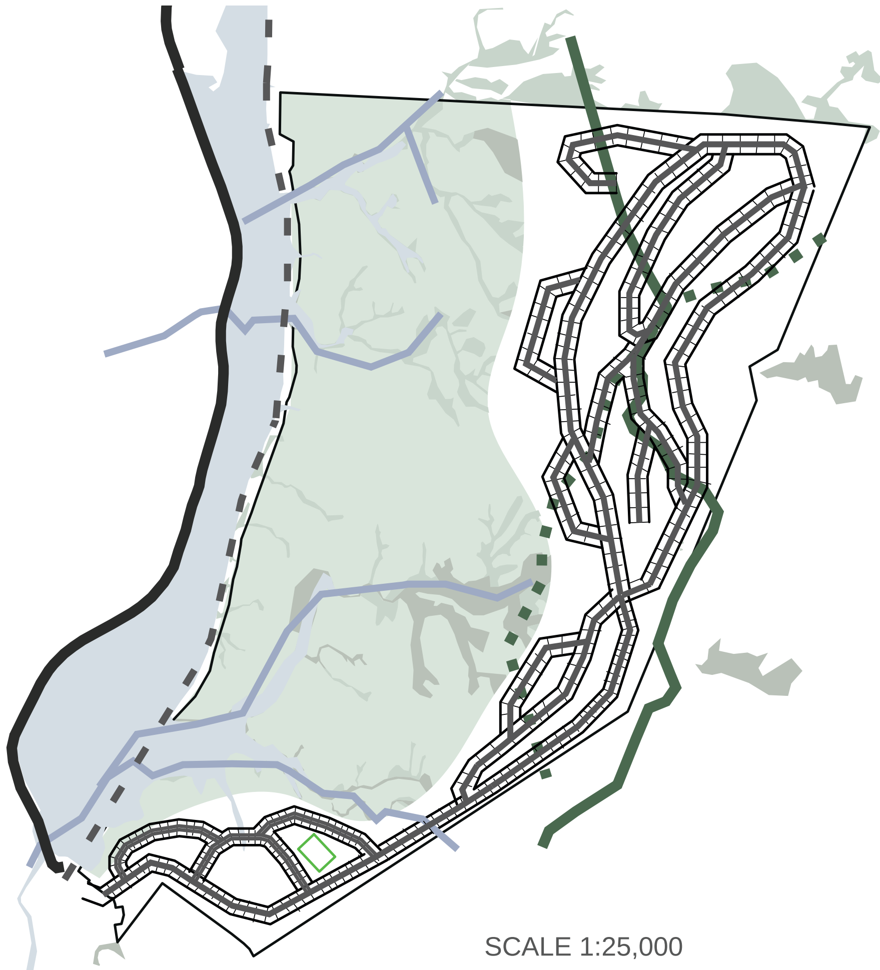


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Figure 103. 2/3 Land Protected – Medium and Suburban Density

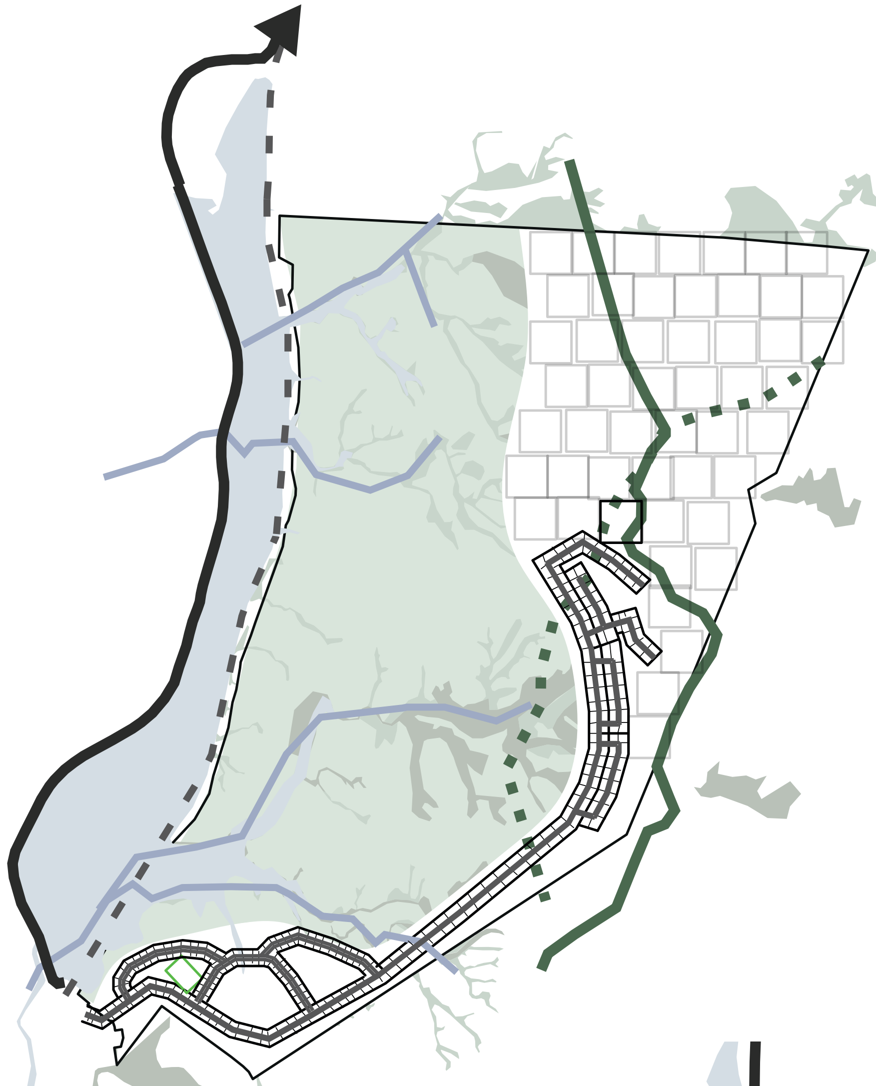

Figure 104. 2/3 Land Protected – Medium, Suburban and Rural Density

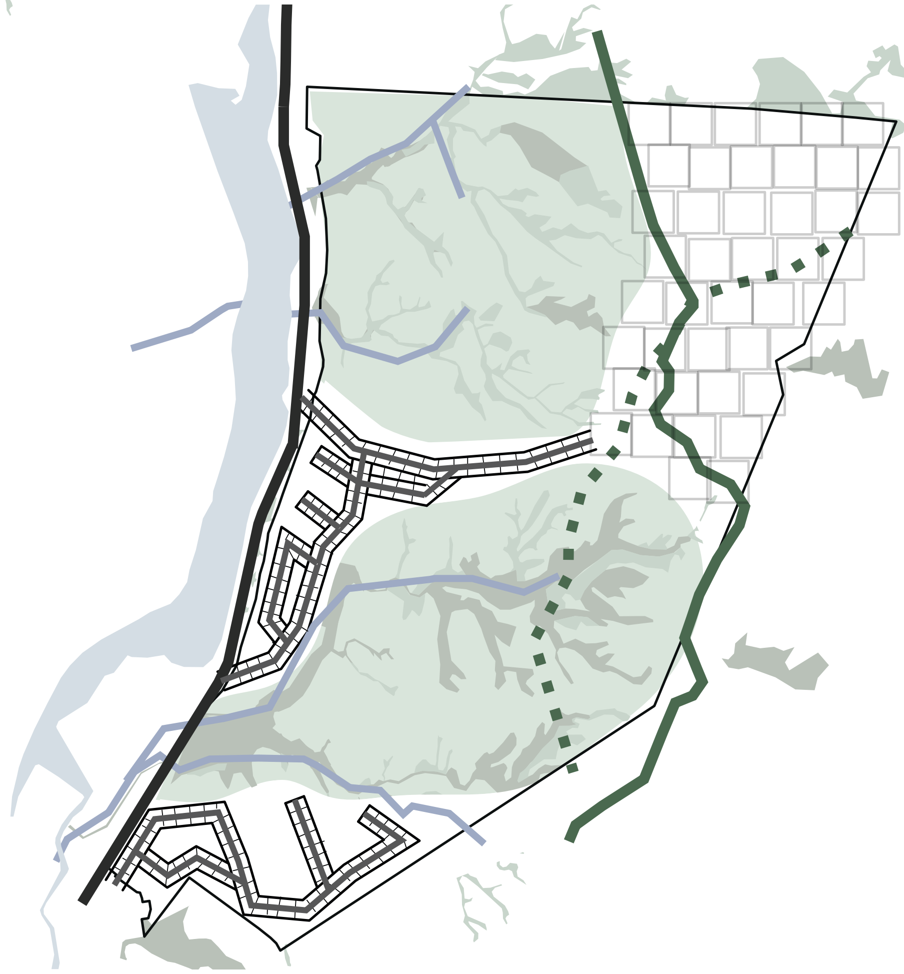

Figure 105. 2/3 Land Protected – Suburban and Rural Density

SCALE 1:25,000

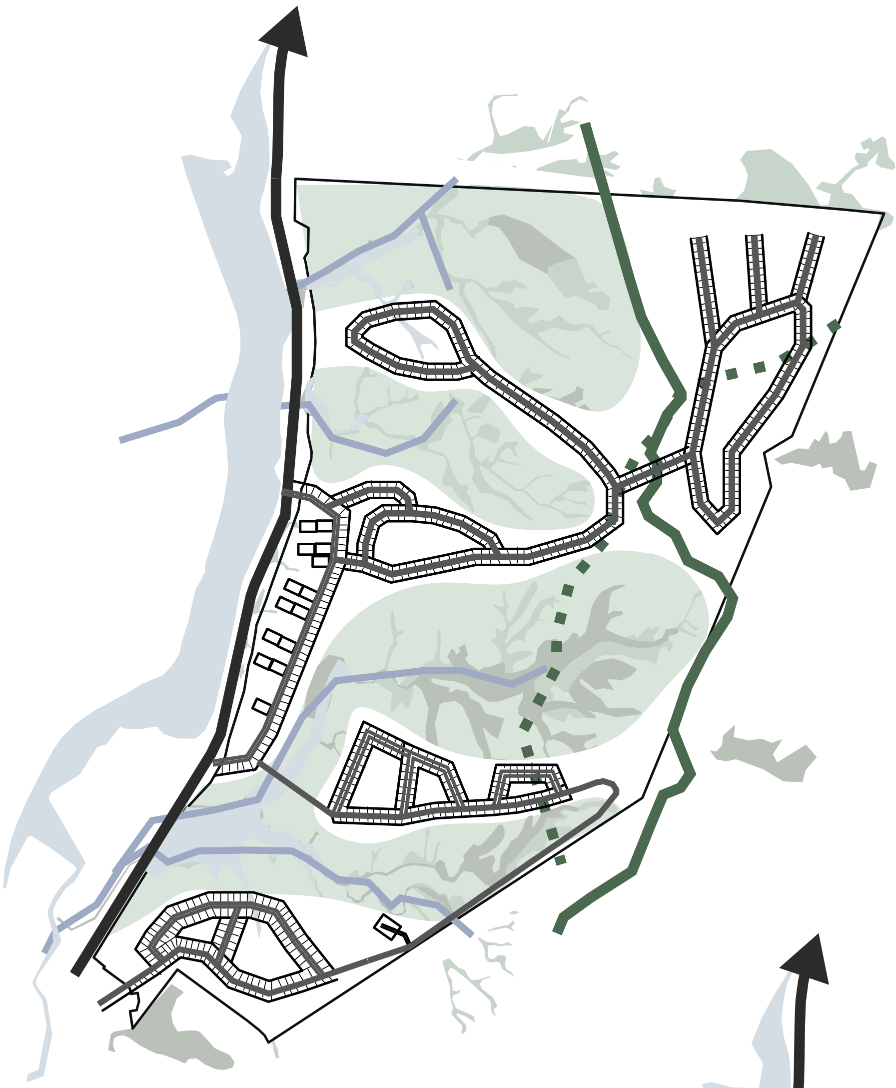

Figure 106. 1/2 Land Protected –
Medium Density

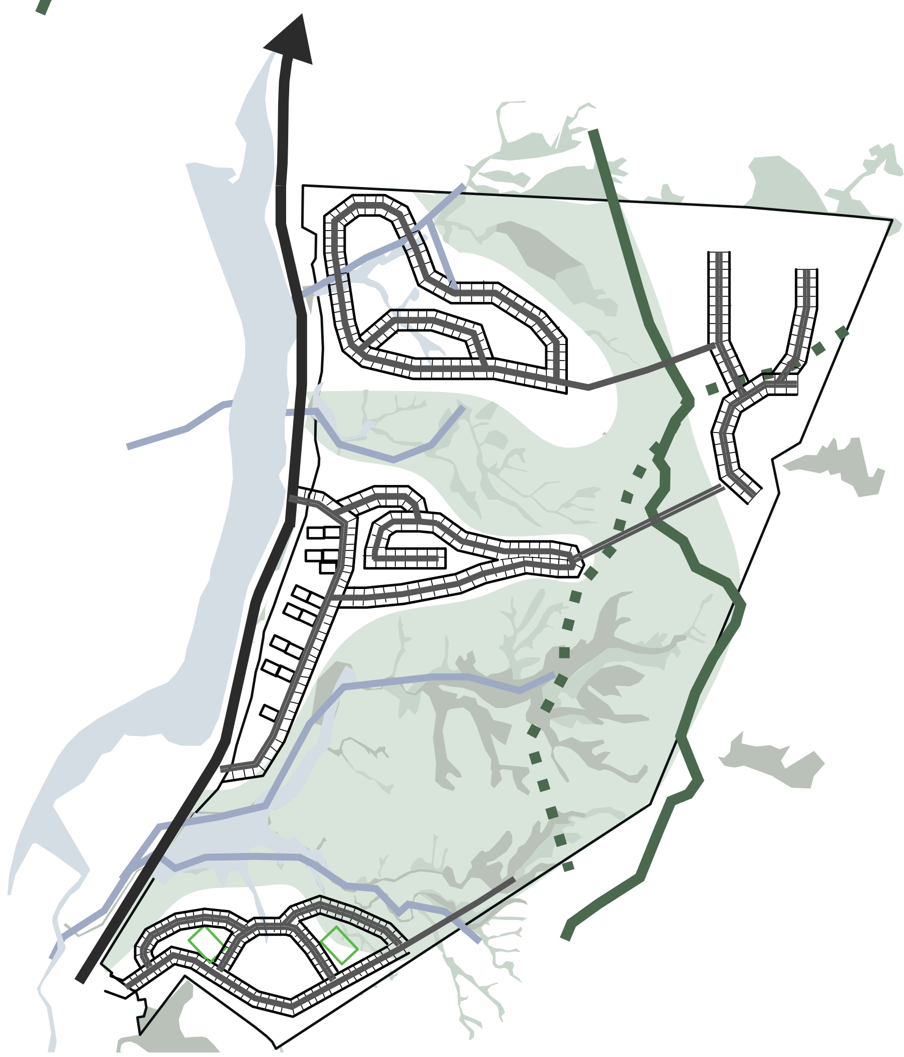

Figure 107. 1/2 Land Protected –
Medium and Suburban Density

SCALE 1:25,000

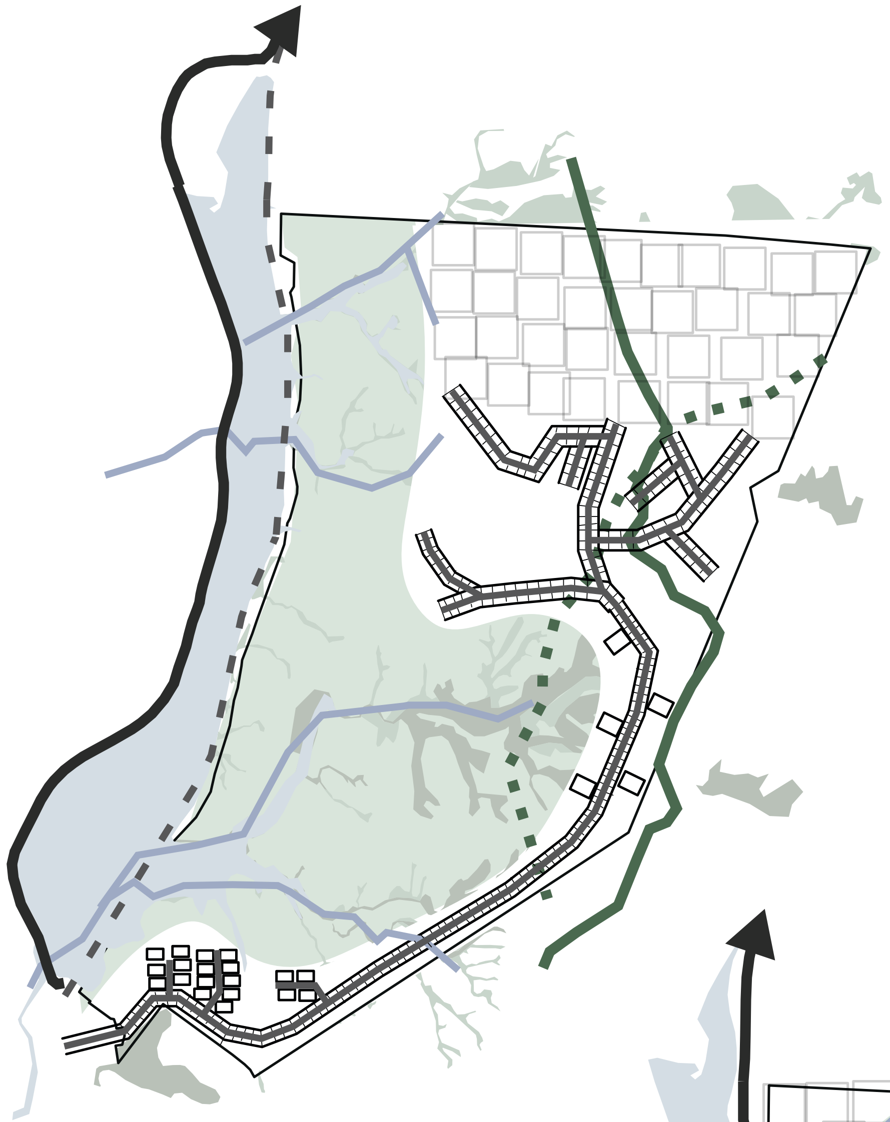

Figure 108. 1/2 Land Protected –
Medium, Suburban and Rural Density

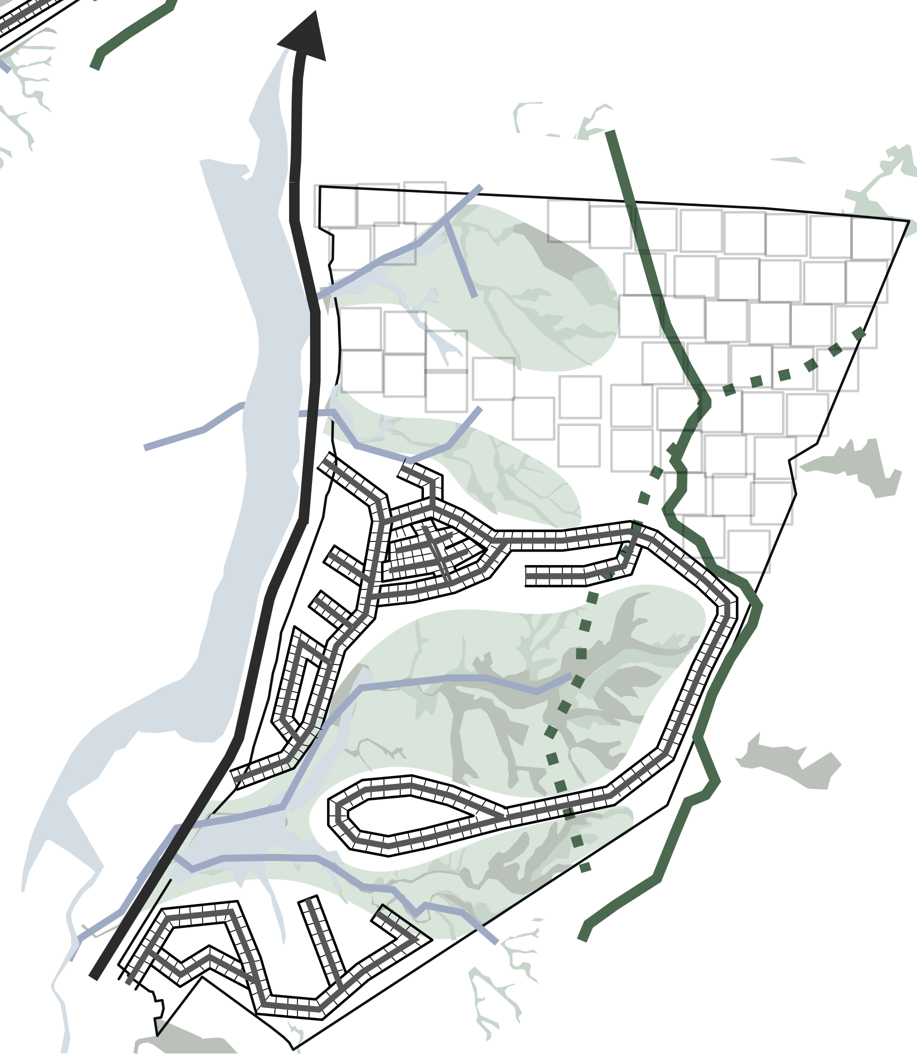

Figure 109. 1/2 Land Protected –
Suburban and Rural Density

SCALE 1:25,000

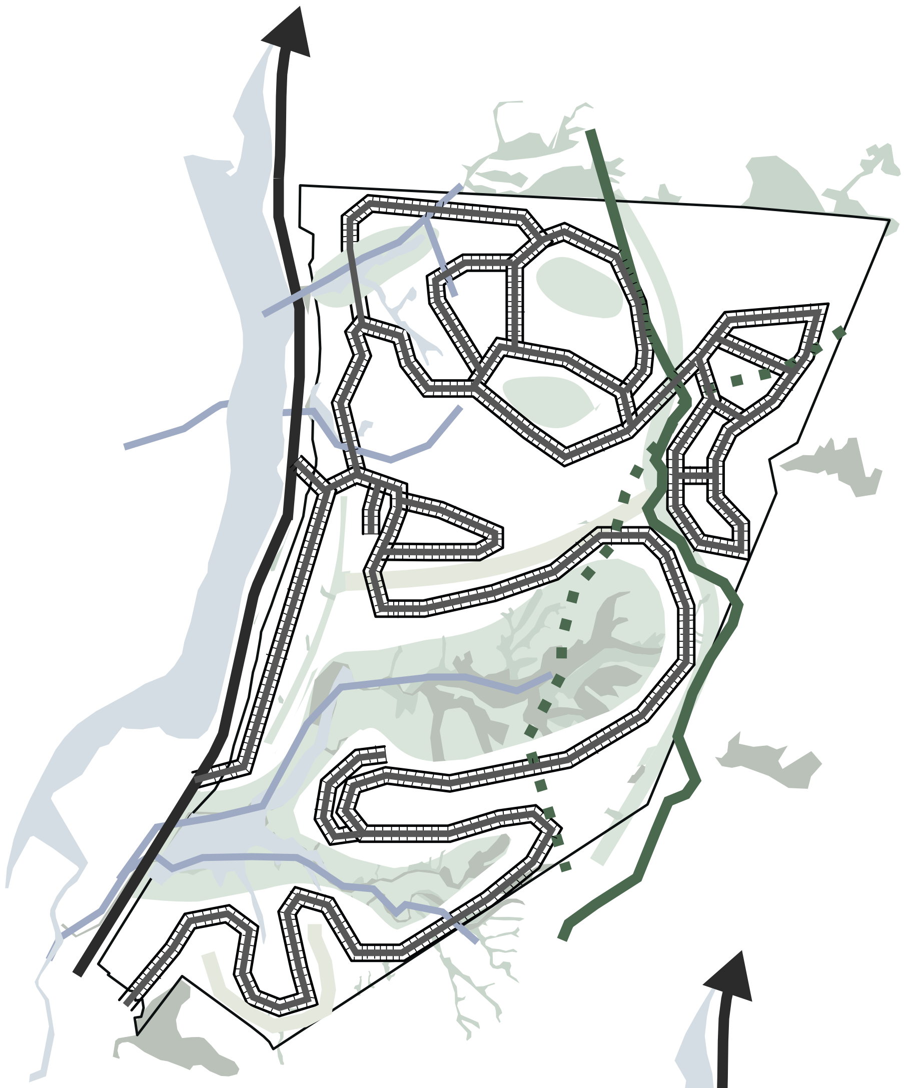

Figure 110. Minimal Land Protected – Medium Density

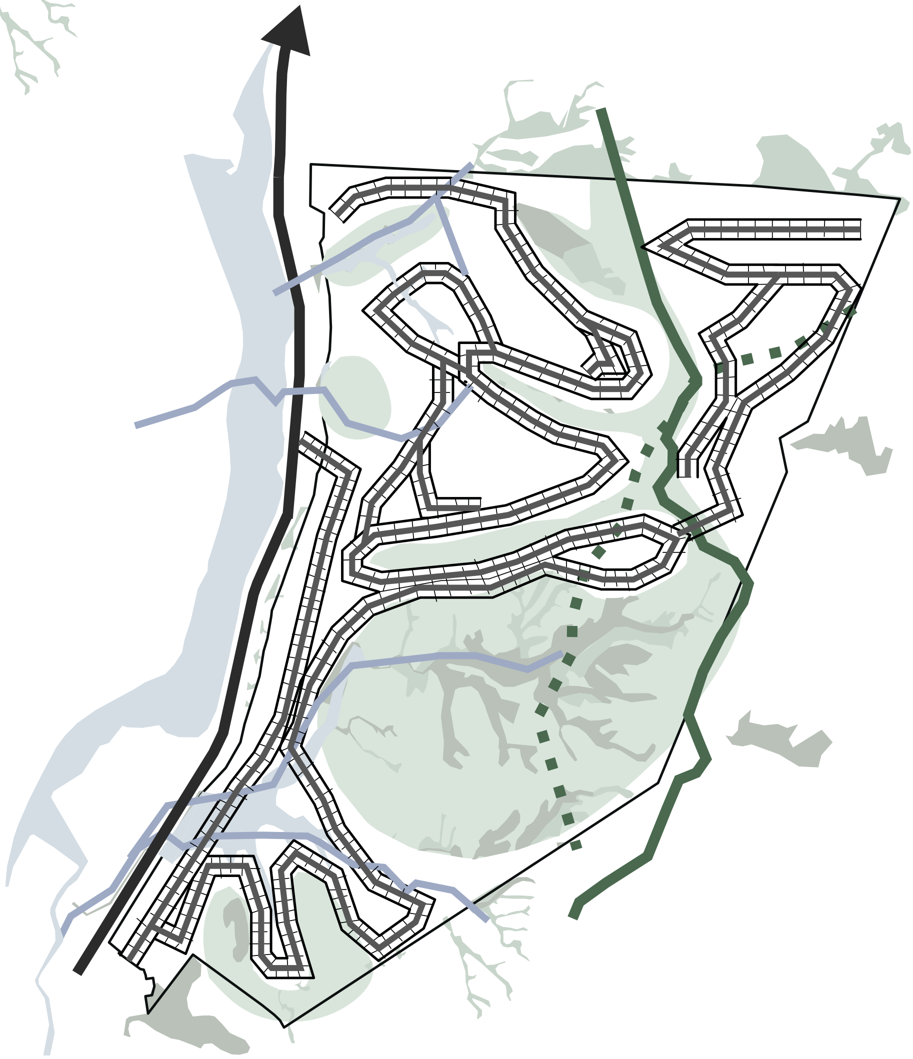

Figure 111. Minimal Land Protected – Suburban Density

SCALE 1:25,000

REFLECTION

While this step was useful in refining the scope of the design, the approach continued to engage in the binary thinking this project is positioning against; reducing the complexity of the problem into housing or reserves.

The ecological literature references varied sensitivity levels of bird life to urban spaces, showing the more nuanced levels of interactions that can occur in suburban environments.

The literature places urban landscapes as the fixed environment that other species must adapt to or avoid, however urban landscapes have the most flexibility to change.
The next design phases will attempt to re-think about this concept as human-occupied areas having an impact level to bird species, and begin to consider how the placement of human occupied areas can work on a scale of impact that ties appropriate human activities with appropriate bird needs.

SCALE OF SENSITIVITY

This diagram explores a change how we might consider different species to be on a scale of sensitivity to human life, but also how different human habitats have varying impact. This process begins to investigate how human environments are suited to specific types of birdlife and bird activity.

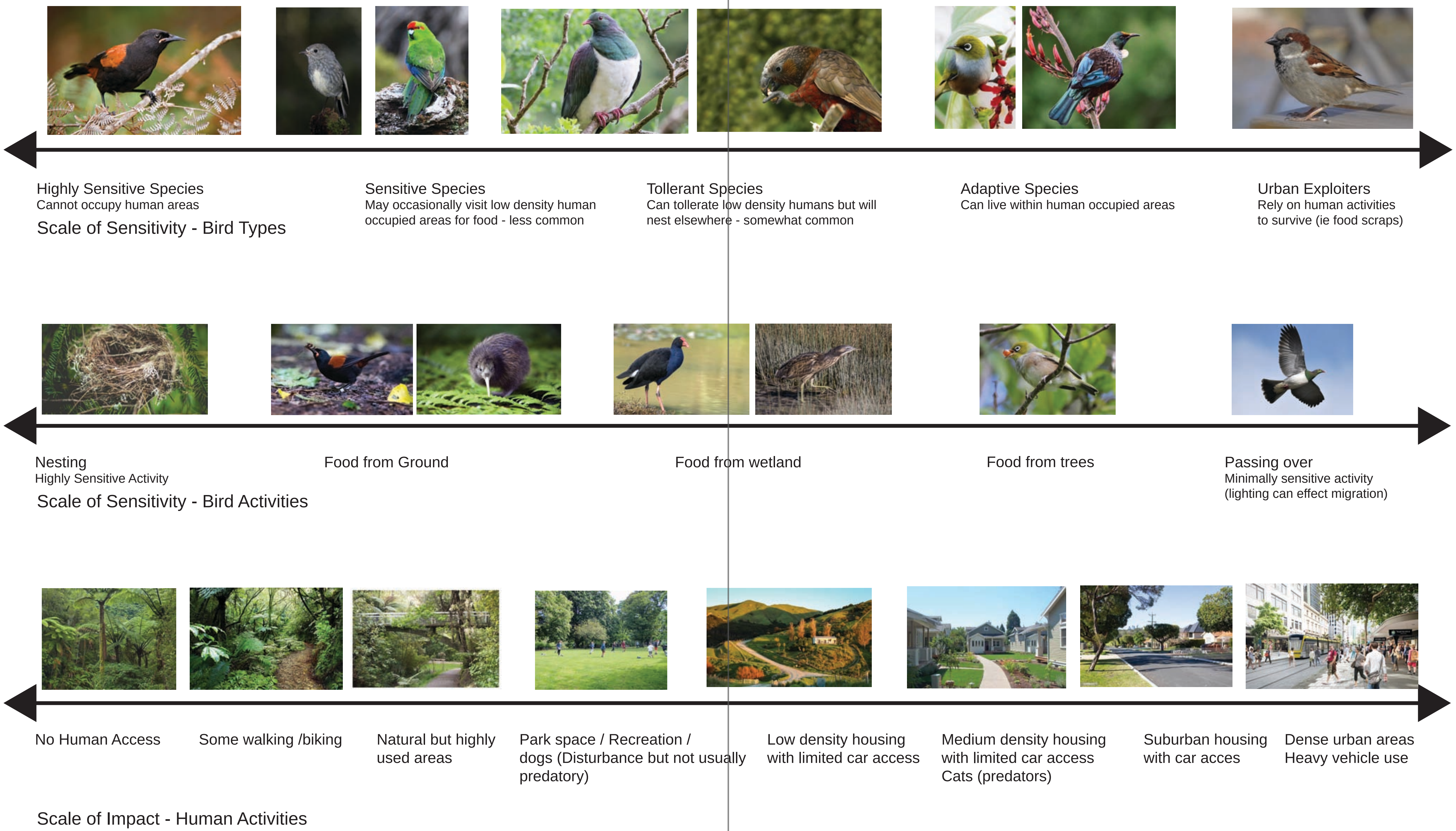

Figure 112. Scale of Interaction Sensitivity

These sections begin to spatialize the Scale of Sensitivity concept and investigate how different programmatic landscapes could be positioned onsite in order to create a gradient of habitat types that soften the boundaries between human landscapes and natural landscapes.

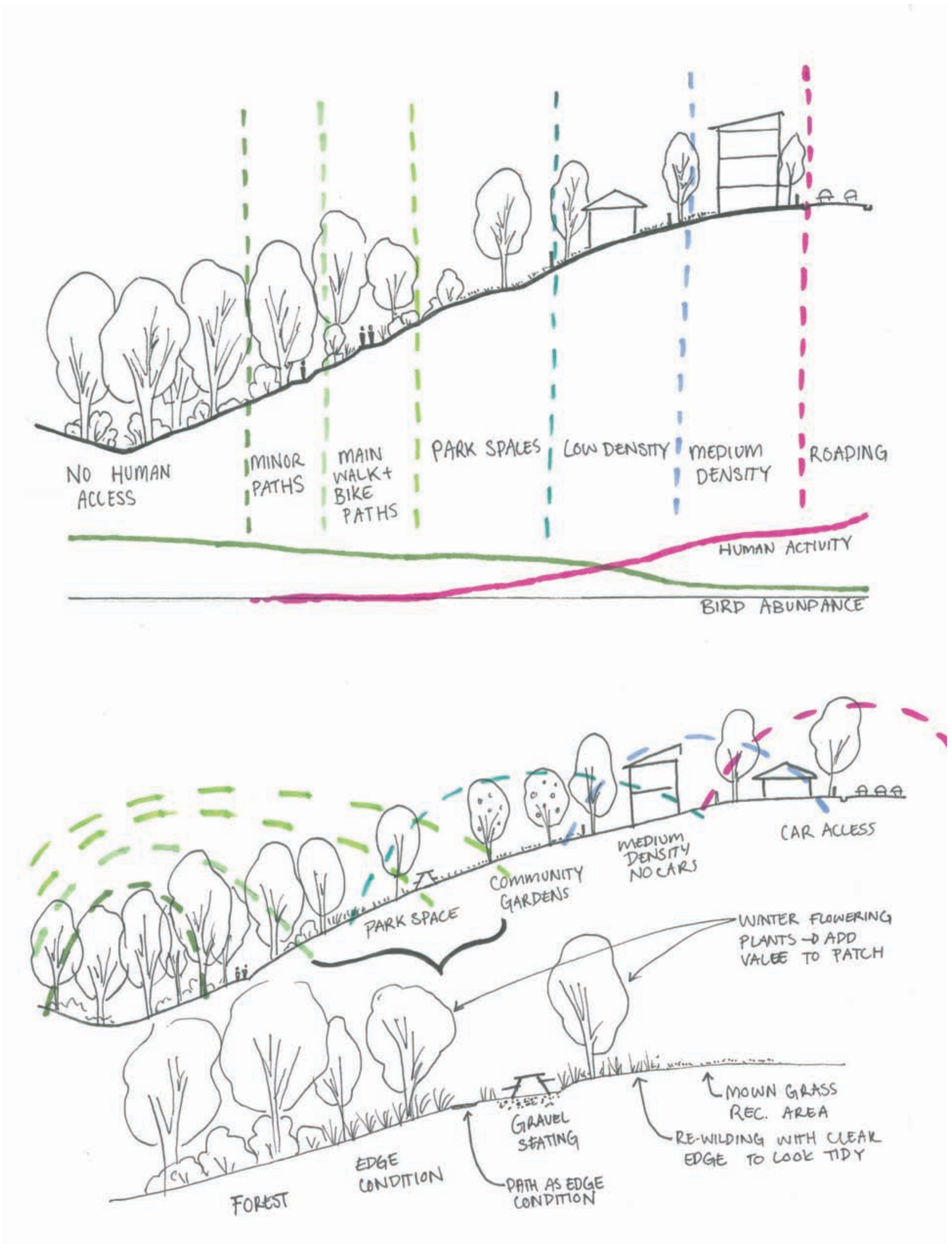

Figure 113. Sectional Explorations

The plan takes this spatializing a step further and considers how these programs might be located onsite to work best with the site conditions.

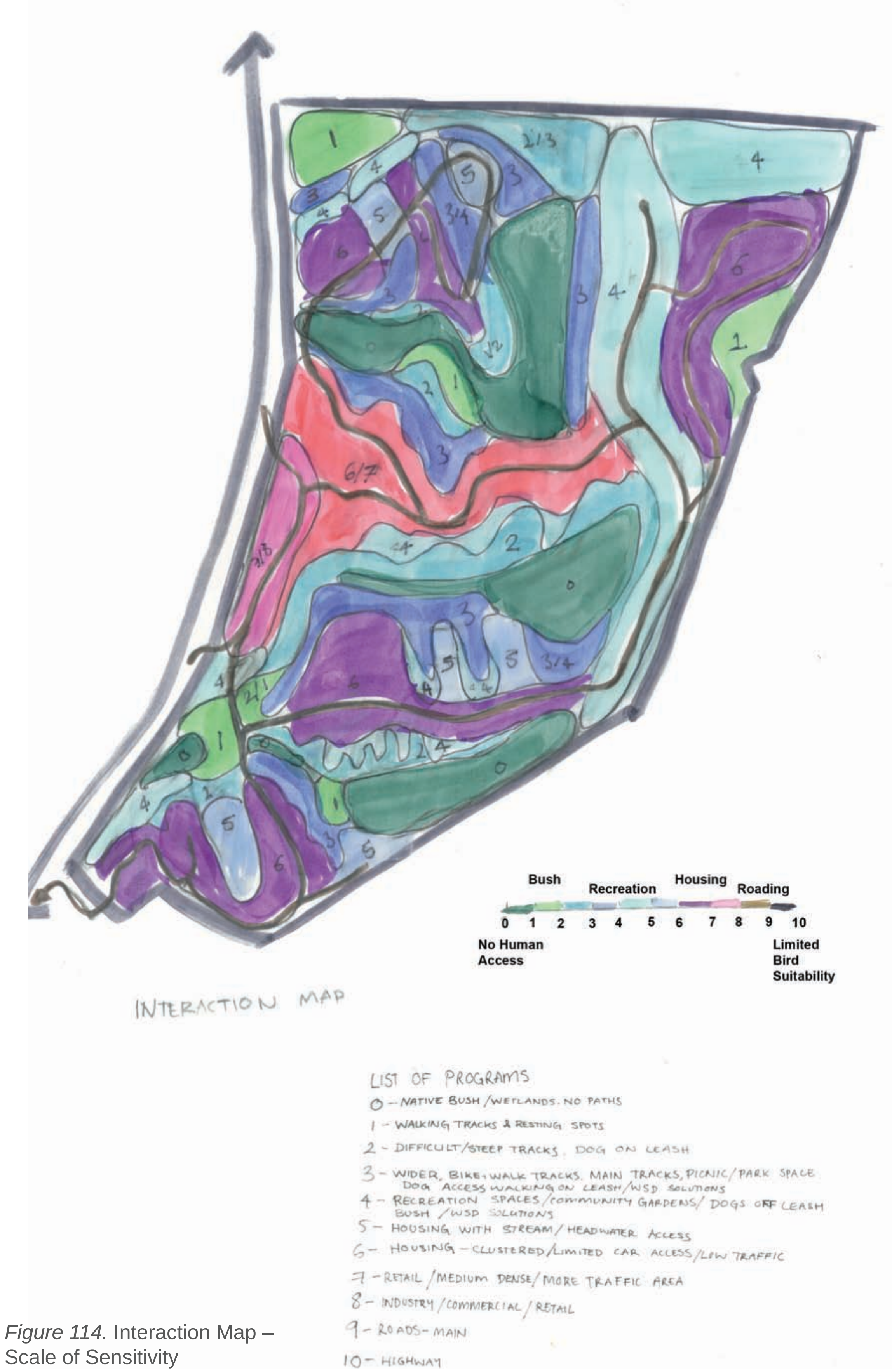

Figure 114. Interaction Map – Scale of Sensitivity

8.1

HOUSING TYPOLOGIES

MEDIUM DENSITY - DETACHED

CASE STUDY - HOBSONVILLE, AUCKLAND

- Detached housing, typically 2-3 stories high.
- Close to neighbouring houses.
- Low-maintenance properties.
- Small, private backyard, front gardens absent
- houses have close street frontage.
- Subtle changes in form prevent monotony while still remaining coherent.
- Small side gardens can increase space between housing allowing additional light penetration.

(Kapiti Coast District Council, 1999)

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Figure 115. Medium Density Detached Housing.

Auckland Council. (n.d.). *Lester Street, Hobsonville.* Retrieved from http://www.aucklanddesignmanual.co.nz/resources/case-studies/55-lester-street

DENSITY NUMBERS PLIMMERTON FARMS 386Ha

AVERAGE PLOT SIZE = 270m2
AVERAGE HOUSE SIZE = 190m2 gross floor area, 120m2 site coverage
AVERAGE SITE COVERAGE = 44%

Area required for 2000 houses = 0.54km2 /54ha
% of Plimmerton Farms site required for 2000 houses = 14.6% (plot size only)
% of Plimmerton Farms site coverage for 2000 houses = 6.4% (houses only)

TERRACE HOUSING

CASE STUDY - BUCKLEY AVENUE, AUCKLAND

- A line of two or three story narrow housing joined on both sides by a similar or identical property.
- Benefits are similar to detached medium density with the addition of being cheaper to build and more thermally efficient due to a reduced external wall area.
- Limited outdoor area and are often combined with some form of shared outdoor space.

(Auckland Design Manual, 2021)

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Figure 116. Terraced Housing,

Auckland Council. (n.d.). *Buckley Terraces.* Retrieved from http://www.aucklanddesignmanual.co.nz/sites-and-buildings/terraces#/sites-and-buildings/terraces/case-studies/buckley_terraces

DENSITY NUMBERS

PLIMMERTON FARMS 386Ha

AVERAGE PLOT SIZE = 218m2
AVERAGE HOUSE SIZE = 196m2 gross floor area,
AVERAGE SITE COVERAGE = 49%

Area required for 2000 houses = 0.44km2 /44ha
% of Plimmerton Farms site required for 2000 houses = 11.8% (plot size only)
% of Plimmerton Farms site coverage for 2000 houses = 5.8% (houses only)

COTTAGE COURTS

CASE STUDY - GREENWOOD AVENUE COTTAGES

- A group of small houses centred around a shared open space.
- Parking is grouped at the edge of the area
- pedestrian only interior space.
- Each dwelling has access to the central green space via their front door as well as a small private back yard.
- Some have communal houses for laundry, cooking and socialising. Others are fully self-sustaining houses on communally owned and managed land.

(Chapin, n.d.)

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Figure 117. Cottage Court

Chapin, R. (n.d.) *Greenwood Avenue Cottages.* Retrieved from https://rosschapin.com/projects/pocket-neighborhoods/greenwood-avenue-cottages/

DENSITY NUMBERS

PLIMMERTON FARMS 386Ha

AVERAGE PLOT SIZE = 455m2 (inc. common area and parking space)
AVERAGE HOUSE SIZE = 82m2 gross floor area,
AVERAGE SITE COVERAGE = 18%

Area required for 2000 houses = 0.91km2 /91ha
% of Plimmerton Farms site required for 2000 houses = 24.7% (plot size only)
% of Plimmerton Farms site coverage for 2000 houses = 4.4% (houses only)

TINY HOUSES

- The traditional “tiny house” is a movable house built on a trailer which therefore avoids many of the regulatory issues with building a traditional house.
- Recommended size to meet NZ regulations is
- 2.4m wide with a length of 7.8m and maximum height of 4.25m (Langston, n.d.).

Tiny houses provide more sustainable and affordable housing but finding permanent or long term sites to park them has been a major reason why tiny houses have not taken off.

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Figure 118. Tiny House.

Homes to Love. (n.d.). *Tiny Homes on Wheels.* Retrieved from https://www.homestolove.co.nz/real-homes/tiny-home-on-wheels

DENSITY NUMBERS | PLIMMERTON FARMS 386Ha

AVERAGE PLOT SIZE = 19m2
AVERAGE HOUSE SIZE = 19m2 gross floor area,
AVERAGE SITE COVERAGE = 100%

Area required for 2000 houses = 0.038km2 /3.8ha
% of Plimmerton Farms site required for 2000 houses = 1% (houses only)
% of Plimmerton Farms site coverage for 2000 houses = 1% (houses only)

APARTMENT BLOCKS

CASE STUDY - NEWTOWN, WELLINGTON

- Mixed unit dwellings.
- Body corporates maintains shared facilities (eg lifts).
- Shared outdoor space sometimes included. Less common in central city apartments.

The Village, is a 56 apartment housing development proposed for construction in Newtown, Wellington.
The unique aspect of this design is that no parking provisions are provided on the site. While many claim the importance of parking for desirability, this projects success shows that peoples mindsets are changing and that many are happy to purchase housing without parking, provided the cost of housing is reasonable and public transport is easily accessible (Devlin, 2018).

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Figure 119. Apartment Buildings.

Devlin, C. (2018). *Majority of 'affordable' apartments in Wellington's Newtown sell off plans.* Retrieved from https://www.stuff.co.nz/

DENSITY NUMBERS | PLIMMERTON FARMS 386Ha

TOTAL SITE AREA = 1808m2 (for 56 apartments)
AVERAGE HOUSE SIZE = 63.5m2 gross floor area,
AVERAGE SITE COVERAGE =49%

Area required for 2000 houses = 0.064km2 /6.4ha
% of Plimmerton Farms site required for 2000 houses = 1.7%
% of Plimmerton Farms site coverage for 2000 houses = 0.86% (houses only)

NEW ZEALAND SUBURBIA

CASE STUDY - ASCOTT PARK, PORIRUA

- Street layout minimizes through traffic. Streets get more private as they move from distributor to residential roads, culminating in the Cul-de-sac.
- The cul-de-sac promotes a sense of community and safety without compromising privacy. The internal focus of housing creates a sense of ownership on the street.
- Car dominance as in-direct nature of the roads makes walking or bicycling take time and bus routes are unable to easily cater to the areas.
- Wide roads, onstreet parking, and private drive-ways and/or garages.

Figure 120. Ascott Park, Porirua.

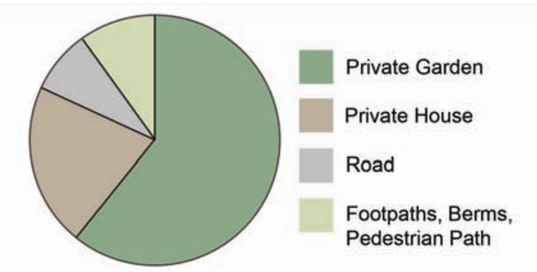

Figure 121. Land Use

Figure 122. Street Plan

DENSITY NUMBERS

PLIMMERTON FARMS 386Ha

AVERAGE PLOT SIZE = 603m2
AVERAGE HOUSE SIZE = 143m2
AVERAGE SITE COVERAGE = 23.7%

Area required for 2000 houses = 1.2km2 / 120Ha
% of Plimmerton Farms site required for 2000 houses = 33% (plot size only)
% of Plimmerton Farms site coverage for 2000 houses = 7.7% (houses only)

HOUSING TYPOLOGIES

SUMMARY

	% of site required for 2000 houses	site coverage (average)	% of site coverage for 2000 houses
TYPICAL SUBURBAN LAYOUT:	33%	23.7%	7.7%
MEDIUM DENSITY DETACHED:	14.6%	44%	6.4%
TERRACED HOUSING:	11.8%	49%	5.8%
COTTAGE COURT:	24.7%	18%	4.4%
TINY HOUSE:	1%	100%	1%
APARTMENT:	1.7%	49%	0.86%

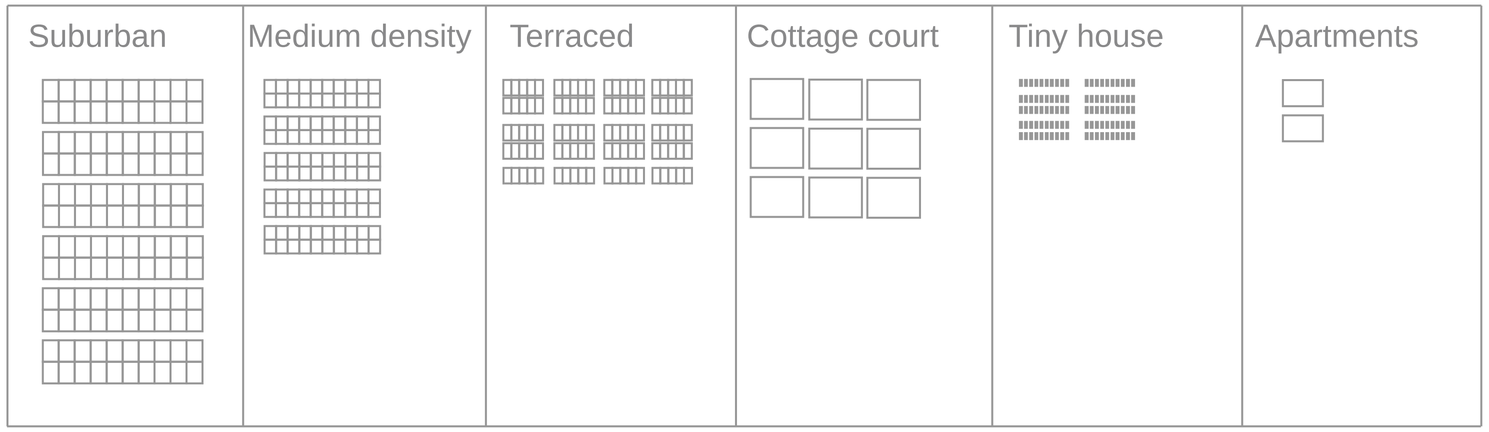

Figure 123. Area for 100 Houses.

Scale 1:10,000

REFLECTION

This process highlighted the ease in which 2000 houses should be able to fit on the site regardless of house type, and the minimal site coverage required.

The developers proposed design aimed for 2000 houses yet the amount of land offered for vegetated patches in minimal. This study shows suburban development has the spatial capacity to include natural habitats.

The cottage court precedent showed how centralised parking can be used to reduce impervious surfaces and prioritise the pedestrian. This approach could be implemented within other housing typologies such as terraced housing.

09

DESIGN PHASE 2
WHERE TO BUILD

Now that the goal of 2000 houses has been established; the first step in design is to decide where on the site is most suitable to build on. Housing placement needs to be approached from an ecological perspective first, prioritising the need to establish healthy ecosystems. Habitat types naturally present on the site would have been broadleaf/conifer forest and freshwater wetlands. Recreation of these two habitats will be prioritised in the ecological approach.

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Figure 124. View over Plimmerton Farms.

Gilles Group. (2019). *Short Plimmerton Farm View.* Retrieved from https://www.youtube.com/watch?v=QXdRlVsUuYk

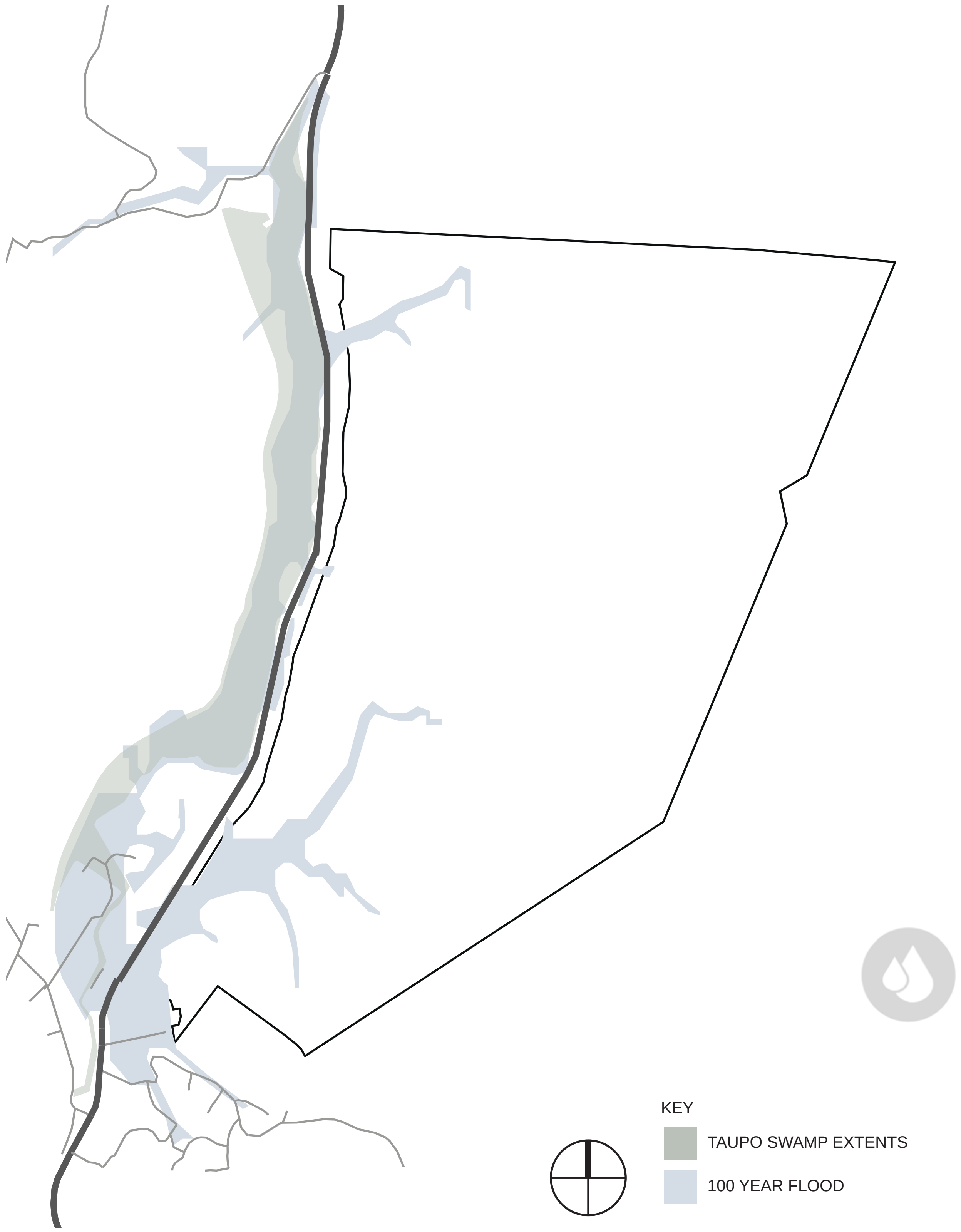


Figure 125. 100 Year Flood Extents.

Flat areas of the site are within flood extents of Taupo Swamp. The area has a high water table and is more suited to wetlands than building.

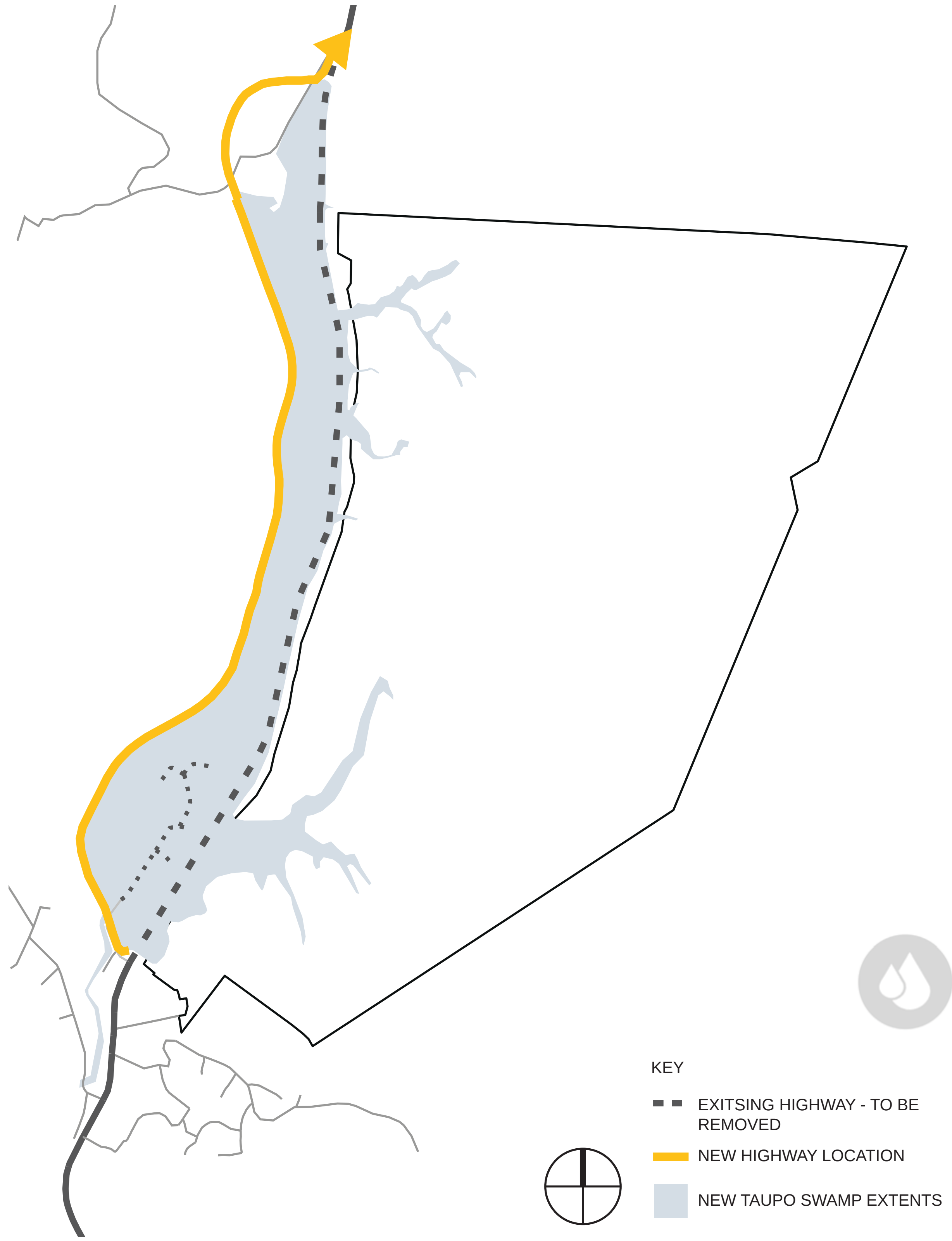
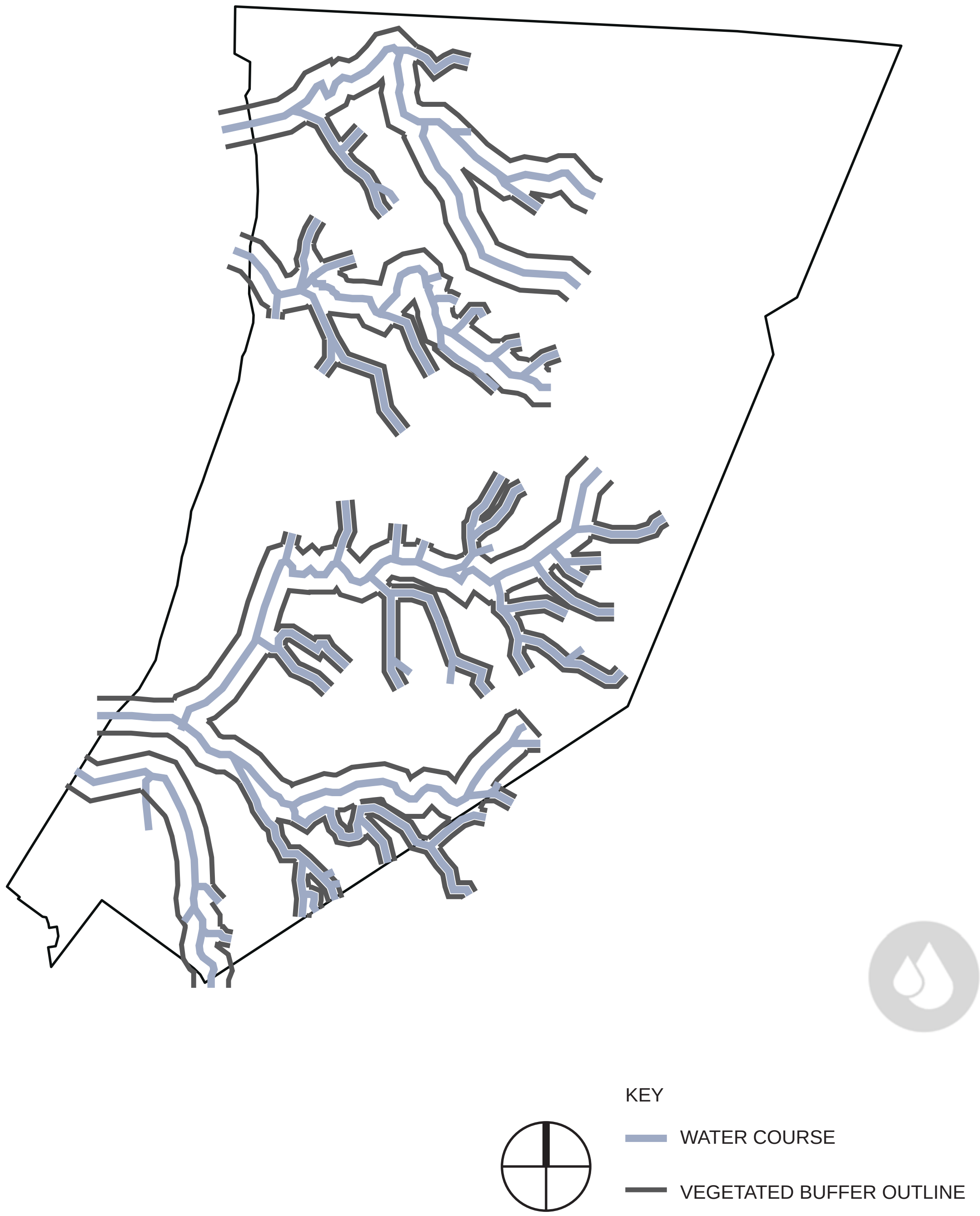


Figure 126. Taupo Swamp Expansion.

If the SHW1 road is redirected to run beside the train line, Taupo swamp could be given space to expand back into the site. This expansion would increase the swamps area by just over 40% as well as allowing the swamp to re-connect with the streams onsite. This connectivity allows wetland bird species to expand upstream, as there is no longer the highway as a barrier.



SCALE 1:20,000

Figure 127. Watercourse Buffers.

Preservation of water ways as naturalised areas is important to provide a clean drinking source for wildlife. A 50m buffer to the primary water course and 20m buffer to the headwaters will be maintained where possible to decrease pollution.

Figure 128. Stream Wetland.

Figure 129. Figure 130. Headwaters with Carex Species

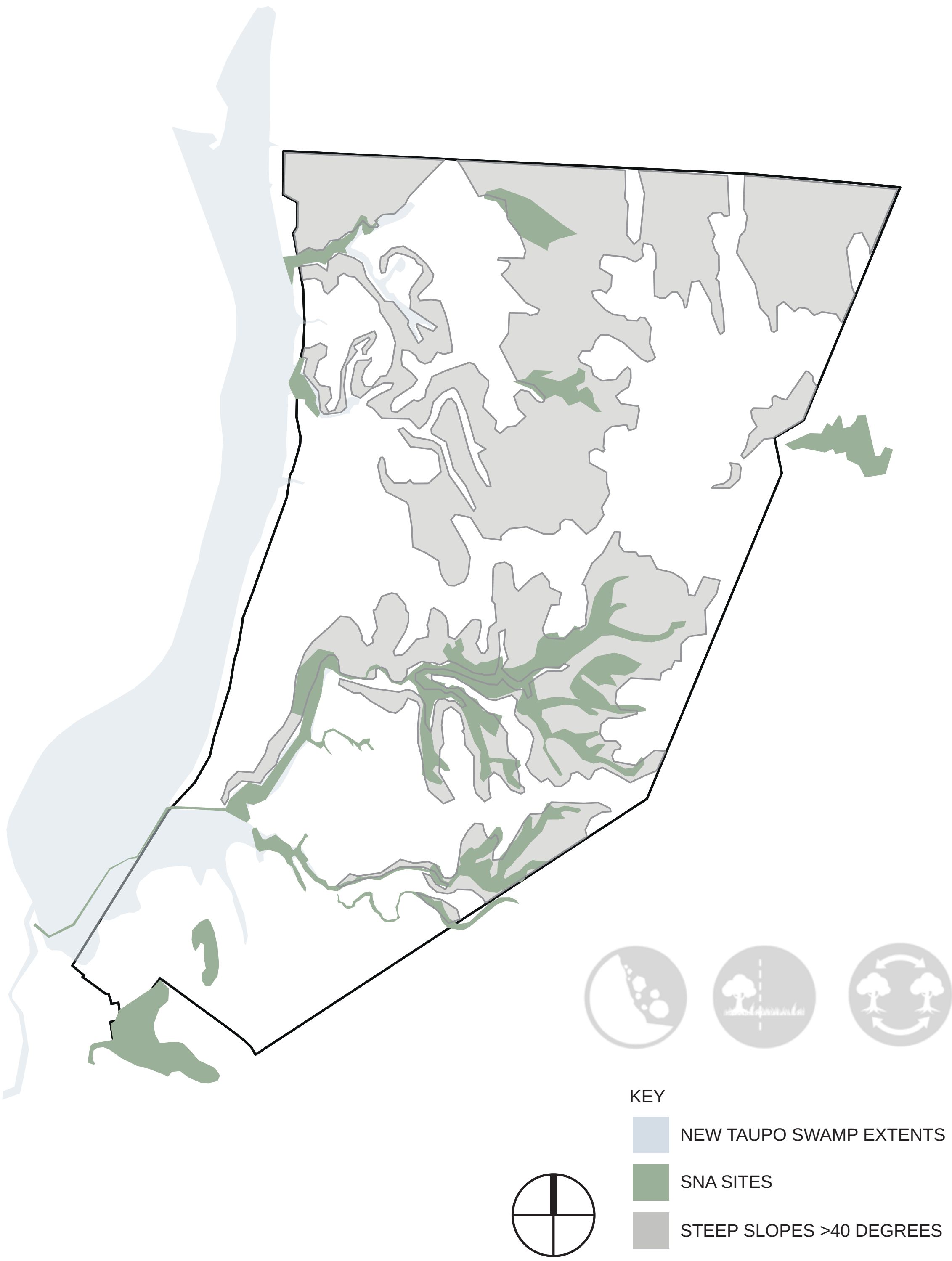


Figure 131. SNA Sites and Steep Slopes

Protection of existing SNA on site will enable the patches to serve as potential seed-sources to aid natural succession and minimise human input. Steep slopes and areas of historic slope failure will be revegetated for slope stability.

Figure 132. Regenerating Manuka and Kanuka scrub with remnant conifers

Figure 133. Example of Steep Slopes on site

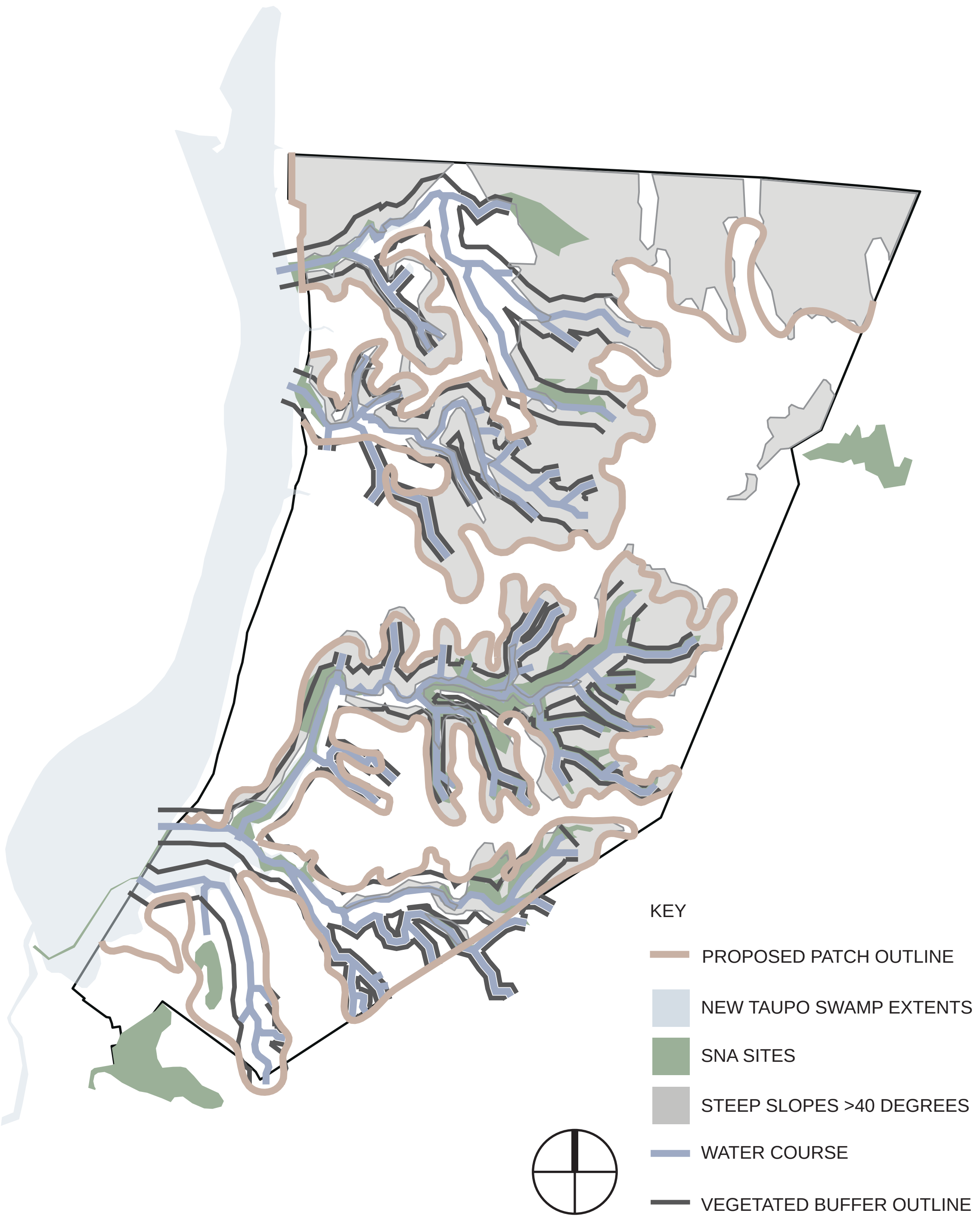


Figure 134. Patch Outline

SCALE 1:20,000

These steps were used to outline spaces where building should be avoided.
The internal line is offset of 30m - the average depth the surrounding matrix impacts a vegetation patch….

Figure 135. Patch Outline Refined

SCALE 1:20,000

This offset showed there were a lot of spaces that did not contribute to a core area. A new patch shape was determined that focused on maintaining a large core. The new shape retains an uneven edge shape as identified in the literature review.

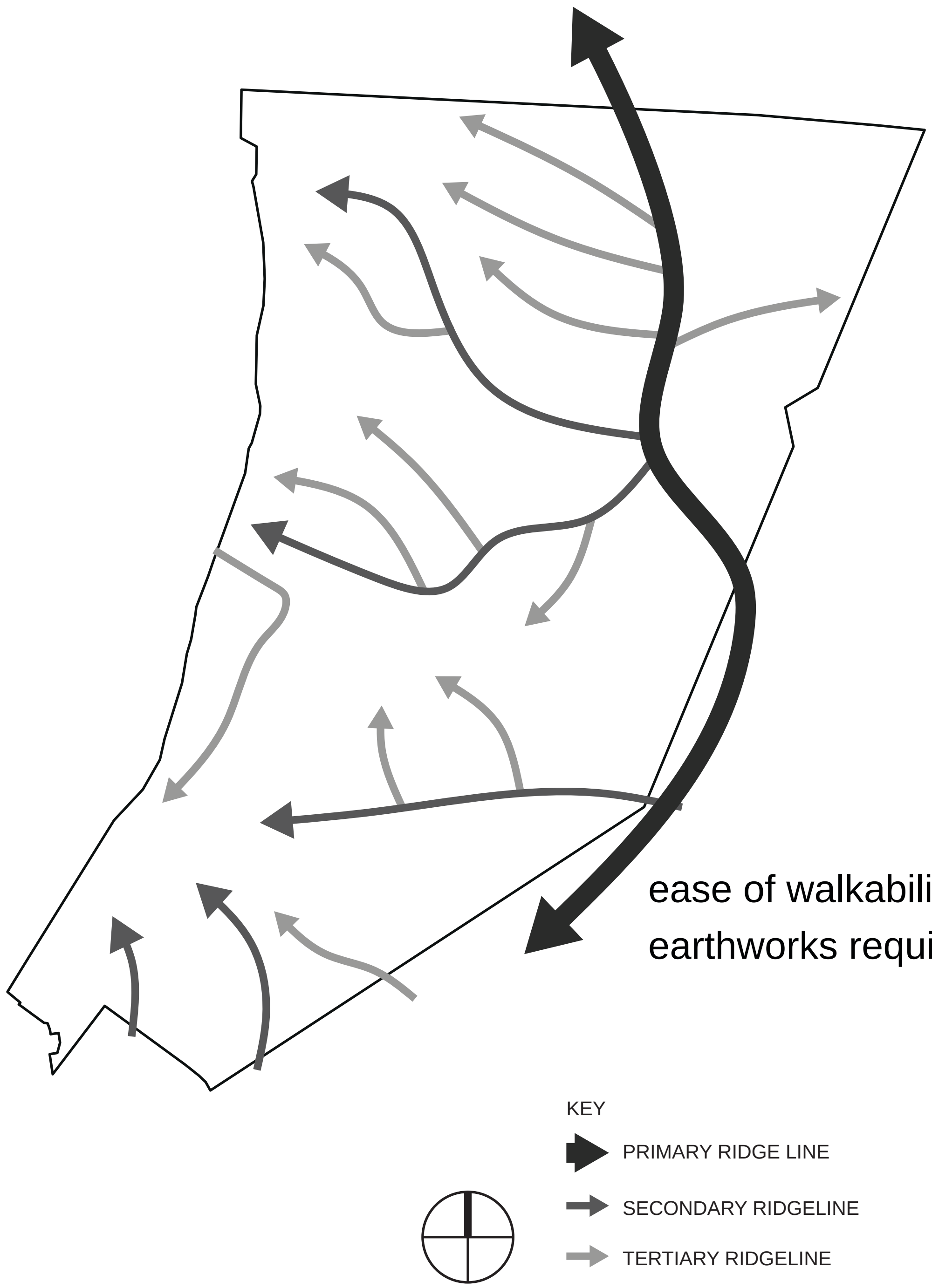


Figure 136. Ridgelines

SCALE 1:20,000

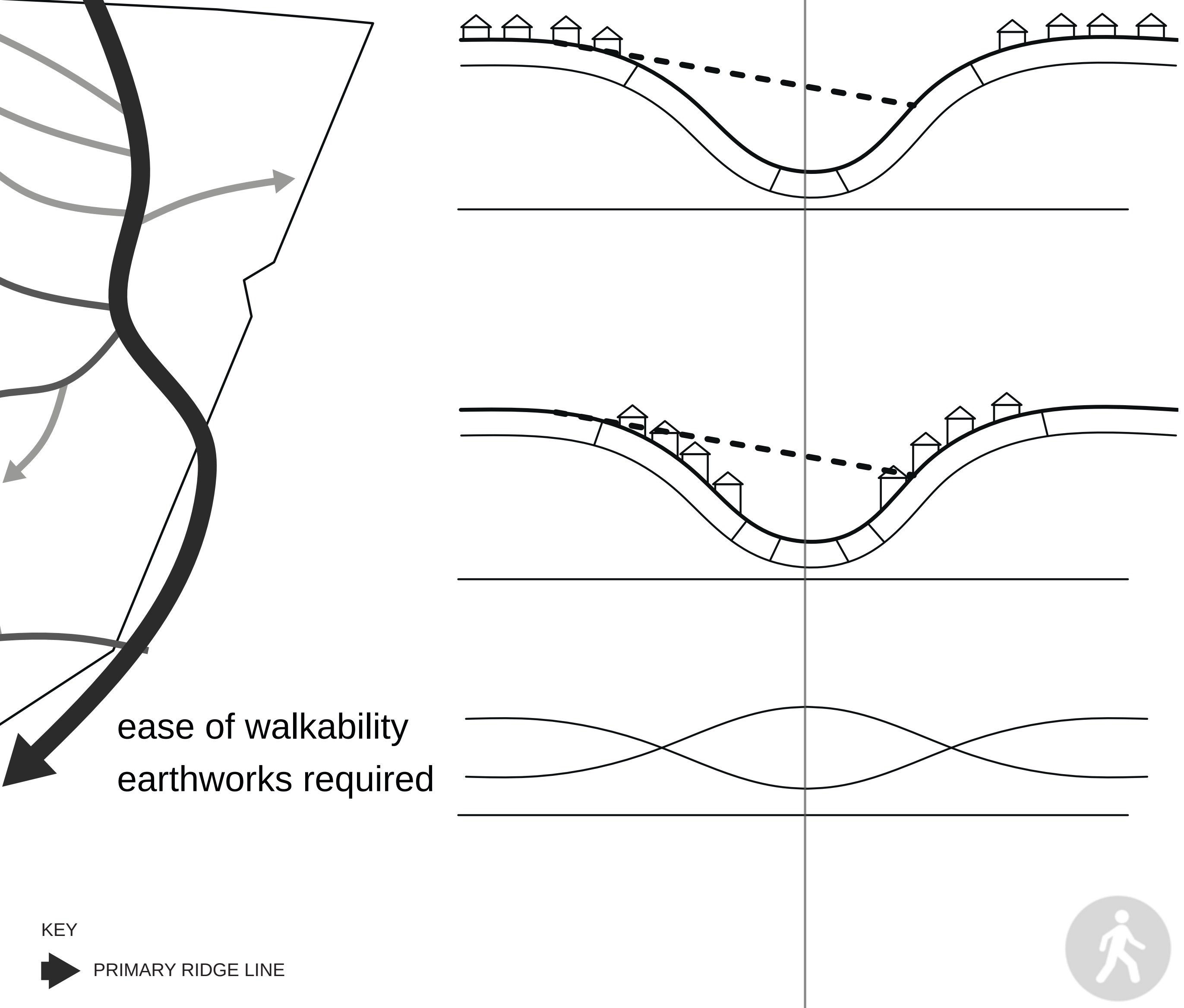


Figure 137. Sectional Comparison of Housing Location options.

NTS

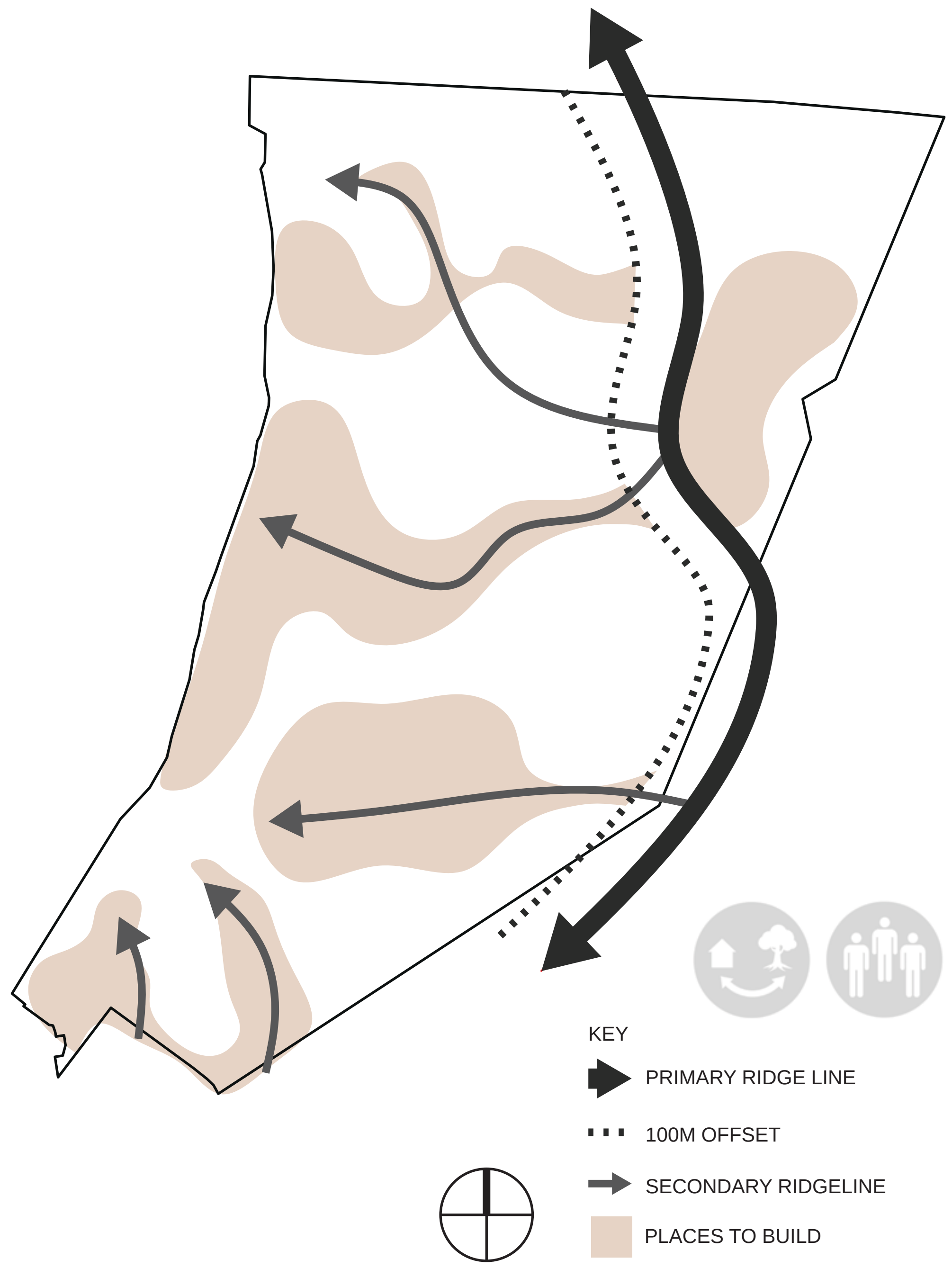


Figure 138. Places to Build

SCALE 1:20,000

Most visual assessments recommend that ridgelines are preserved for the visual amenity.

But further exploration showed that ridgelines were most appropriate to build on. They are the flattest areas so the most walkable and require the least earth works. The sunlight studies also showed ridgelines were the only places to get sun year round. When maintaining stream buffers, building on ridges allowed for the largest un-broken patches.

The Landscape Assessment Report highlighted the main ridgeline as a key point of visual interest which will be maintain as an amenity area.

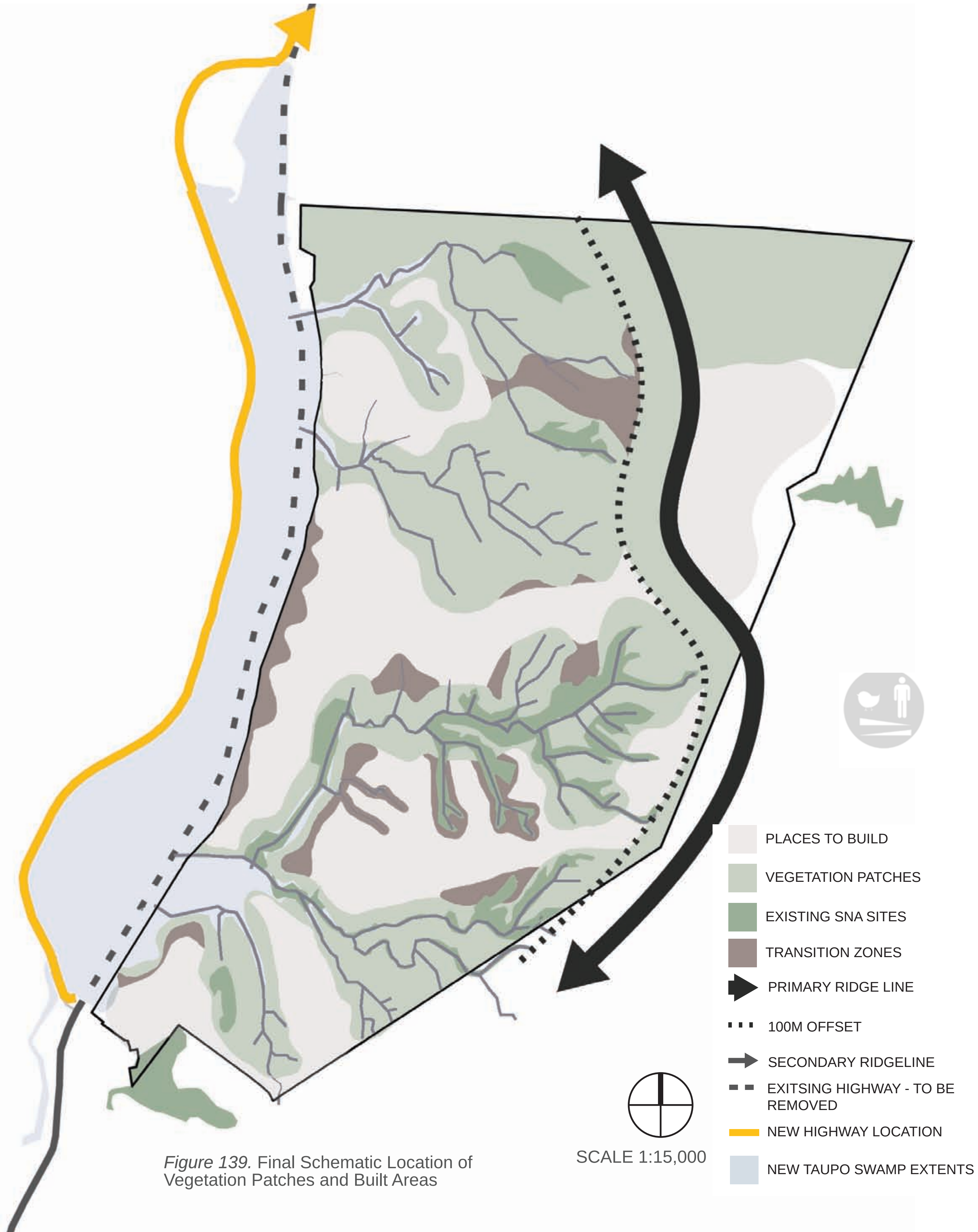


Figure 139. Final Schematic Location of Vegetation Patches and Built Areas

Final outline of where to build and where to revegetate. Areas that were outlined as stream heads or SNA areas but outside the designated core vegetation areas are to be incorporated as "transition zones". These zones will have a positive ecological impact but also offer high human activity – such as moderately vegetated park or recreation areas.

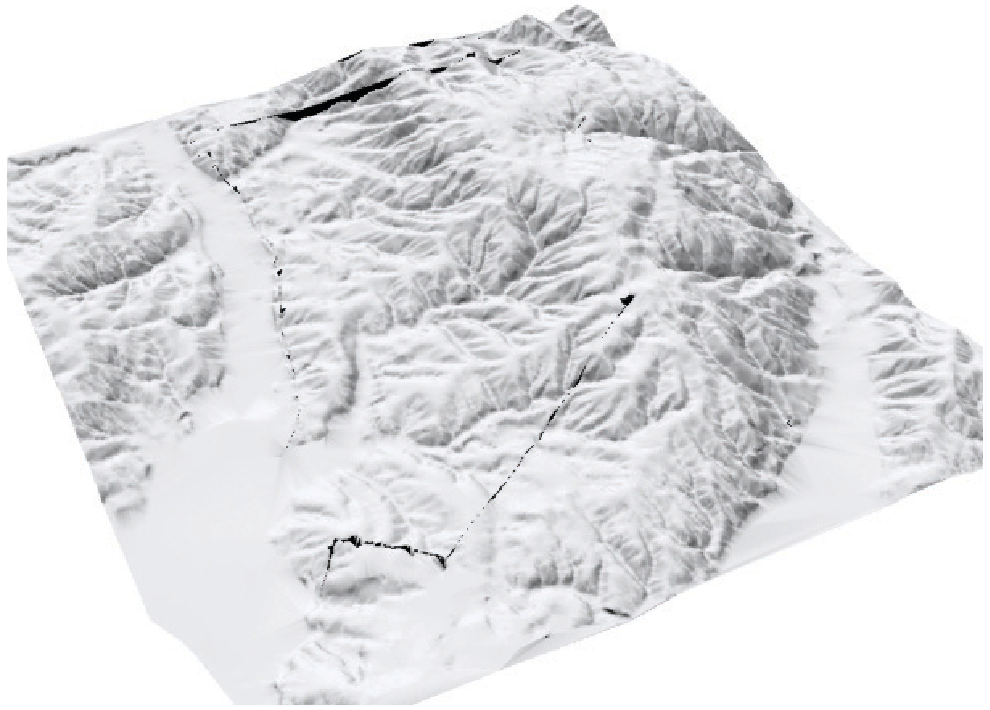


Figure 140. Site Typography and Shadow Location

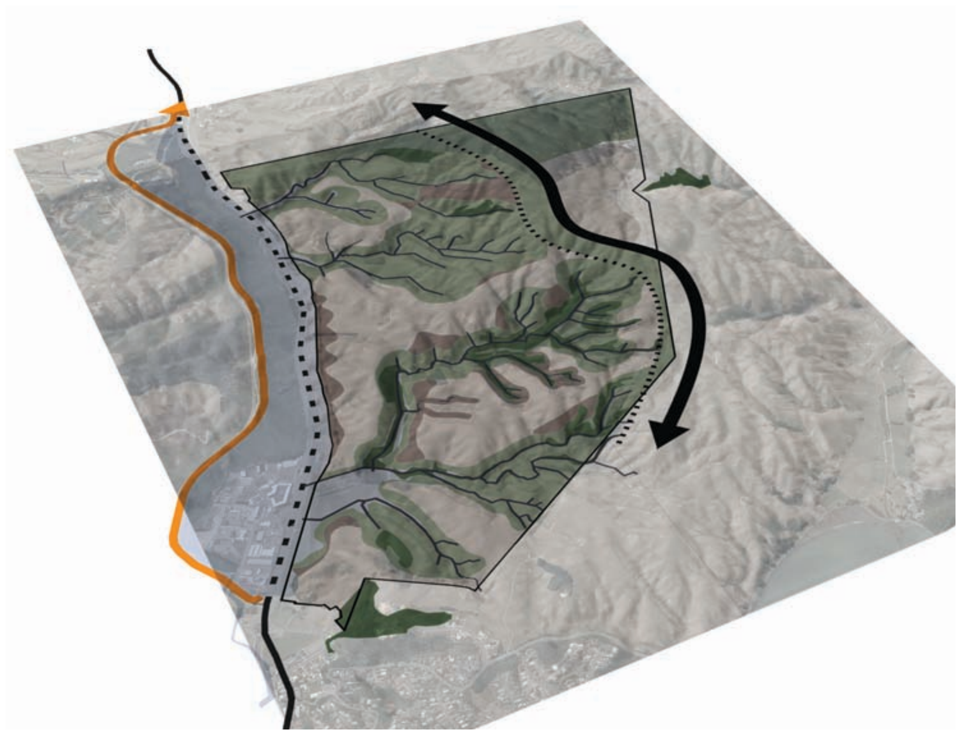


Figure 141. Final Schematic Overlayed on Site Typography

REFLECTION

The ecological approach surprisingly resulted in a schematic that offers the most appealing land-use to both humans and wildlife, with little compromise required. Damp, steep, shaded valley floors are easily revegetated and provide water for wildlife while being unappealing habitat to humans. Sunny ridgelines offer the most appealing location for housing while also requiring the least amount of earthworks to build upon.

The expansion of Taupo swamp connects the existing swamp inhabitants with the site, and acts as a corridor that connects all the patches together. While this limits the sites accessibility to a single entrance, but it also offers the potential to capitalise on the views and relationship with the swamps edge that is created by this move.

The final vegetation patch locations are similar to that of the proposed developers design, but are larger and shaped to provide larger core areas so to better support bird species.

The primary point of difference of this approach compared to the developers design is that the flat areas of the site are used for stormwater treatment rather than housing. This means less people living close to the train station.

Overall, this process reinforced the applicability and success of many of the design principles, as the resultant layout still provides many opportunities for housing to be placed on the site.

The design implication of providing several patches rather than one large patch, enables more housing to have a close relationship with natural spaces and will encourage cohabitation as bird species will be more likely to occupy human areas as they travel between patches via housing areas.

It also creates a sense of community by creating smaller housing clusters with clear physical boundaries, separated by reserves.

10

DESIGN PHASE 3
HOUSING AND ROAD LAYOUTS

After establishing a rough guide on where to build, the next step is to lay out roads and housing on the site. The following design phase undertakes three separate design approaches, with the priority of minimising earthworks and reducing the impact of human settlement on the neighbouring vegetation patches.

These approaches are undertaken separately from one another as three individual concept explorations, but will be reviewed and compared at the end of the design phase to inform a final schematic plan.

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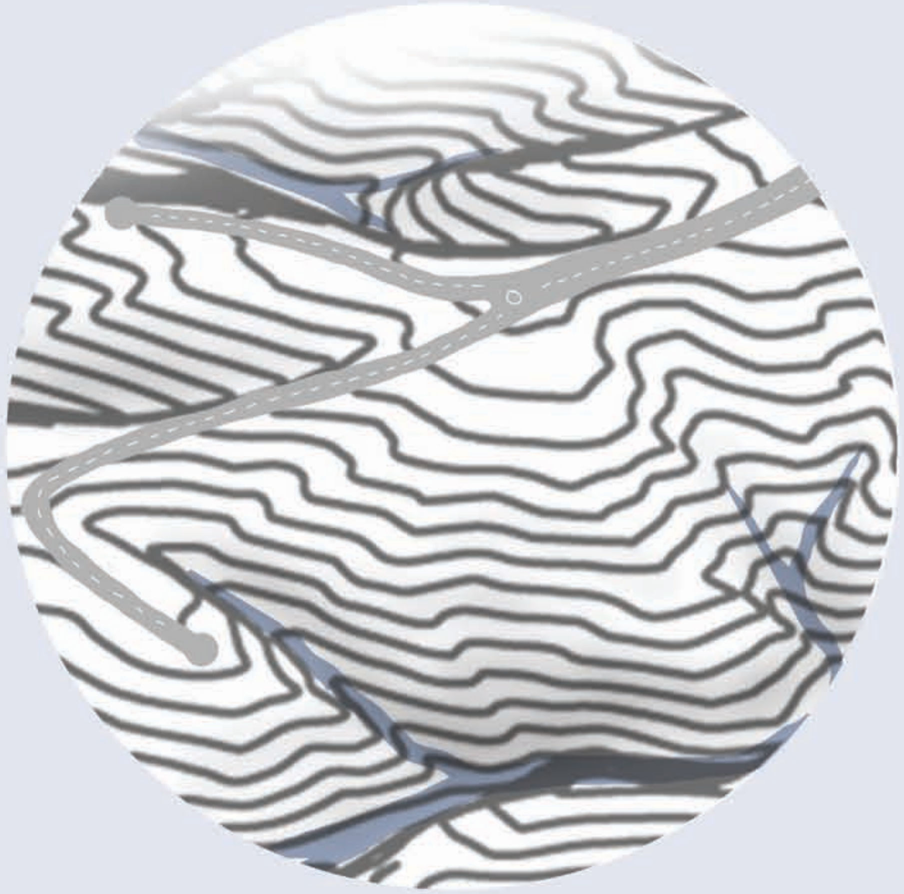
Figure 142. Plimmerton Farms

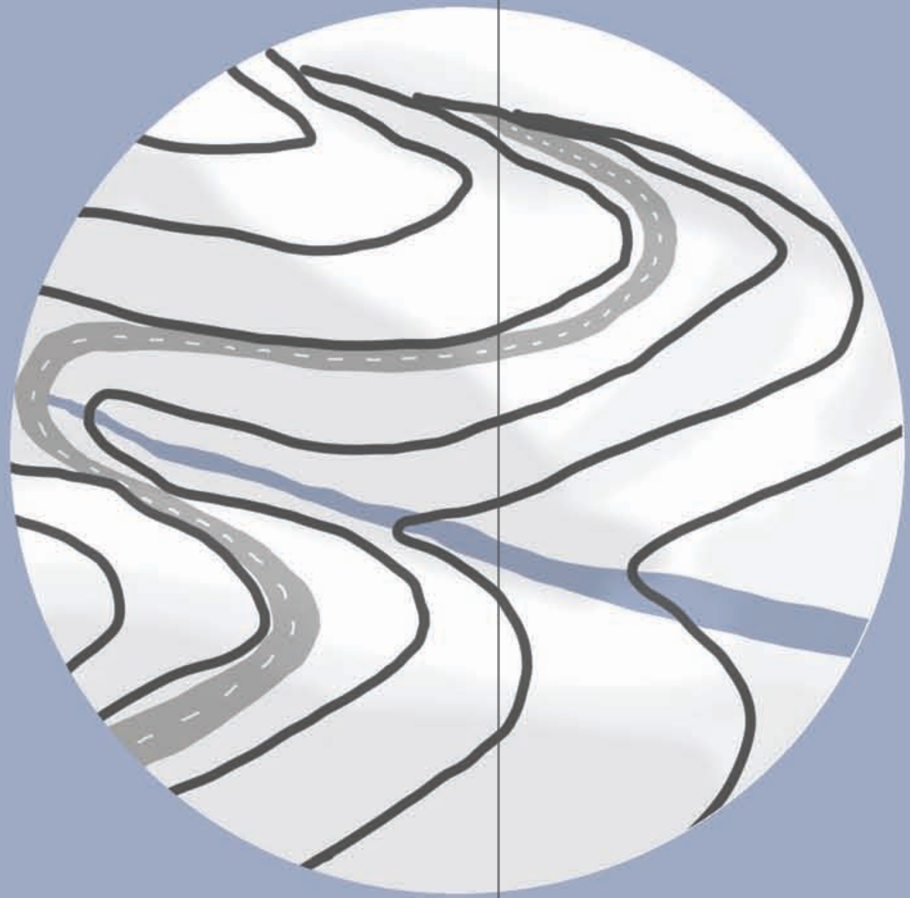
Porirua City Council. (2019). *Open days for Plimmerton Farm District Plan change.* Retrieved from https://www.scoop.co.nz/stories/AK1905/S00632/open-days-for-plimmerton-farm-district-plan-change.htm

APPROACH 1



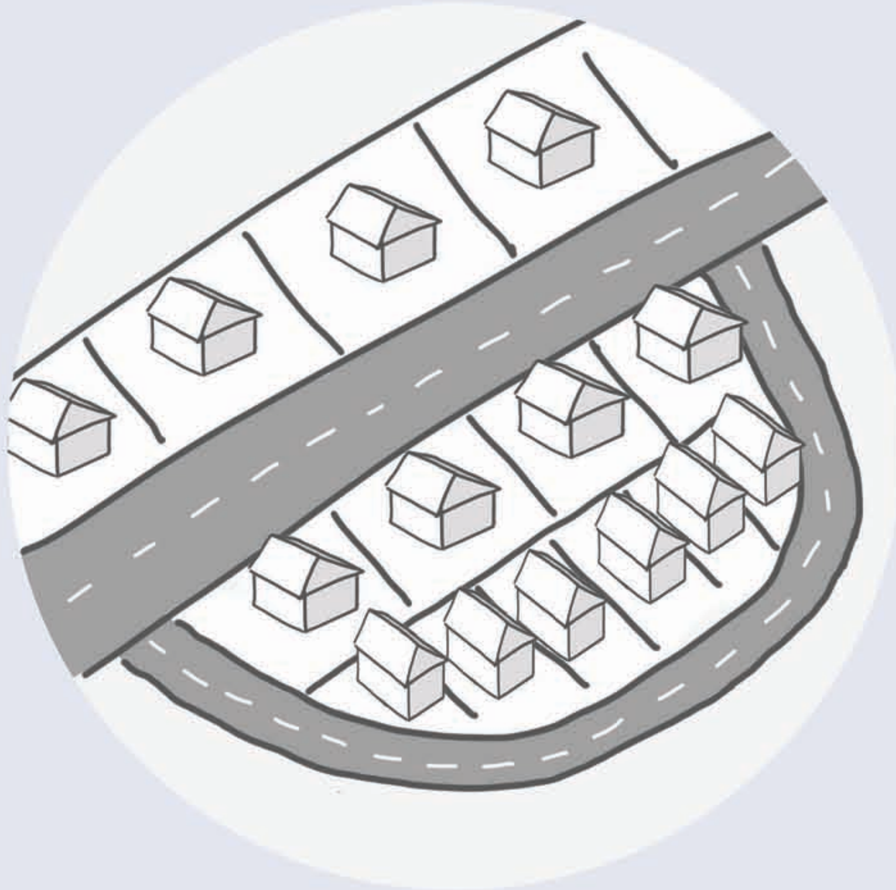
RIDGELINES

APPROACH 2



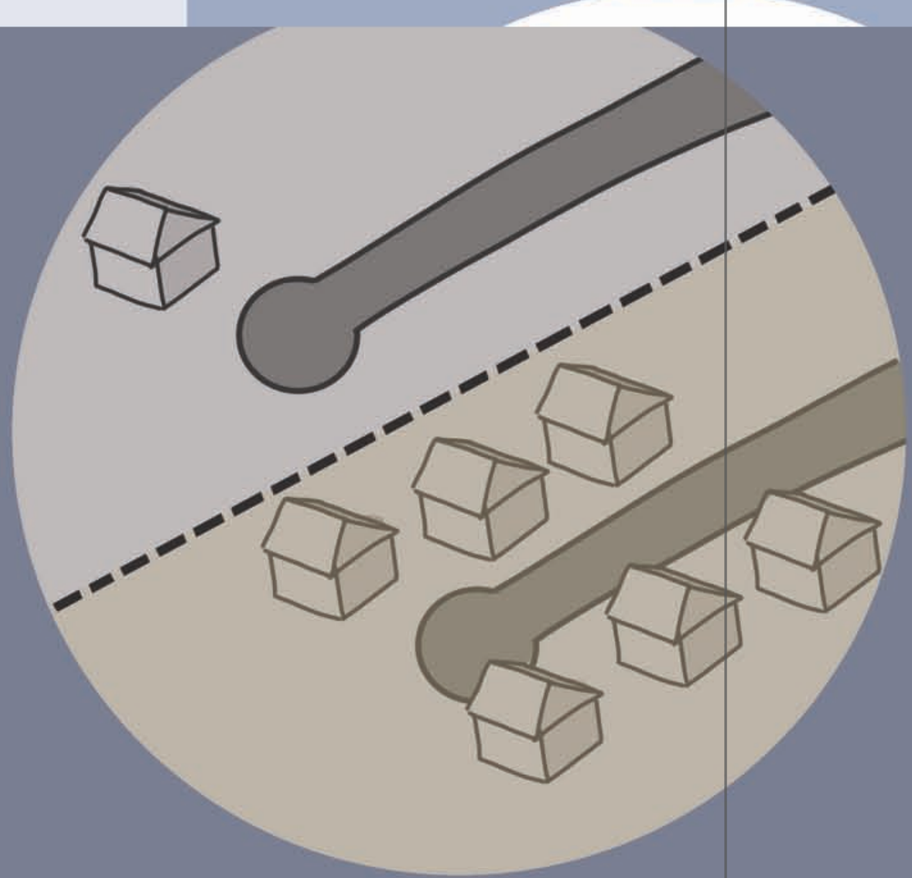
CONTOURS

APPROACH 3

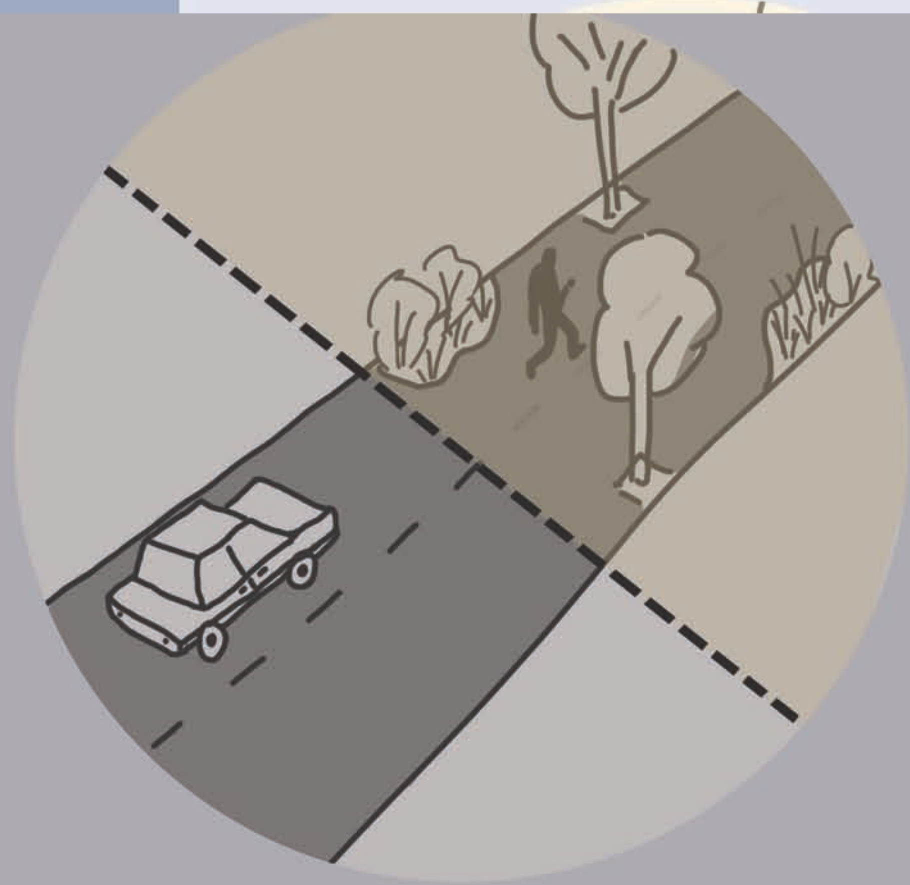


LOOPED ROADS

CUL-DE-SAC



CLUSTERS



CHANGE OVER TIME

Figure 143. Phase 10 Approaches.

10.1

APPROACH 1

Key design strategies:
A) Road layout to utilise ridgelines as a way to navigate the site via the gentlest slopes and therefore decrease earthworks required.

B) Main road loops to offer easy access to public transport for most houses.

C) Utilise cul-de-sacs to create a sense of community living by reducing the amount of through-traffic on residential streets.

D) Decrease the impact of roads on wildlife and distancing main road from vegetated areas where possible.

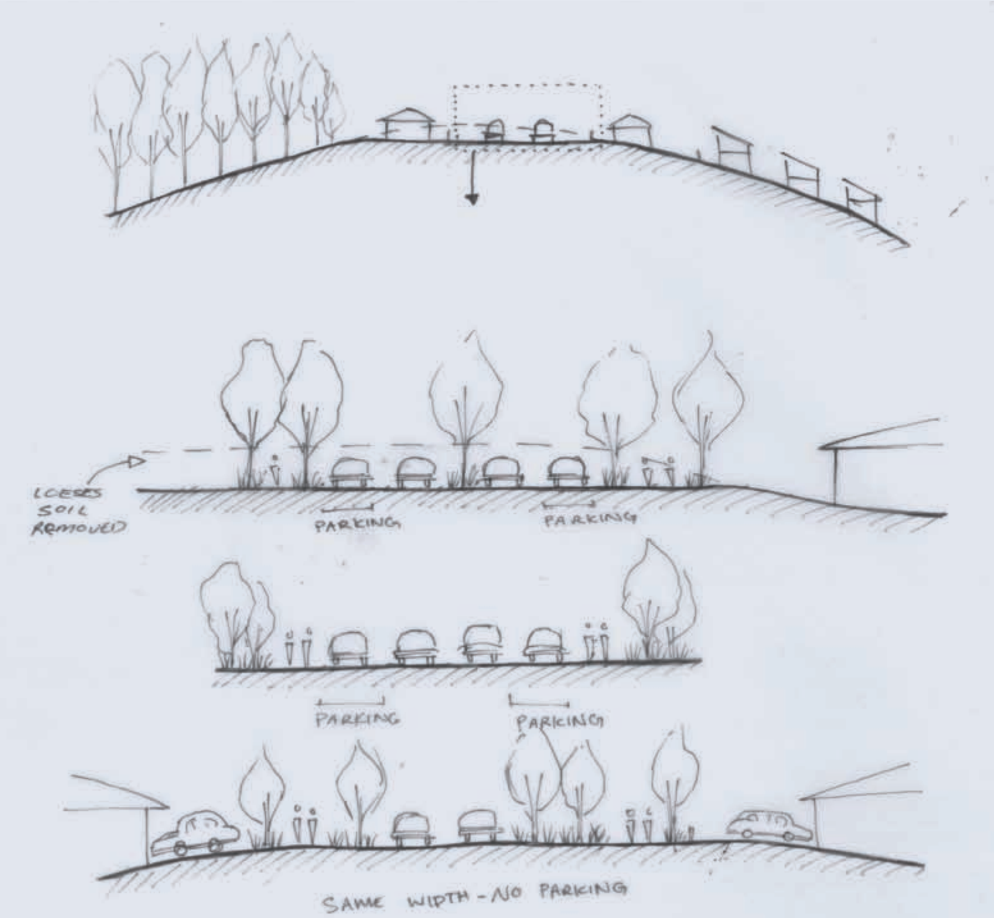


Figure 144. Sections

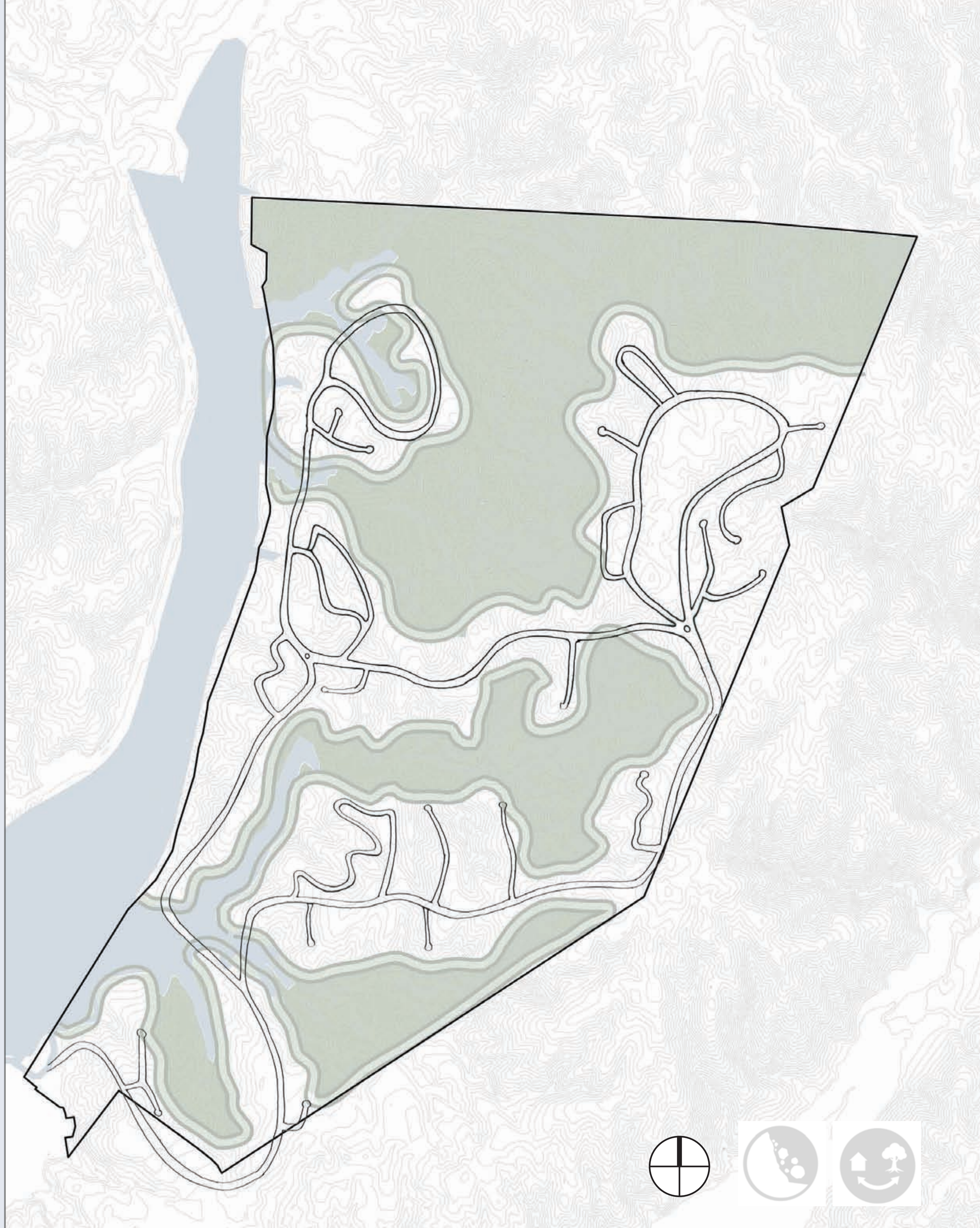


Figure 145. Road Layout

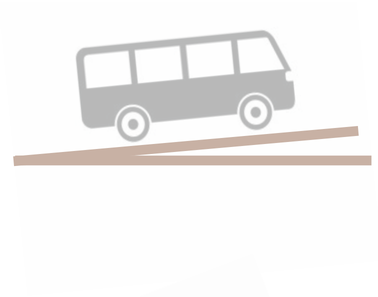
SCALE 1:15,000

PUBLIC TRANSPORT LINKS

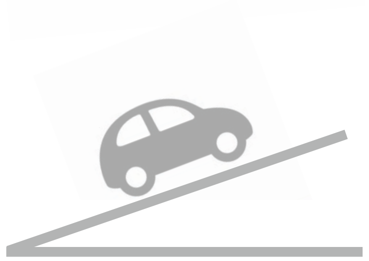
The initial desire was to design a primary road loop that could serve as a bus route, with minor roads coming off; however it quickly became apparent that most of the site was too steep for roads to be graded at a level acceptable for busses.

An alternative possibility is a mini-van system that collects locals and takes them to the train station. Grading needs to only be suitable for cars and vans which can navigate steeper slopes.

The road layout for concept 1 allows most streets to be within a 5 minute walking distance of the main road loop on which the mini-vans will circulate.



Bus routes should not be over 1 in 15 (4 degree slope) GWRC guidelines https://wellington.govt.nz/~/medi



Cars can typically drive up to 20 degree slope

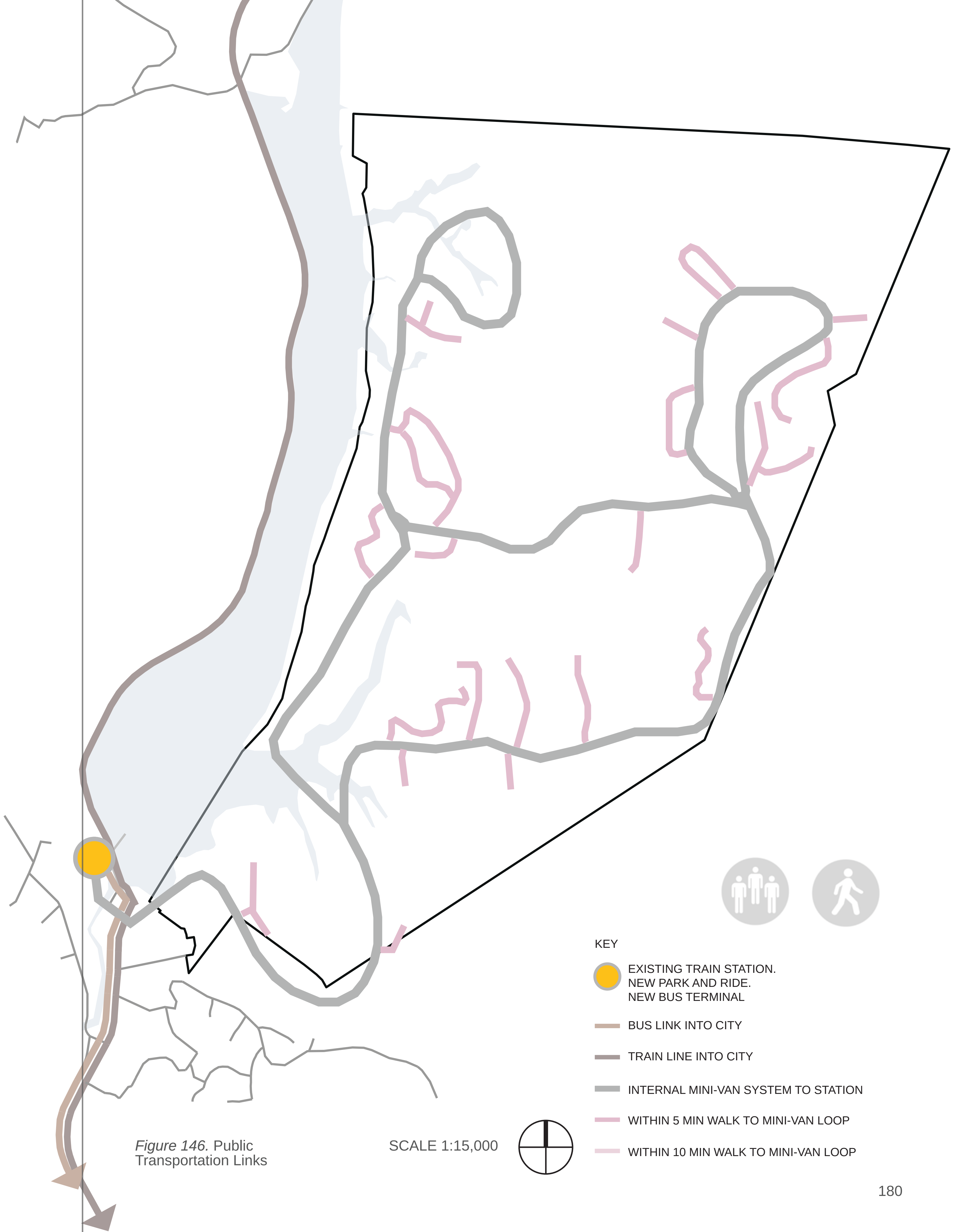


Figure 146. Public Transportation Links

MEDIUM DENSITY

THE TRADE-OFF MODEL

A majority of residents surveyed in medium density apartments in Wellington central desired to own a lower density house in the future; the main reason being the noise from both traffic and close neighbours. (Dunbar & McDermott, 2011)

The common approach to housing places the most density along main roads with larger lots further back. This method comes from a transport orientated approach that assumes downsides of dense living are balanced by location and convenience. In a suburban context, this approach no longer works as all areas within the site are still a distance from the city centre.

An alternative approach is to place medium density along cul-de-sacs off the main road, where traffic noise is reduced and the houses have close access and views to natural spaces, to compensate for the lack of private outdoor space.

This approach offers better cohabitation, buy reducing traffic impacts near natural areas while encouraging the most people to live near and interact with them.

Gradient transition between vegetation areas and primary road - centralizing the impact

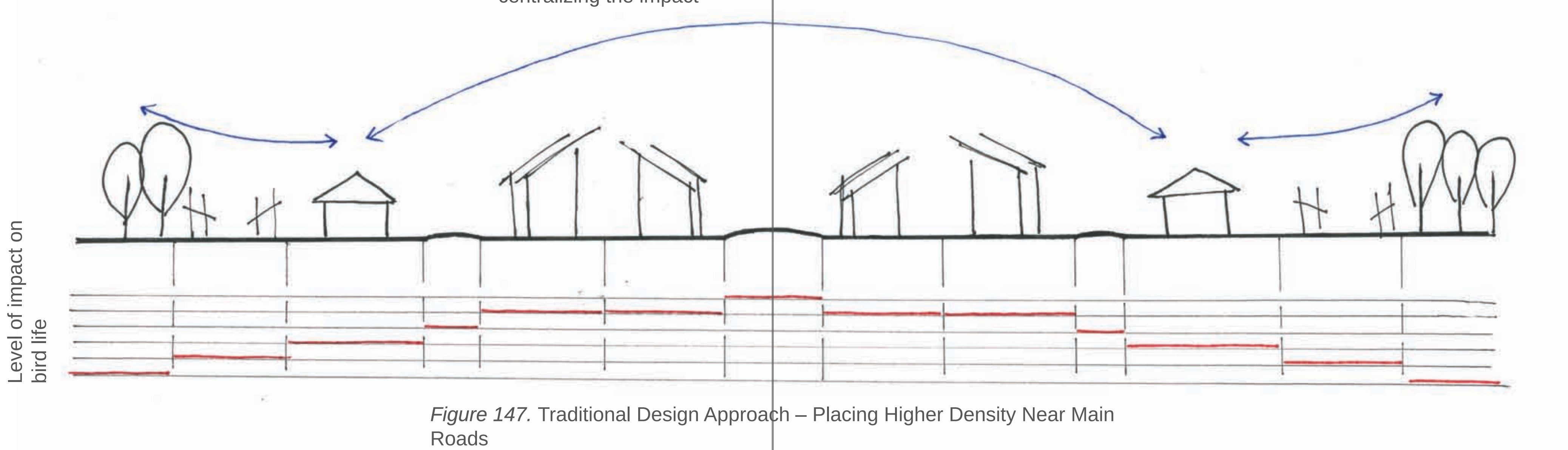


Figure 147. Traditional Design Approach – Placing Higher Density Near Main Roads

Shorter distance with low density acting as stepping stone environments to make traversing easy

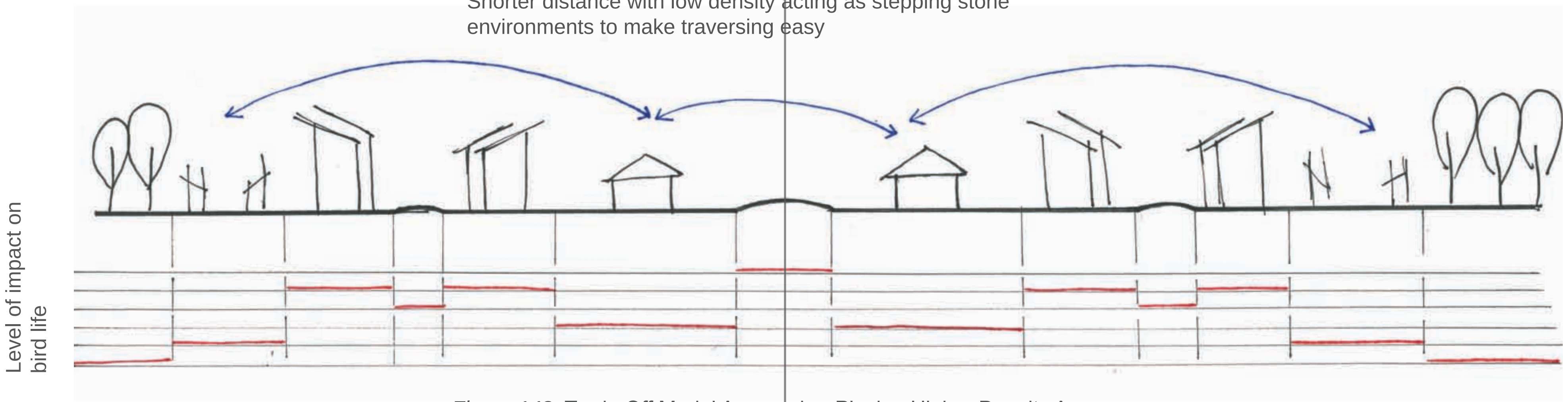


Figure 148. Trade Off Model Approach – Placing Higher Density Away from Main Roads

For residents who desire larger lots, these are located along the main road, where houses can be set-back from the road as well as having ample back garden space. These houses will also have either direct car access to their house, or where slopes prevent this, street parking will be available.

Low density is a primary factor of the biodiversity peak in suburbia. By concentrating the low density housing to the main road, these houses act as a sound buffer, while still being an easily traversed environment for wildlife.

The medium density cul-de-sacs will have communal car parking, with the end of each street being pedestrianised. Communal car parks will be located a maximum of 100m from the end of the street to maintain a level of convenience for residents. Traffic is therefore concentrated to the primary road loop, with low traffic streets acting as a sound buffer between the primary road and vegetation patches.

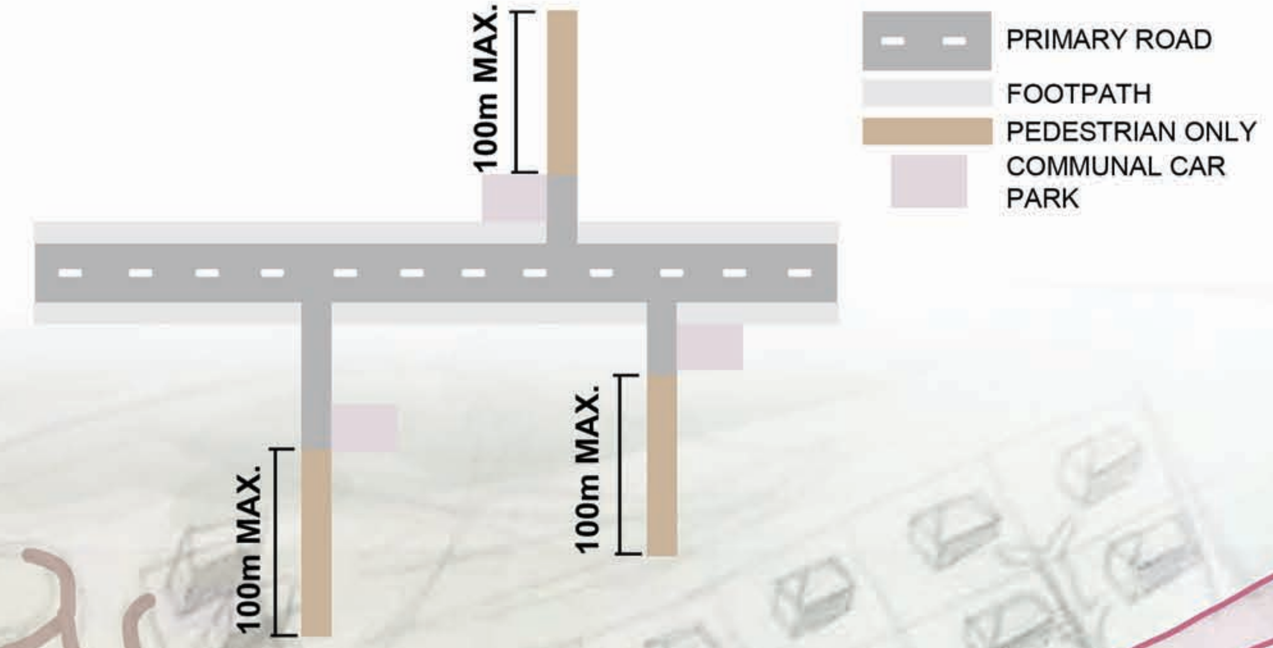


*Figure 149.*Axonometric of Housing and Main Road

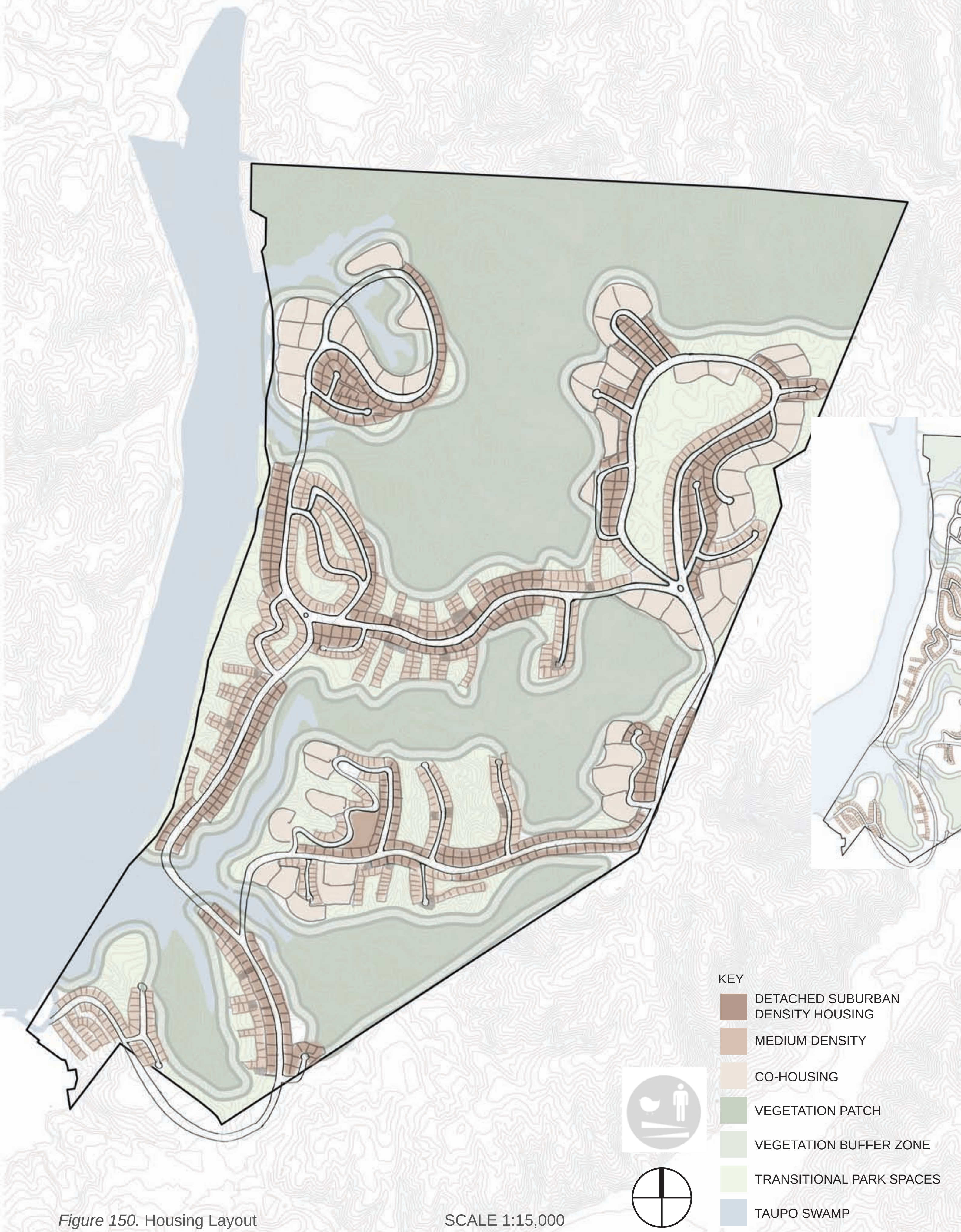
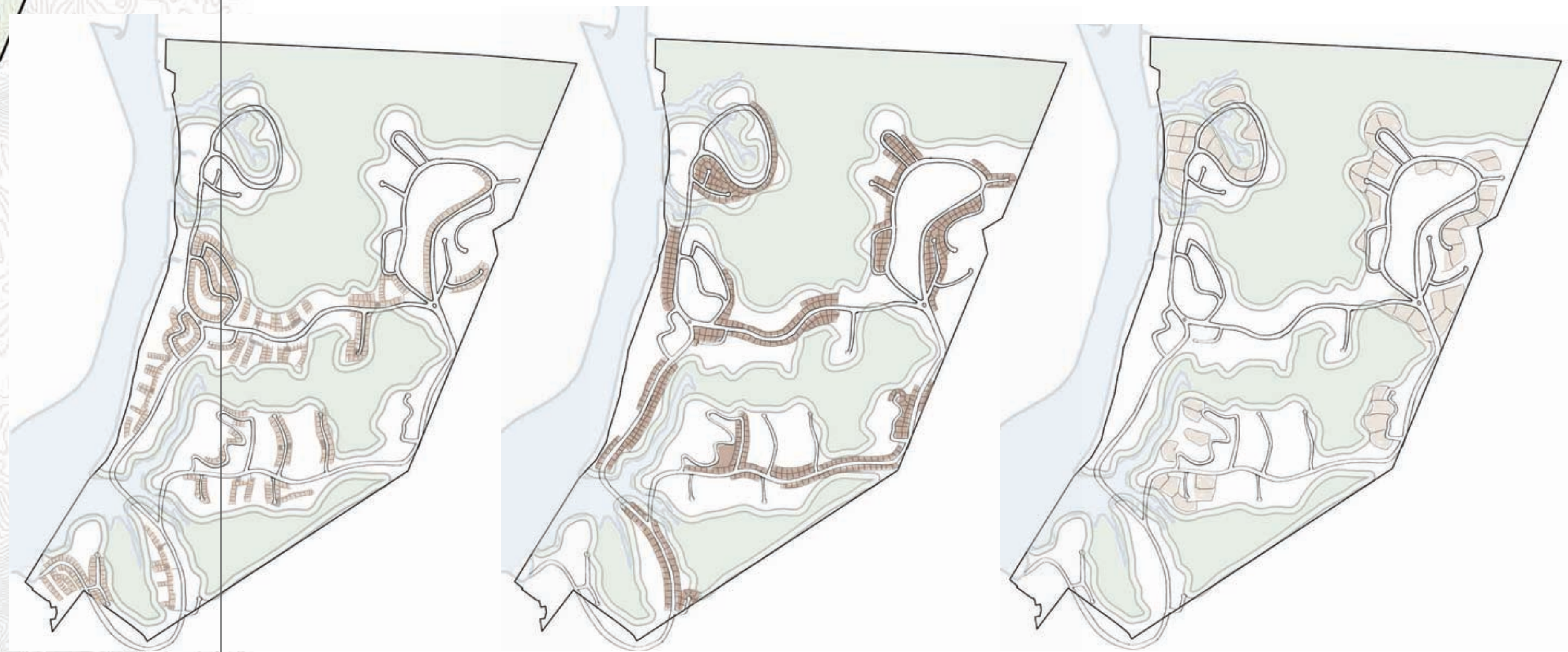


Figure 150. Housing Layout

SCALE 1:15,000

HOUSING TYPES

Co-housing has also been located at edges of vegetation patches to minimise the impact of residential construction through the low levels of impermeable surfaces and anticipated high levels of planting within these communities.



- **SUBURBAN HOUSING - 525**
- **MEDIUM DENSITY HOUSING - 575**
- **CO-HOUSING 48 - AV. 10 HOUSEHOLDS**
- **TOTAL 1580/1600 HOUSES**

CAR-FREE PARK SPACE

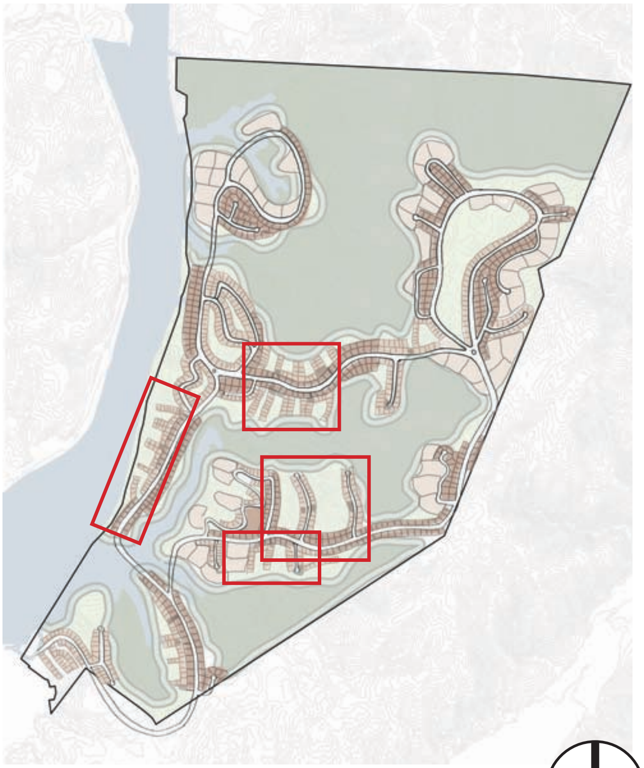


Figure 151. Key NTS

Some of the medium density areas are centred around a car-free park space that then connect into the larger vegetation patches. These areas begin to dissolve the binary of human vs nature through transitional spaces that spread into both habitat types.

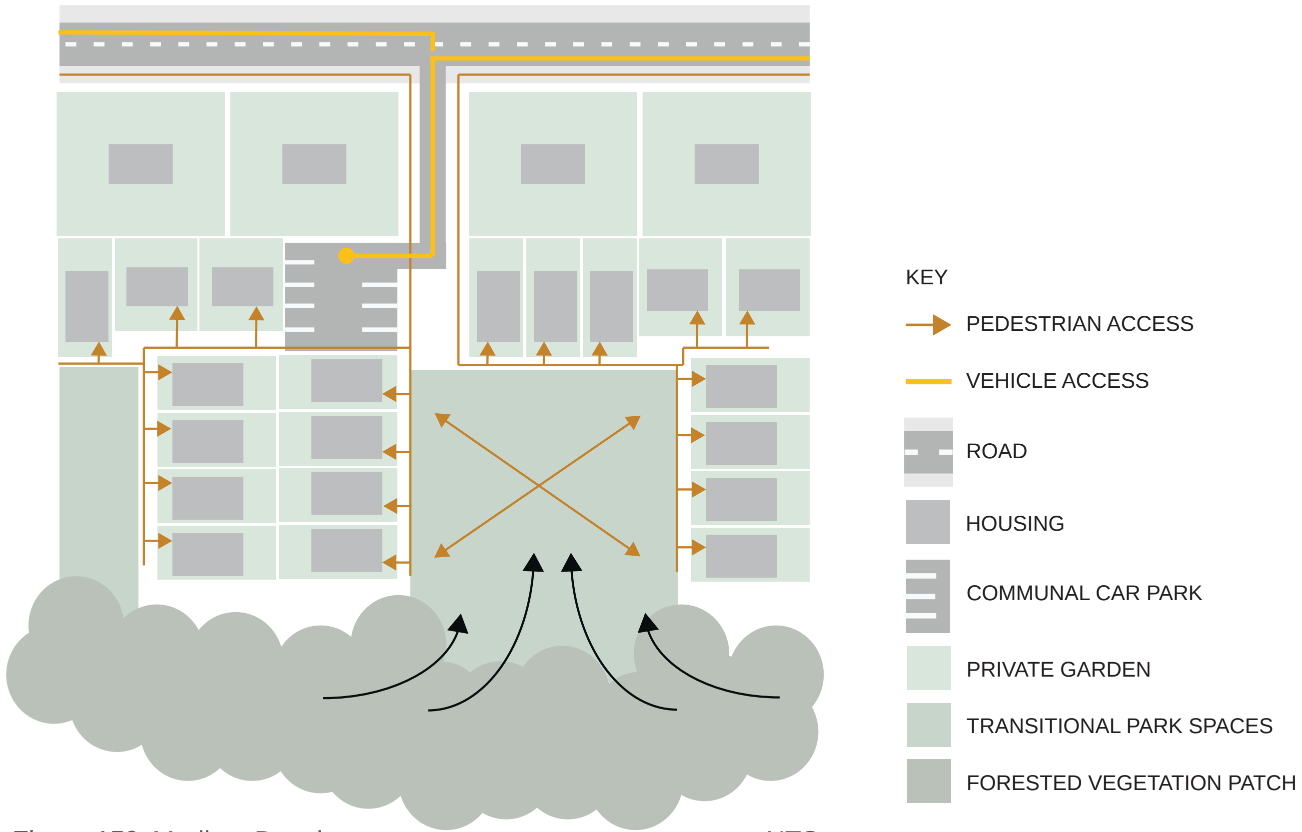


Figure 152. Medium Density Centred Around Park Space NTS

VEGETATION PINCH POINTS

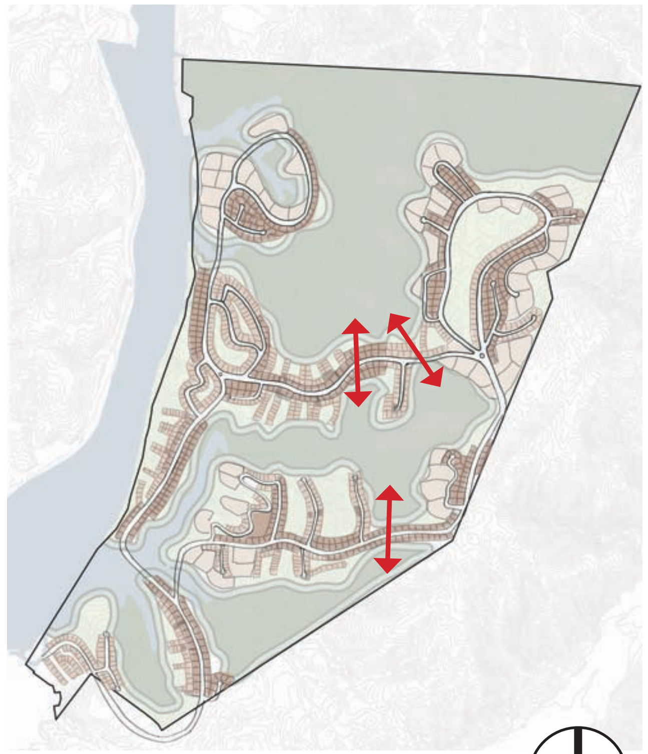


Figure 153. Key NTS

At points where vegetation patches lose connectivity due to roads, “pinch points” of single lot depth, low density housing is placed to minimise the distance and disturbance between patches.

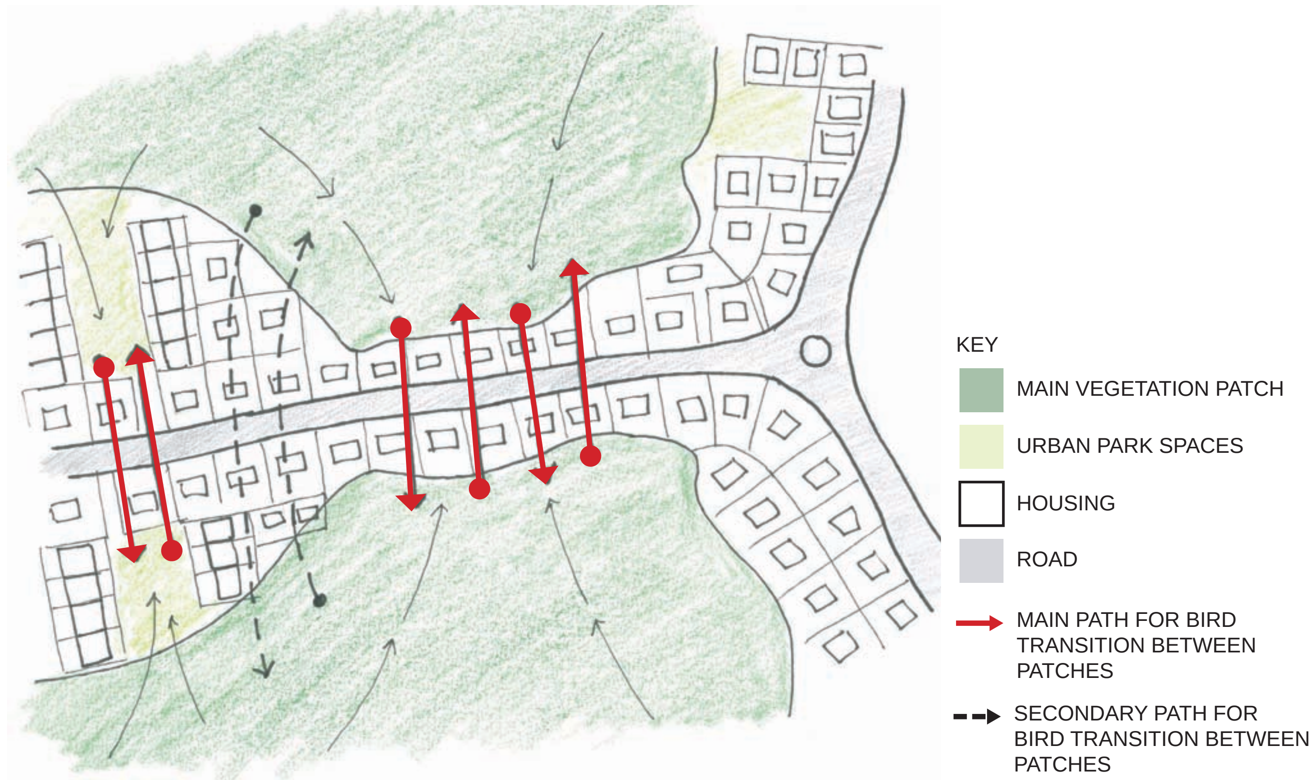


Figure 154. Vegetation Pinch Point NTS

REFLECTION

Design successes:

The literature review showed that traffic noise was a main deterrent for occupation of medium density housing. This concepts alternative approach locates medium density on pedestrianised cul-de-sacs that removes noise pollution as a way to encourage medium density living within edge city developments. These houses have close access to outdoor space, with the benefit of a low maintenance property.

Those residents that desire larger lots or direct car access to their properties are accommodated for along main roads. These houses are more suited to the traffic noise as the large lot size allows housing to be setback from the street, with garden vegetation or fencing acting as sound depressors.

This layout also benefits wildlife. Road noise is limited to the central road loop, with housing near the vegetated patches being car free. Having lower density along the main road minimises the difficulty wildlife may have crossing between patches, by providing large areas of green space (through suburban gardens) either side of the road as a break between traffic and medium density areas with higher impervious surfaces.

Having pinch points of suburban density is theoretically beneficial, however many of the existing Porirua properties do not have any vegetation in the gardens, only mowed lawn. In this situation, the biodiversity benefits of suburbia are not present. Residents of these lots may need to be encouraged to plant trees and shrubs in their gardens for the layout to be beneficial to bird life.

Design failures:

Approach 1 did not meet the housing density required, placing only 1600 houses on site.

Next Steps:

10.2

APPROACH 2

Key design strategies:

A) Road layout to follow existing contours to minimise earthworks.

B) Consideration of vegetation succession leading to the use of lifestyle blocks that transition into clusters of houses in forest over time.

ROAD EXPLORATIONS

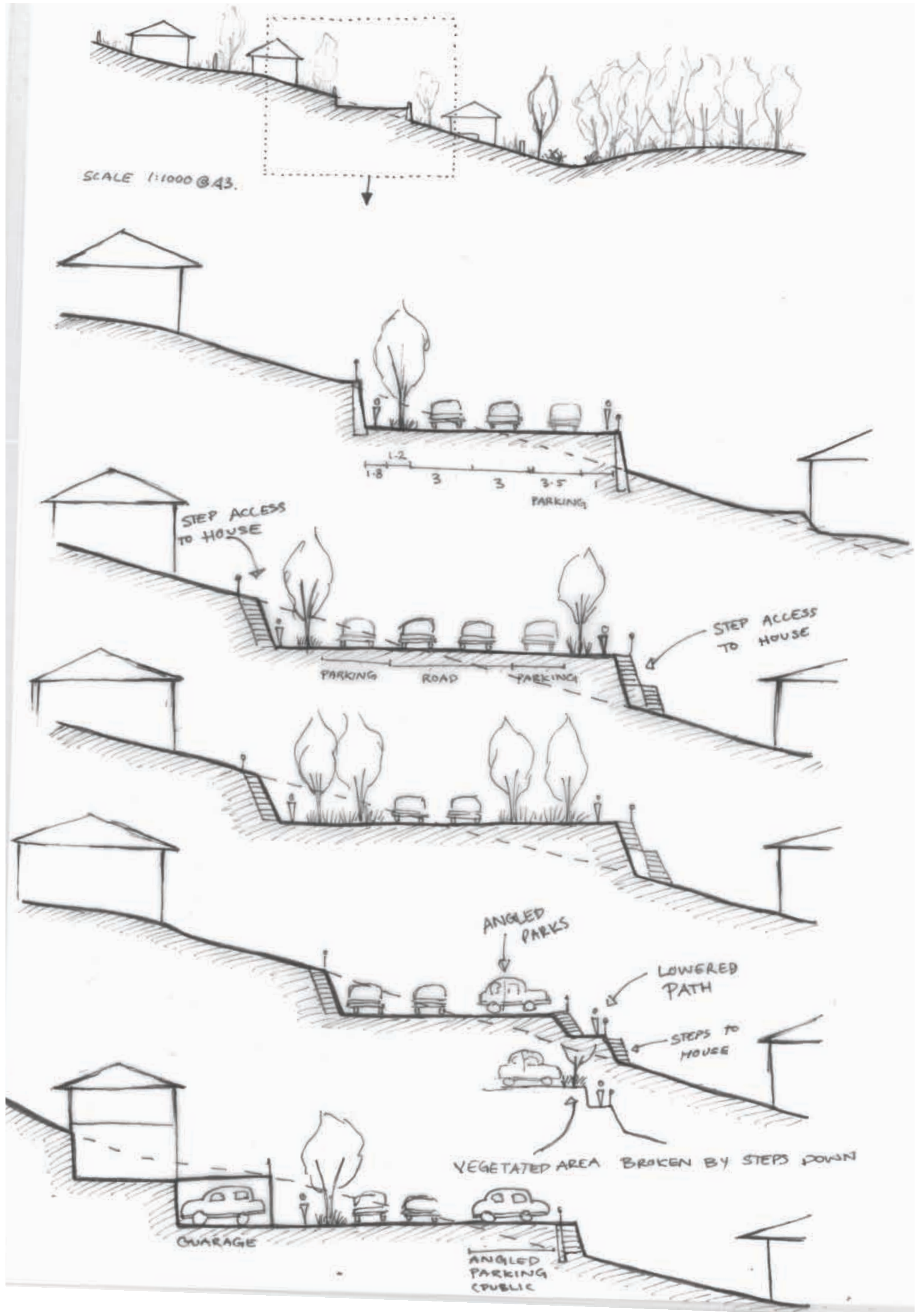
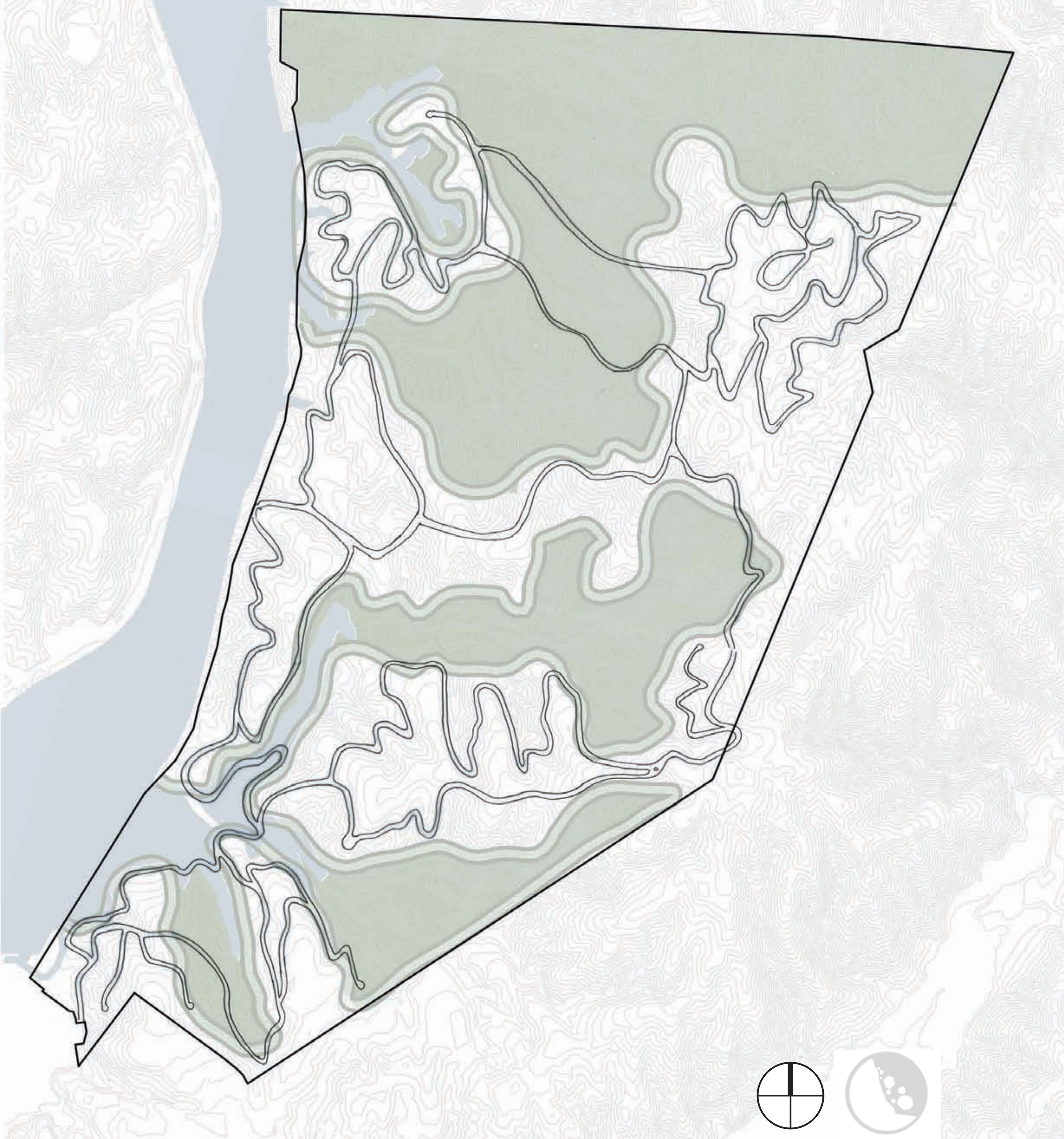


Figure 155. Road Explorations NTS

Following contours was challenging due to the large height difference across the site. The downside is more winding minor roads, but the upside is the flat ridgelines can be utilised for pedestrianised housing. Following contours means gentler slopes than approach 1 and encourages cycle and pedestrian movement.



SCALE 1:15,000

Figure 156. Road Layout

PUBLIC TRANSPORT LINKS

This layout is less suitable for public transport with less streets within 5 minutes of the main loop.

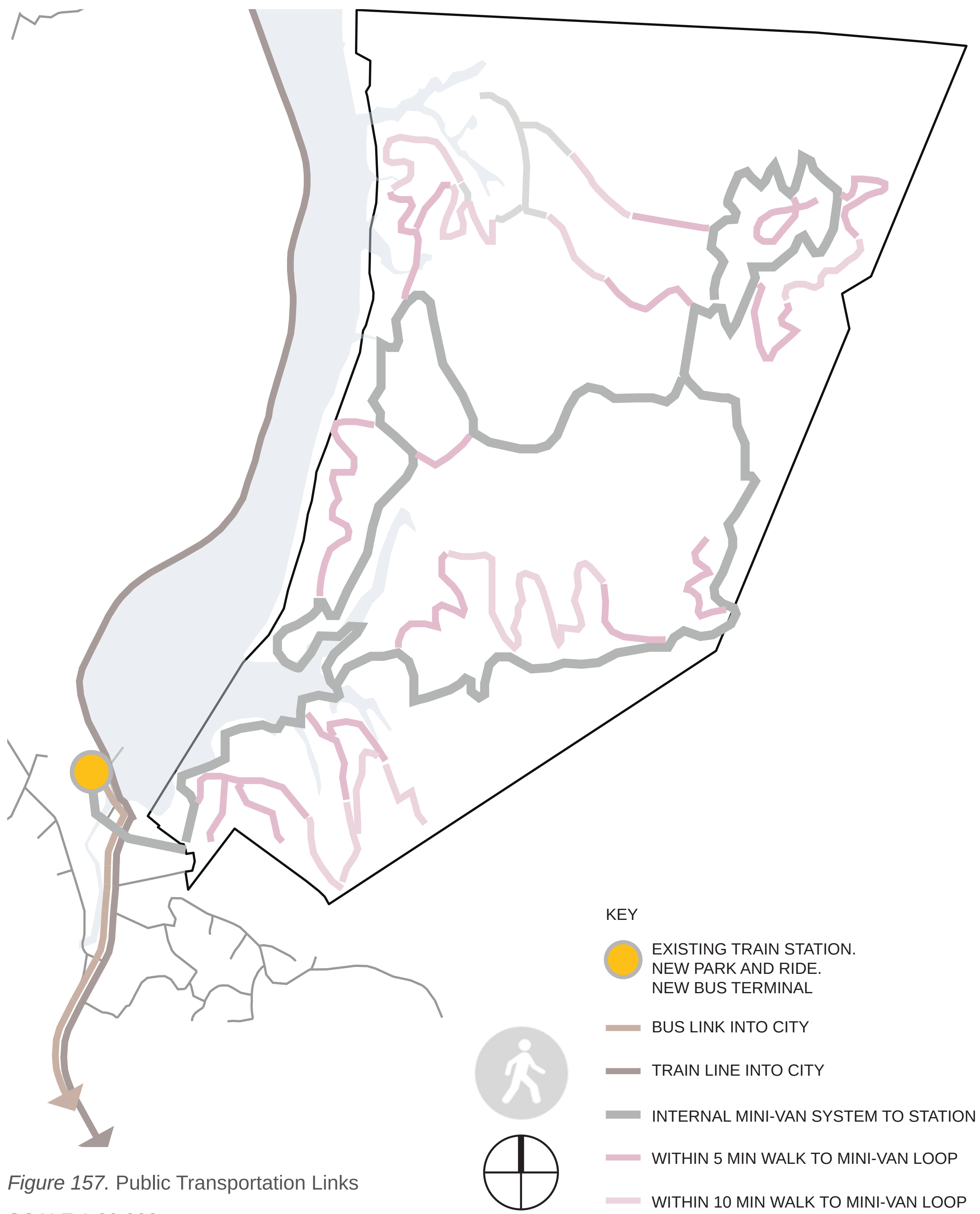


Figure 157. Public Transportation Links

SCALE 1:20,000

CLUSTER HOUSING

Throughout this process I began to consider the time taken to vegetate such a large site, and that regeneration will need to be phased.

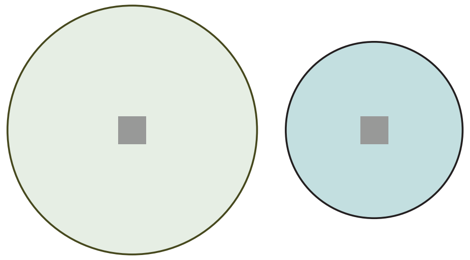
As shaded, sheltered slopes are easier to regenerate, and sunny sites are more desirable for housing, it seemed logical to begin revegetation on sheltered sites while utilising the sunny sides temporarily for housing.

Current NZ market still sees a high desire for “life style blocks” (large lots that typically allow residents the space for small amounts of livestock). Sunny slopes can be sold as lifestyle blocks in the short term, with buyers knowing that at a specified time in the future the land would have to be given up for forest regeneration.

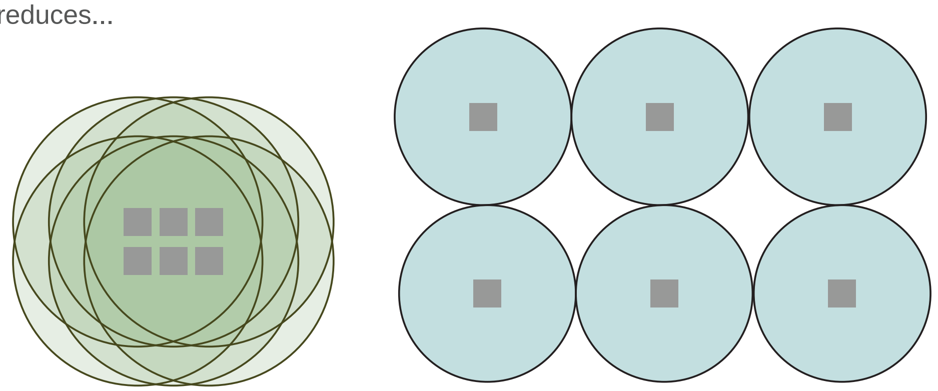
Research on cluster housing showed that while per house cluster housing had a larger observed impact on surrounding habitats than dispersed housing (with regards to observed exotic weed species), the impact of a small cluster on the may not be much more than that of a single house. (Lenth, Knight and Gilgert, 2006).

At the point that life style blocks are converted to forest, additional housing may be built to form small clusters of 4-8 houses.

The area of impact is greater for a cluster house (green) than dispersed (blue)...



However once several houses are clustered together the impact greatly reduces...



(Cluster) (Dispersed)

Figure 159. Impact of Exotic Weed Species in Relation to Cluster Housing vs Dispersed Housing

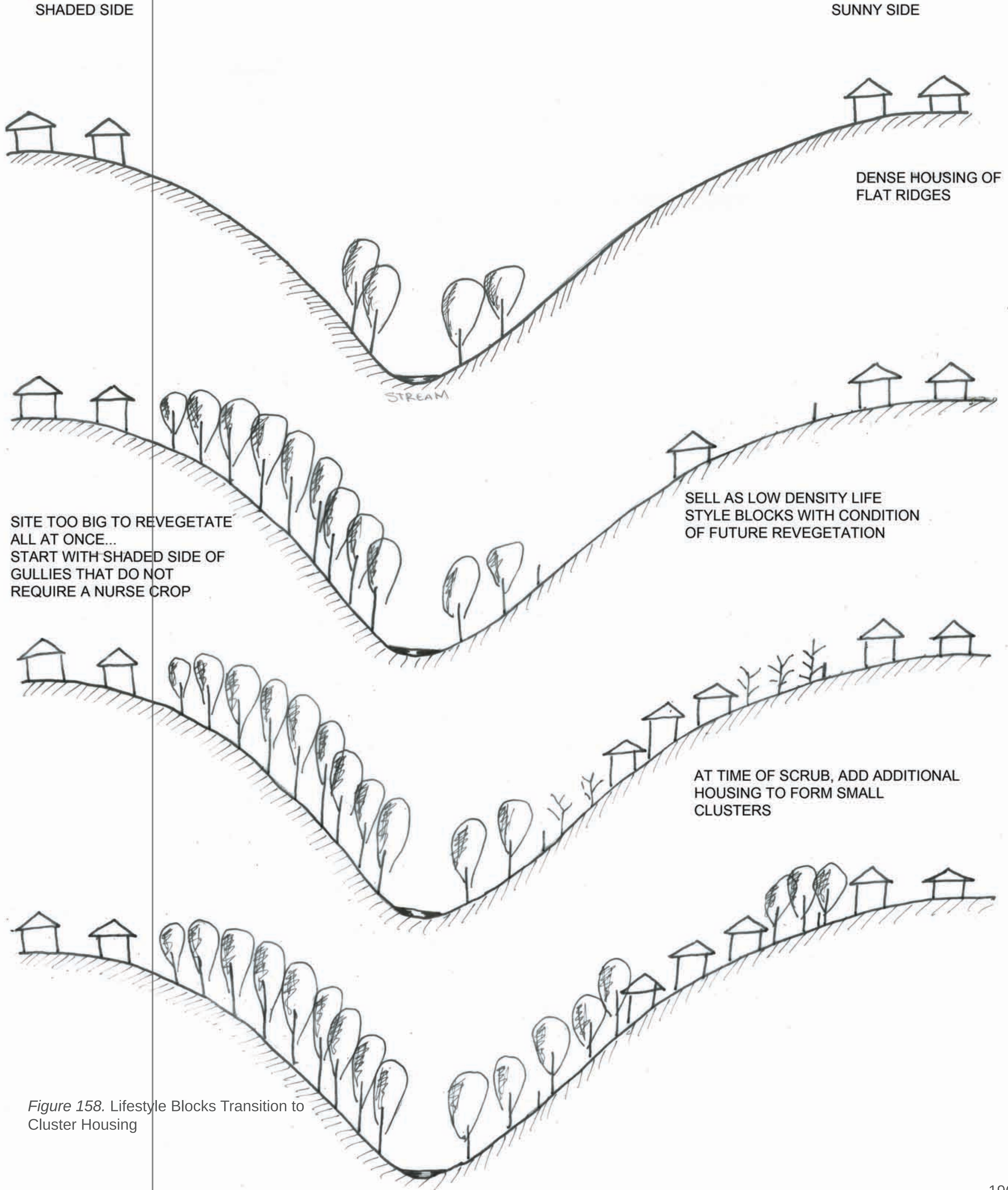


Figure 158. Lifestyle Blocks Transition to Cluster Housing

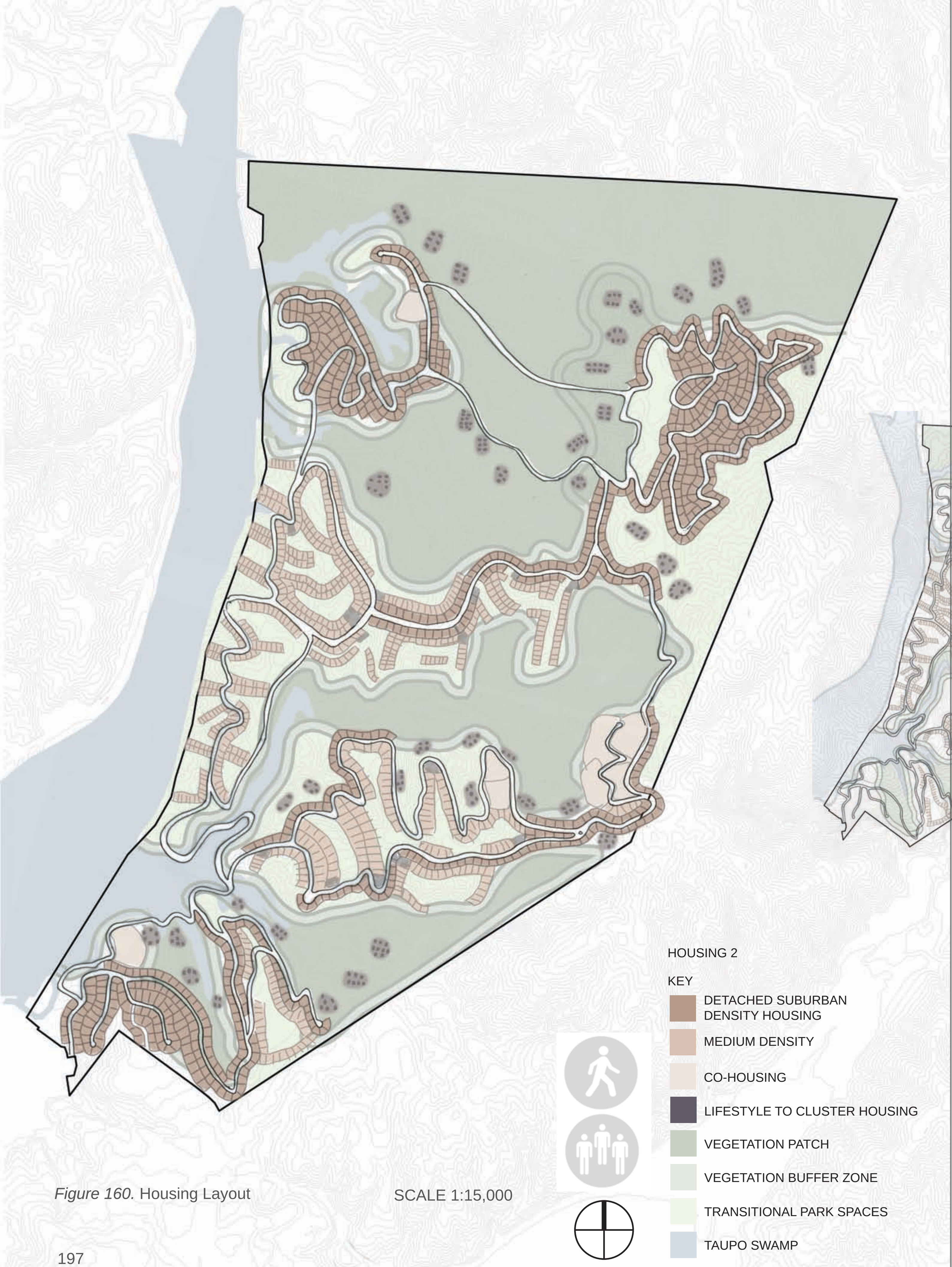
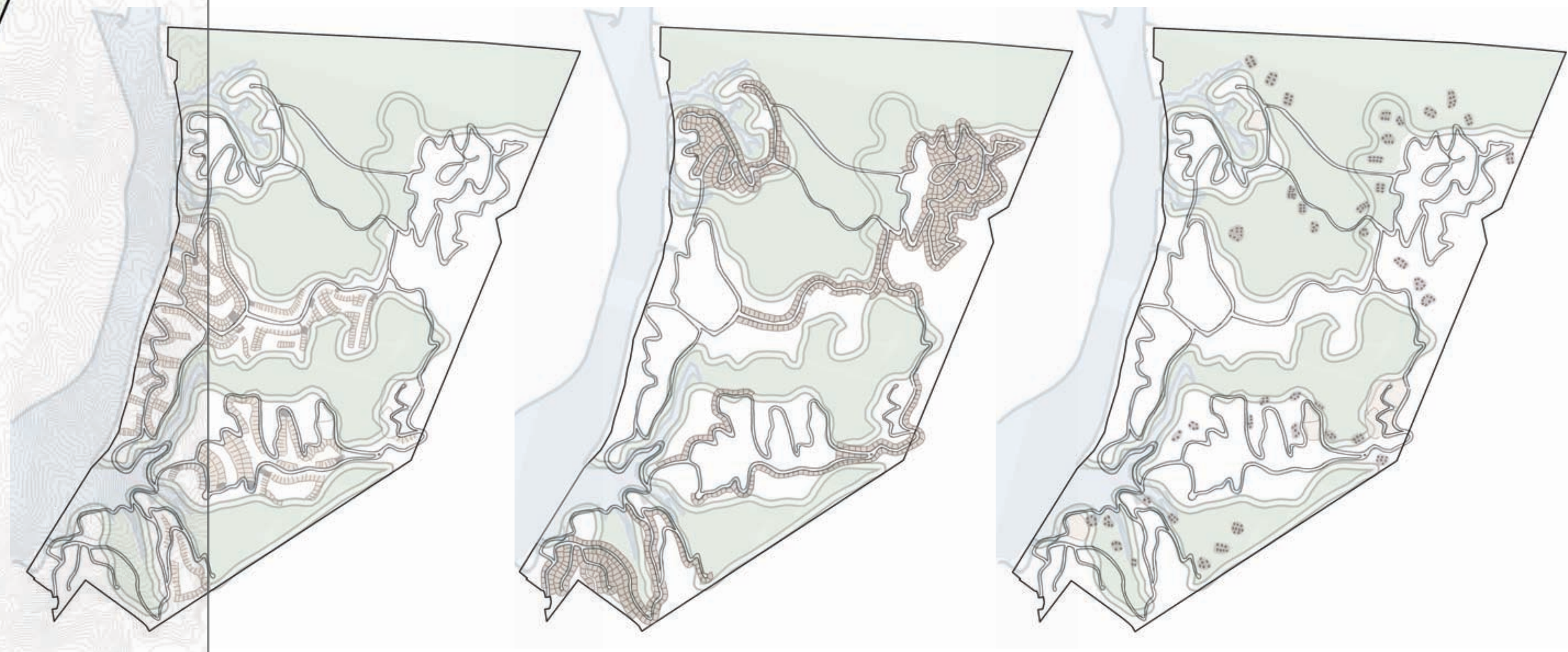


Figure 160. Housing Layout

SCALE 1:15,000

HOUSE TYPOLOGIES

Due to the reduced accessibility to public transport, the northern corners of the site are primarily suburban housing, with larger lots and direct car access. Medium density is concentrated to two ridges. The first is beside Taupo swamp, with the housing centred around linear parks that create view shafts to the swamp. The second ridgeline is to the south of the site, with much of the housing frontage to pedestrianised park spaces.



- **SUBURBAN HOUSING - 760**
- **MEDIUM DENSITY HOUSING - 625**
- **CLUSTER HOUSING 39 X 6 HOUSES**
- **CO-HOUSING 7 - AV. 10 HOUSEHOLDS**
- **TOTAL 1600 HOUSES**

REFLECTION

Successes:

Design Phase 1 discounted the inclusion of life-style blocks due to the poor biodiversity value of these homes, however the phasing of lifestyle blocks to cluster housing allows the site to offer for the current market demand, while also adapting to a more community-based approach to living over time.

This design had a higher integration of the Taupo swamp expansion. Having high access and engagement with the swamps edge is a key drawing point for residents to live in this area and provides an attraction to buyers for living in medium density housing on edge city developments.

Design failures:

Approach 2 did not meet the housing density required, placing only 1600 houses on site.

Following the contours limits the accessibility of public transport but does improve walkability. An integration of the contour and ridgeline approaches should be explored for optimal layout.

Housing typologies were less integrated potentially creating homogenous living environments.

10.3

APPROACH 3

Key design strategies:

A) Adaptability of road layout enables a decrease in car-use over time.

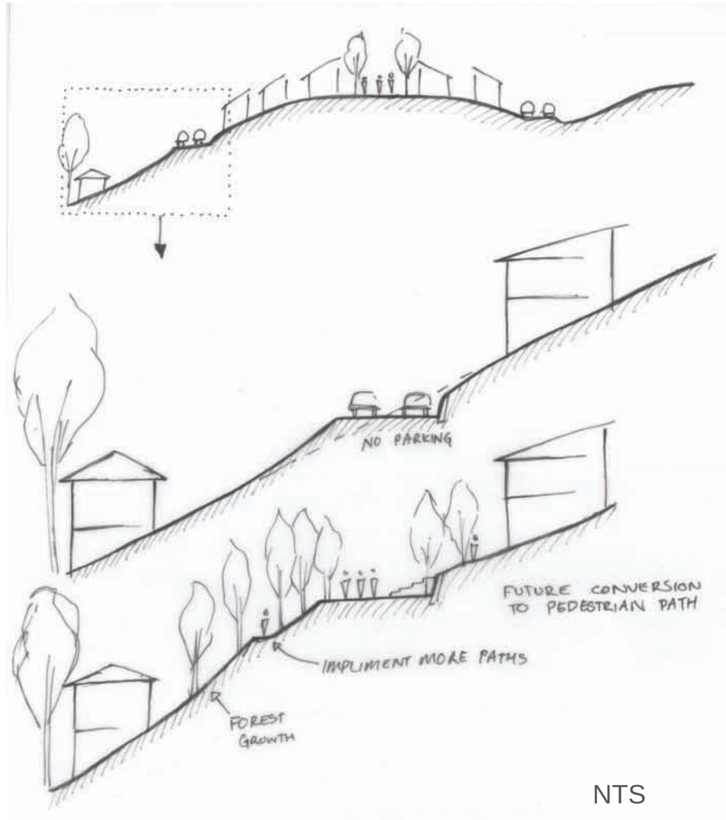
Looped roads will become shared roads, with car access restricted to ride-share cars only. Communal car parking will be provided at a lower number than the amount of residences. Roads with parking will see a conversion of these spaces into planting as demand lessens.

B) Infrastructure for electric vehicles will be increased as popularity increases – with car parks being converted to charging stations over time.

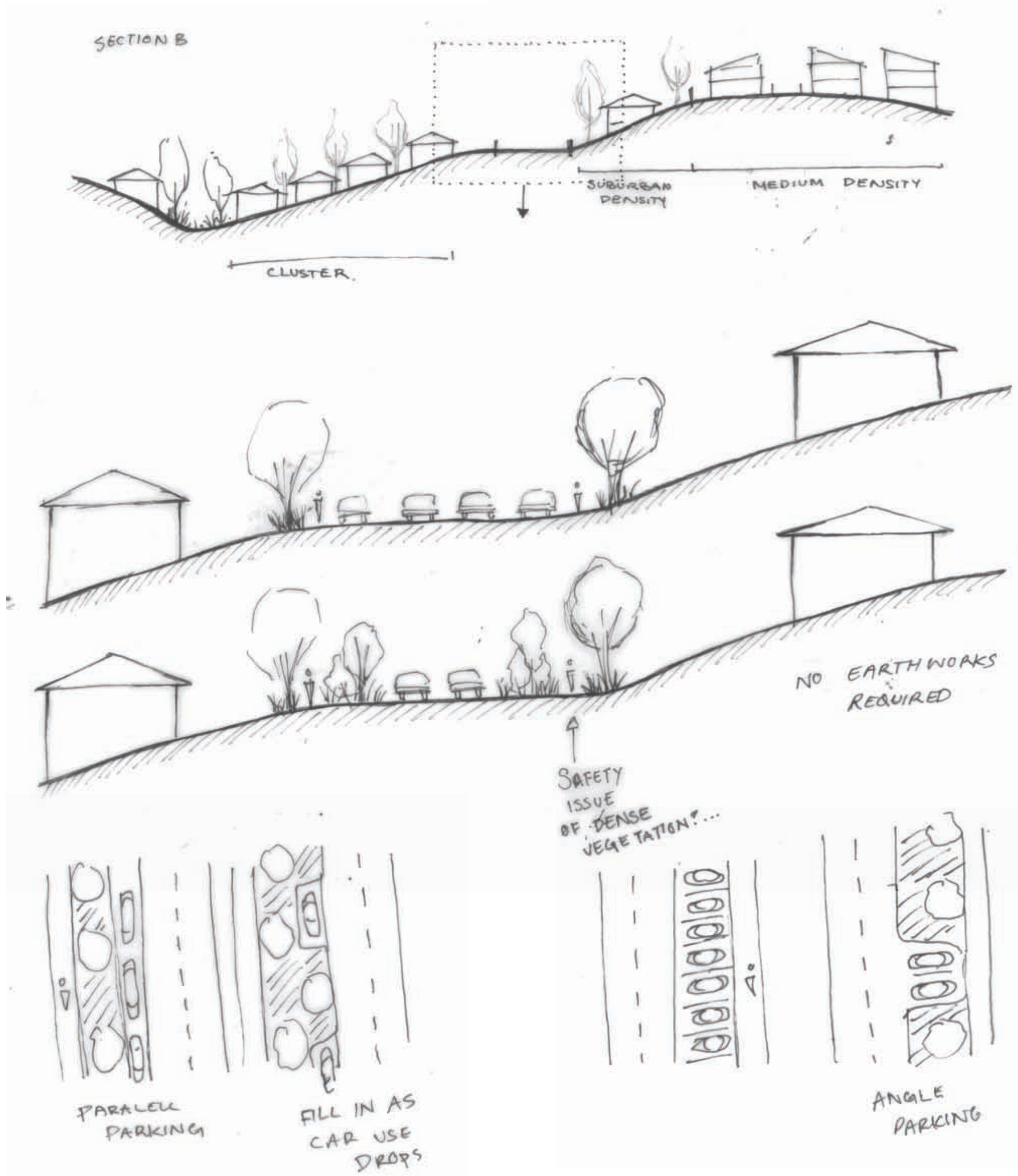
FUTURE CHANGE

After considering vegetation change over time, I began thinking of how our housing might change over time. This concept explores how to create adaptable road and housing layouts that cater to the current market but can easily transform to become less car-dominated as ride-sharing and working from home become more common.

Figure 161. Explorations of Roads Changing Over Time



NTS



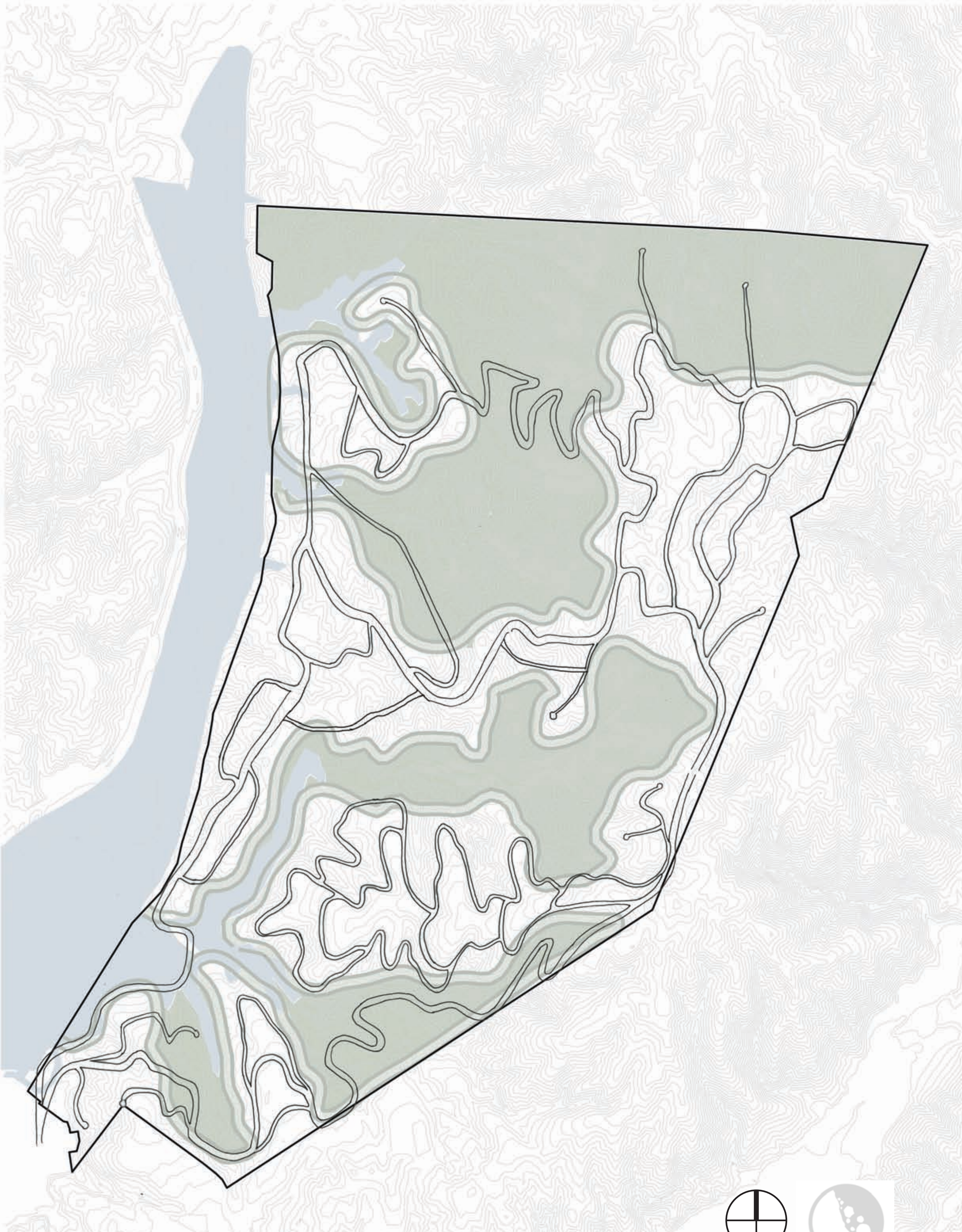


Figure 162. Road Layout

SCALE 1:15,000

PUBLIC TRANSPORT

The primary road utilises both ridgelines and contours to minimise earthworks. Minor roads are looped off, allowing individual loops to become shared roads restricted to ride-share cars (eg. Mevo) over time. Loops can be one way streets to minimise road width and earth works required.

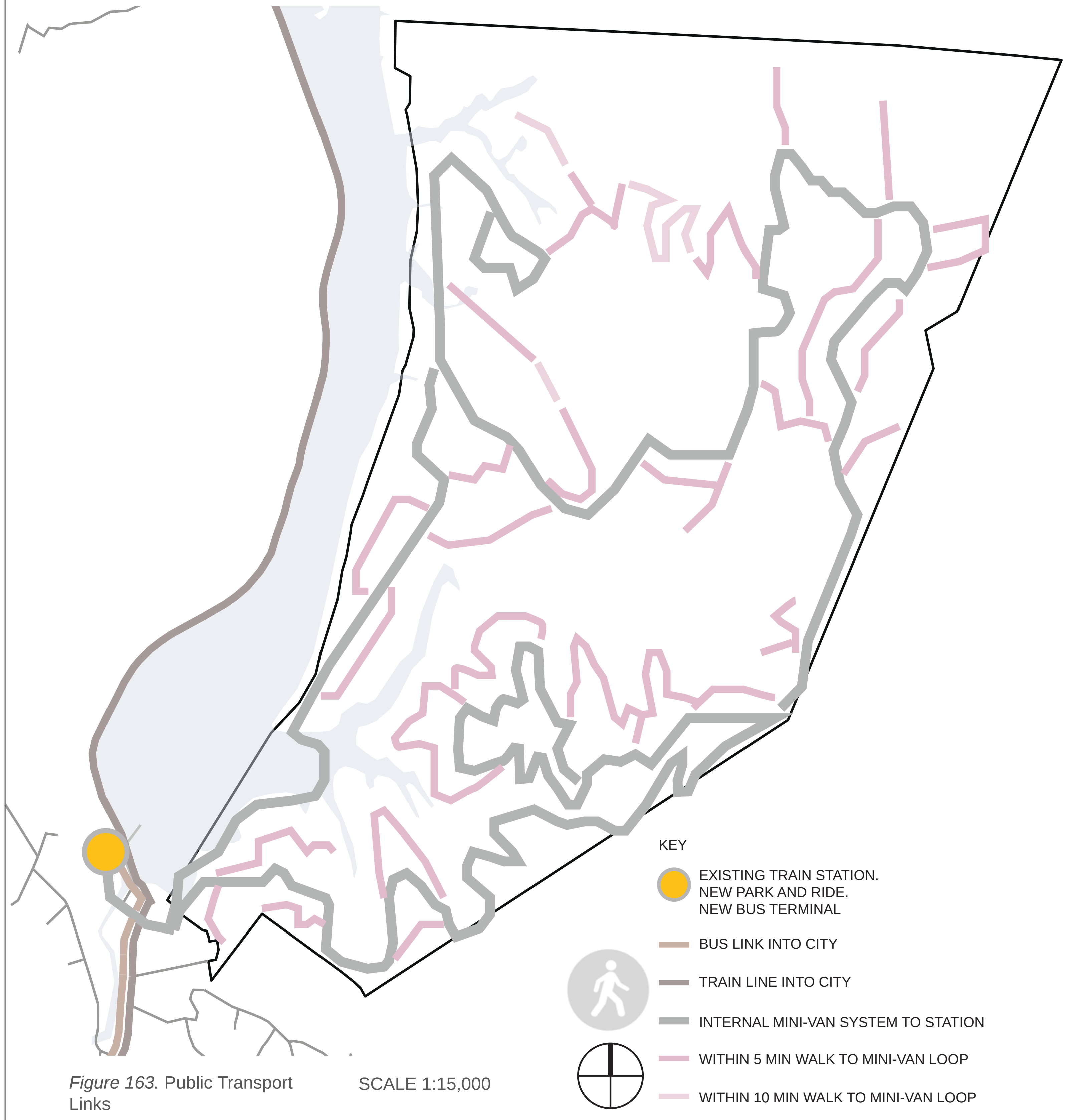


Figure 163. Public Transport Links

SCALE 1:15,000

No parking for private vehicles. residents encouraged to use ride sharing cars which do have parking access.

Some loop roads may be converted to pedestrianised areas as car use declines in the future.

Figure 164. Roads that Transition Over Time

SCALE 1:15,000

ROADS THAT TRANSITION OVER TIME

The top design was exploring an aesthetic that would be for pedestrianised streets only, however car access is still going to be needed in emergencies, so maintaining a clear and stable roadway will be necessary. A simple modification of road edges to increase planting will make pedestrian activity more enjoyable but still suit vehicle access.

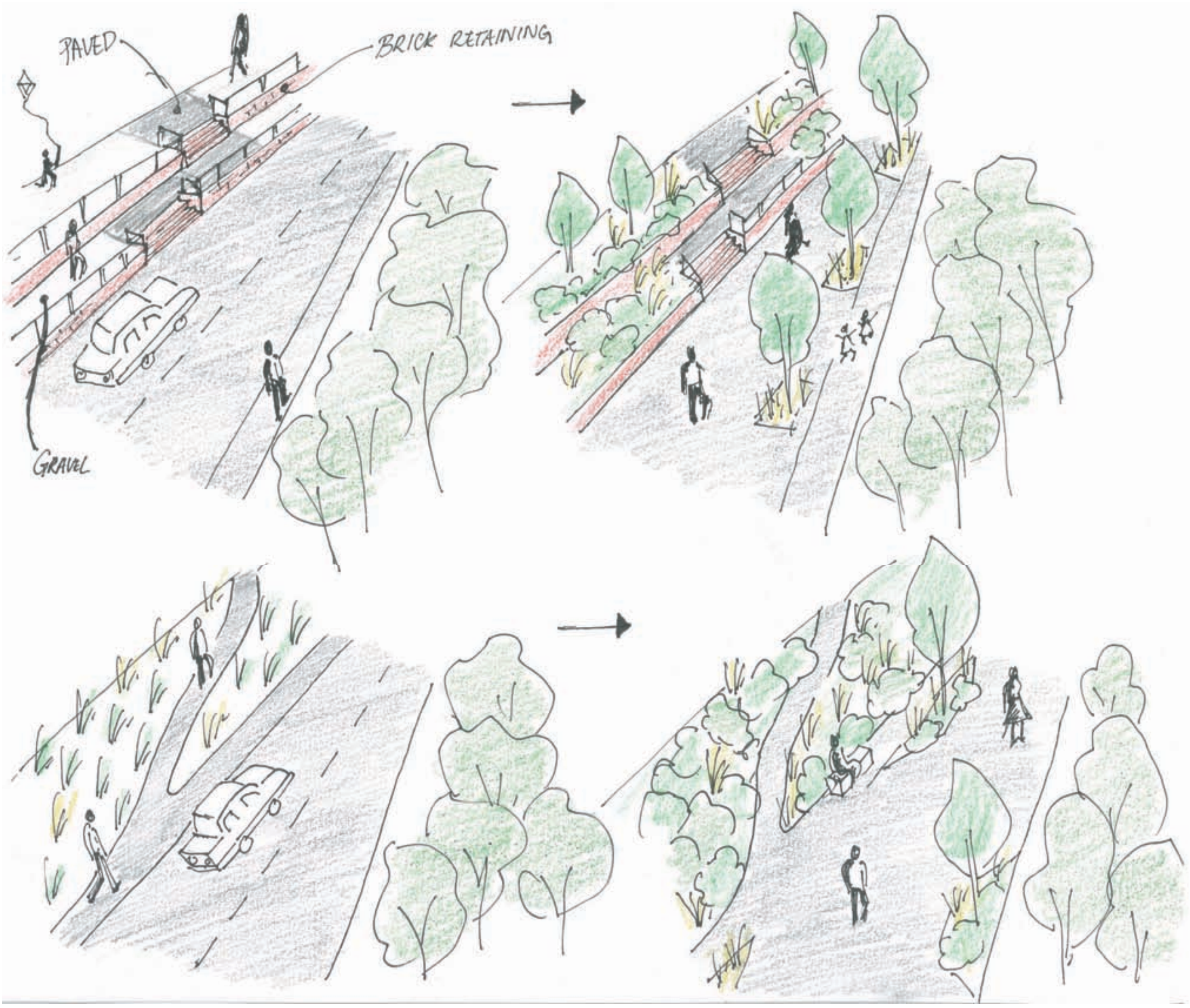
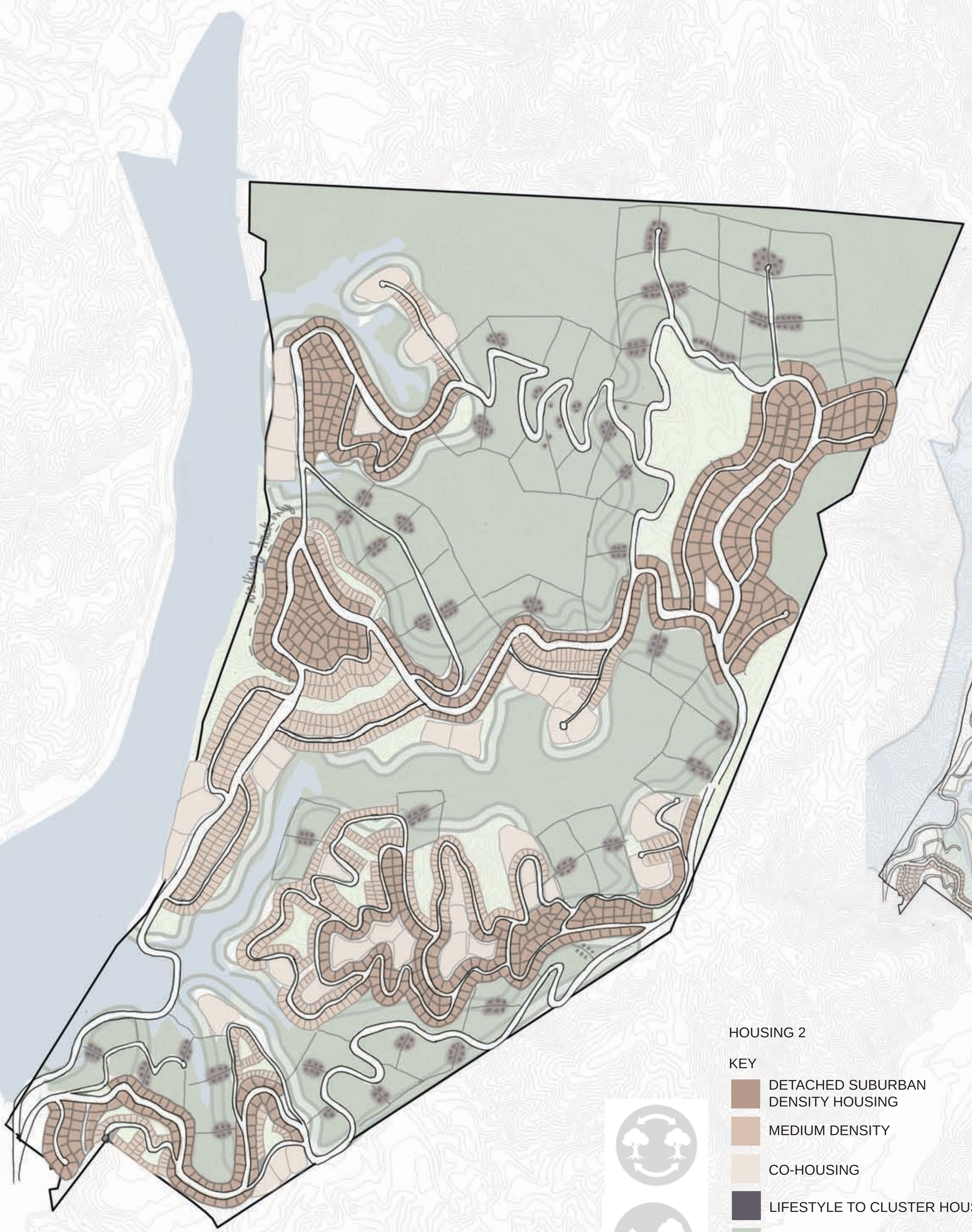


Figure 165. Road Change Explorations - Before and After



HOUSING 2

KEY

- DETACHED SUBURBAN DENSITY HOUSING
- MEDIUM DENSITY
- CO-HOUSING
- LIFESTYLE TO CLUSTER HOUSING
- VEGETATION PATCH
- VEGETATION BUFFER ZONE
- TRANSITIONAL PARK SPACES
- TAUPO SWAMP

Figure 166. Housing Layout

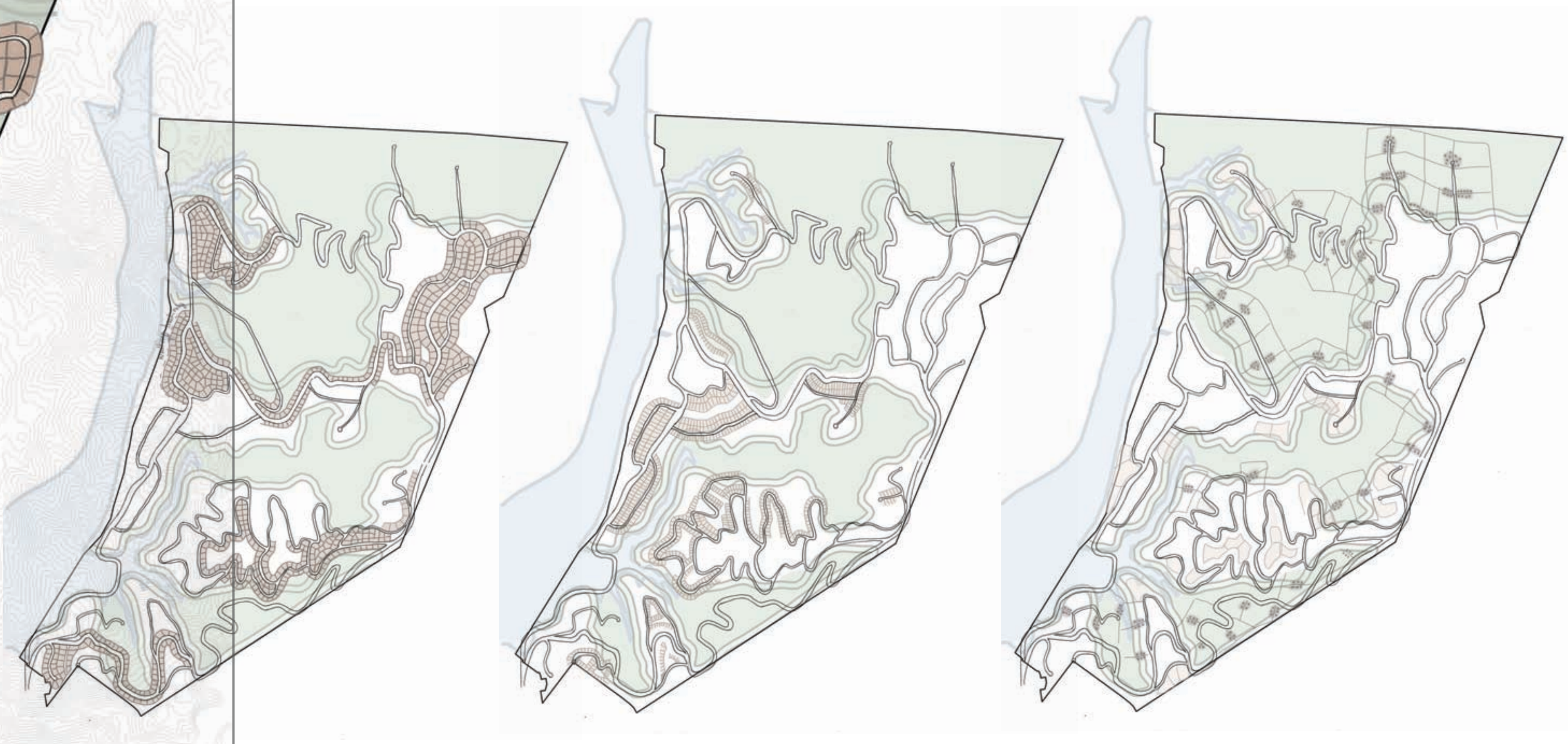
SCALE 1:15,000

HOUSING TYPOLOGIES

This layout offers the most houses on site out of the three concepts.

Medium density is focused around the roads suggested for future car restrictions, with co-housing areas behind.

Northern areas of the site will maintain car access and low density suburban lots to meet a variety of market demands and acknowledge the difficulty accessing some of these areas by public transport due to distance from the train station.



- **SUBURBAN HOUSING - 725**
- **MEDIUM DENSITY HOUSING - 725**
- **CLUSTER HOUSING 45 X 6 HOUSES**
- **CO-HOUSING 30 - AV. 10 HOUSEHOLDS**
- **TOTAL = 2020 HOUSES**

REFLECTION

Successes:

This concept explores how housing and road layouts can be designed to become more sustainable over time, thus meeting current market restrictions in electric vehicles and ride sharing availability, while engaging with the need for more sustainable living practices long term.

This also reflects the growth of vegetated areas explored in previous designs. As the site develops and sees an increase in bird life, the design can adapt to limit car use, transitioning to a cohabitated space over time.

2000 houses were placed on site.

Failures:

Did not engage with the Taupo Swamp edge successfully.

Medium density layout is too linear – will not provide an engaging street scape.

SUMMARY

Each approach provided a new way of considering suburban developments and showed the ability of the design principles to be successfully integrated into a master plan. Learnings and design concepts from each approach will be brought forward into the schematic masterplan.

As is shown in Figure 167 on the next page, not all principles were relevant at this scale, but the focus and inclusion of the ones that were greatly improved the ecological value of the design.

APPLICATION OF DESIGN PRINCIPLES WITHIN DESIGN PHASES

Implication groupings		Literature Review	Precedent Review	Design phase 1	Design phase 2	Design phase 3 - aproach 1	Design phase 3 - aproach 2
Transportation	Design Implication 1	minimise car use within the development	Example of how to action - Design to accommodate public transport routes. Make parking difficult.	Considered	Example of how to action - maximise walkability	Considered	Considered
	Design implication 2	limit car speeds within development	Example of how to action - narrow roads			Considered	Considered
Vegetation	Design implication 6	Provide human-free areas within recreation patches to allow birds to nest undisturbed.	Example of how to action - Zealandia				
	Design Implication 3	Restrict human movement to designated paths within natural areas to help habituate birds to human activity.	Example of how to action - Zealandia				
	Design Implication 23		**Transitional levels of human interaction with patches to reflect species sensitivity**		Example of how to action - Transitional park zones inbetween housing and reserves	**Example of how to action - Create car-free housing communities near vegetation patches to minimise disturbance.**	Considered
	Design Implication 7	locate patches to utilise natural succession including seed source and spread.		Considered	Considered		Considered - utilising shaded sides first as no nurse crop needed
	Design implication 8	provide several medium sized patches within the development.		Considered	Considered		
	Design implication 9	where possible, provide continuous vegetated corridors between vegetation patches. If Steppingstone connections are being implemented, minimise distance travelled between resting spaces.		Considered	Considered - streams used as vegetated conenctions	Example of how to action - Pinch points of suburban density	
	Design implication 10	Patches should be shaped with non-linear edges to increase edge sizes while maintaining a large and healthy core.		Considered	Considered		
	Design implication 11	Edges should reflect a natural gradient of species that would typically occur in each habitat type, including a varied and complex understory planting.					
	Design objective 4	Develop of a re-vegetation outline that compliments residential development.					
	Design objective 5	minimise negative impacts of edge conditions				Incorporated within DI 27 - transitional zones limit forest patch edge to harsh environments	
Housing	**Design objective 1**	implementation of medium density in suburban context	observations: public private conflict.	Considered		Turns into design implimentation 28	
	Design Implication 24					**Balance MD lack of outdoor space through locating close to natural spaces**	Considered - cluster housing idea. Medium desnity focused around creating viewshafts and relecionship with Taupo Swamp
	Design objective 3	reduce the impact of housing and urban parks on birdlife to allow co-habitation in these areas.				Incorporated within design implication 27	
	Design objective 2	encourage residents' engagement with local wildlife and natural habitats.	Design objective 3 turns into design implications 25 & 26				
	Design implication 21		Use nodes of open space to encourage walking and engagement with forested areas				
	Design implication 22		Open spaces to include understory plantings with thinning trees to create view shafts encourages biodiversity and allows sunlight into space.				
	Design implication 20		Use housing orientation to create small communities		Considered loosely through overall housing location	action through a mix of street frontage and internally facing housing groups	action through facing of housing over communal parks
Lighting	Design implication 12	Only light up trees where birds will not be nesting (eg street trees and key residential trees only). Limit lighting in forested areas.					
	Design implication 13	design public lighting to limit skyward projection and select hues that interfere the least with sleeping patterns (blue and green light).					
	Design implication 14	Additional mitigation: ask residents to buy UV reflective collars for pets to make them easy to see by native birds.					
Water systems	Design implication 15	50m buffers to main waterways, 20m buffers to headwaters where possible		Considered	Considered		
	Design implication 16	Minimise channelling of waterways and maintain a naturalised stream bed where possible.		Considered	Considered	Considered - minimised stream crossings.	Considered - minimised stream crossings.
	Design implication 17	Manage water use through rainwater harvesting and grey water recycling.	Example of how to action				
Earthworks	Design implication 18	minimise earthworks	Example of how to action - stilt housing	Considered	Considered	Considered - ridgelines successful	Considered - contours
	Design implication 19	vegetate steep slopes for soil stability		Considered	Considered		
	Design implication 4	reduce impermeable surfaces.	Example of how to action			Considered - co-housing and restricted car access lowers road surface	Considered - co-housing and restricted car access lowers road surface
	Design implication 5	Prioritise rejuvenation of soil and access to insect food sources.					

Figure 167. Excell spreadsheet used to track how design implications were derived, implemented and changed at each stage of the design process.

MATERIALS PALETTE

As part of the cohabitation goal of this project, a reduction in carbon emissions during the design and usage of the site is important. The materials selected are, where feasible, to be low impact and sustainable.

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Figure 168. Recycled Crushed Concrete Aggregate

Recycled crushed concrete can be used for several purposes depending on the quality of source material.
1. Poor quality as an aggregate underlay for new paved roads
2. Medium quality as crushed gravel driveways or low use roads (eg. to cluster housing)
3. High quality, finely crushed concrete as a gravel alternative for pedestrian paths and landscaping
4. A drainage aggregate for wastewater wetlands

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Figure 169. Recycled Wood

Where possible, external timber used in pathways, stairs, bridges, seating, fencing or other landscaping elements will use timber that has been treated with a non-toxic, eco-friendly alternative such as x or y.

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Figure 170. Wooden Pallet

Timber for path edging and other non-structural elements can use recycled pallets or other recycled wood sources where possible.

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Figure 171. Recycled Bricks

Seats, ledges, low retaining walls and garden bed edging can use recycled bricks.

THIS IMAGE IS UNAVAILABLE DUE TO COPYRIGHT.

Figure 172. Geotextile Living Walls

FlexMSE. (n.d.). *Green Construction.* Retrieved from https://www.flexmse.com/green-retaining-wall/

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The use of ABG Webwall Geocell can save up to 77% on the carbon footprint compared with traditional gabion baskets gravity retaining walls.

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Beside is a project that had 2 retaining walls and reseeded to look completely natural as well as being soil it maintains a lot of the absorption properties etc

Figure 173. Figure 174. Geocell Living Walls

ABG Creative Geosynthetic Engineering. (n.d.). *Vegetated Retaining Wall.* Retrieved from http://www.abg-geosynthetics.com/case-studies/vegetated-retaining-wall-westfield-pembrokeshire

Additional Design Principle:
Environmentally friendly materials to be used where possible

11

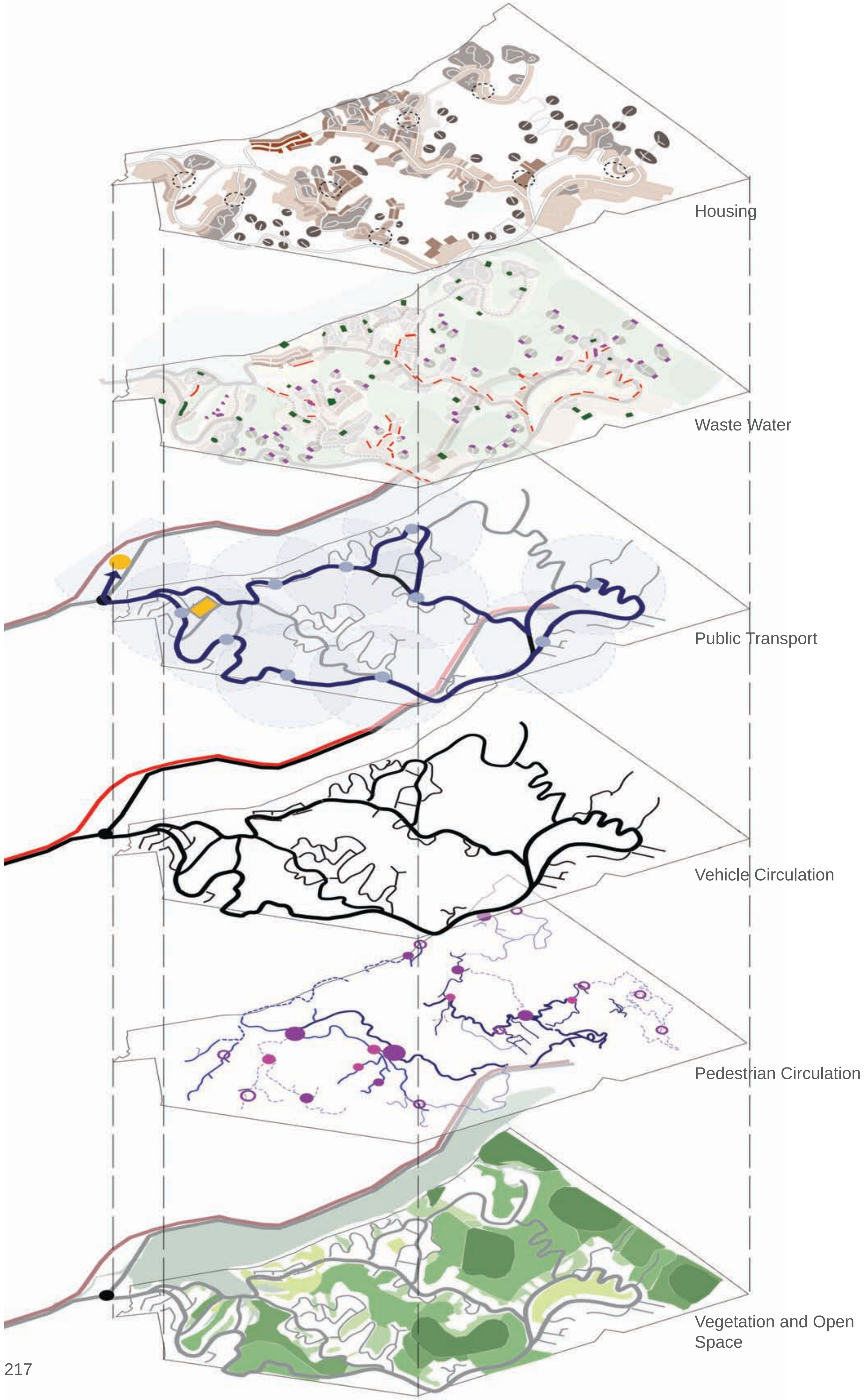
DESIGN PHASE 4
SCHEMATIC PLAN

The schematic plan is not considered a final “master plan” but an example of how different design elements might be comprised to encourage cohabitation.

This concept builds on the three previous concepts, taking aspects and learnings from each as well as expanding past housing layout into wastewater, stormwater and vegetation strategies. All of these can be thought of as potential strategies rather than a fixed placement of solutions.

This design phase will address:

- Housing layout, typologies and the effects on cohabitation
- Vehicular circulation and public transport
- An offline water strategy including; on site wastewater treatment, stormwater wetland locations and strategies for safe fish passage.
- A vegetation strategy including; phasing, management systems. A vegetated ‘scale of sensitivity’ plan that informs human activity types, the location of pedestrian circulation paths and open space destination points within forested areas.
- An exploration of how to design forest edge conditions that minimise negative impacts of surrounding land use and protect the integrity of the vegetation patches.



This plan dictates the impact / sensitivity levels of different areas of the site. Green areas prioritise birdlife and limit human interaction. The lighter the green, the more human interaction with the space, such as local park spaces or cluster housing areas. Orange areas indicate human prioritisation, with dark areas indicating dense housing and main roads, while lighter orange show areas of housing that have lower impact on birdlife, such as co-housing which has limited car use and high levels of vegetation that may support several bird species. The spatial layout of these sensitivity levels prioritises placing similar colours together to create a gentle transition between human and birdlife that encourages a permeability of use and encourages co-habitation within the light green and light orange areas.

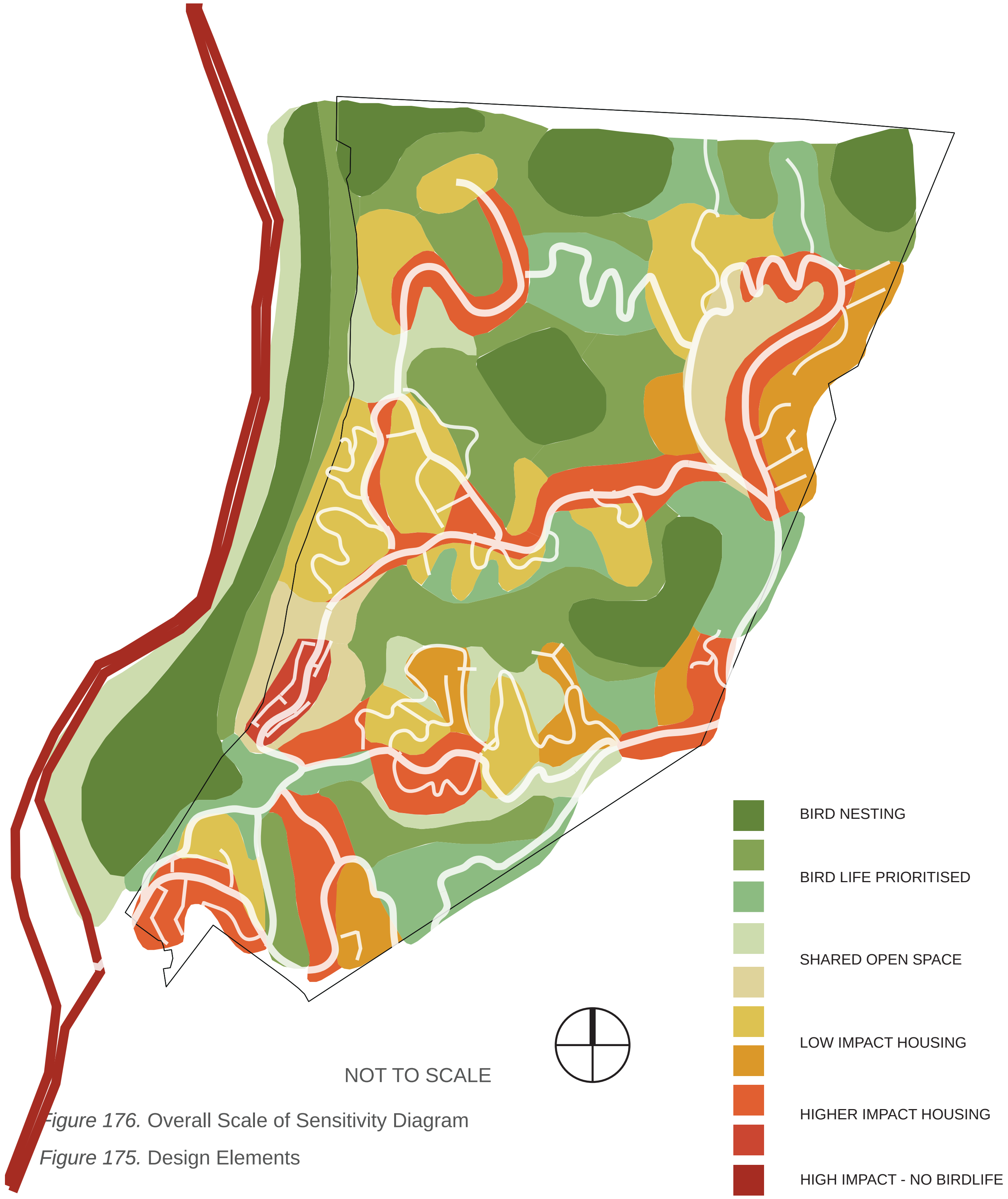


Figure 176. Overall Scale of Sensitivity Diagram

Figure 175. Design Elements

SCHEMATIC LANDSCAPE PLAN

The prioritisation of ecosystem restoration and cohabitation has resulted in a final layout that immerses residents in nature. The landscape is dominated by native forest, with small neighbourhoods located on high ground, enjoying views of bush and Taupo Swamp. The quiet, pedestrian focused streets encourage an abundance of birdlife for residents to enjoy. This development shows an alternative way of living that prioritises daily interactions with nature while still providing amenities of suburban living.

KEY

- FREE-STANDING 500-600M2 LOTS WITH VEGETATION COVENANTS
- COMMUNAL SPACES FOR TERRACED HOUSING
- CO-HOUSING LOTS
- MEDIUM DENSITY DETACHED
- TINY HOUSE LOTS
- CLUSTER HOUSING
- PUBLIC OPEN SPACE
- OPEN SPACE NODES WITHIN FOREST
- HOUSING
- ROAD
- RAISED BOARDWALK
- WALK AND CYCLE TRACKS

SCALE 1:10,000

Figure 177. Rendered Plan

HOUSING TYPOLOGY LAYOUT

Figure 178. Housing Layout

SCALE 1:12,500

HOUSING TYPOLOGY DESCRIPTIONS

Free-standing 500-600m2 lots with vegetation covenants.

Max site coverage 25%, with additional 10% for paved surface area.
Mown lawns max 20% of the site unless lawn is "rewilded".
At least 1 tree per 100m2 of property size (Ie, a 500m2 property must plant a minimum of 5 trees).

The peak biodiversity seen is suburbs is due to low site coverage and a high variety of plants, including exotics that extend the flowering period. The covenant on these lots will not specify a plant list, to encourage plant variety.

Co-housing lots.

Housing communities for between 6 to 20 households.
Each lot should offer a variety of house sizes.
The degree of "community living" can vary between co-housing lots, with some having communal cooking areas etc, while others allow a more conventional daily living with communally owned and managed external spaces.
Communal car spaces only, internal car access limited to emergencies or short-term use (eg. heavy deliveries).
Impervious surfaces (excluding housing) max 15% site coverage.

Medium density detached housing.

Lots of 270-350m2, max site coverage 45%.
External spaces may be paved with porous paving.

Terraced housing.

Lots of 200-270m2, max site coverage 50%.
External spaces may be paved with porous paving.

Part of the appeal to residents of medium density housing is having a low maintenance external space. For this reason, vegetation requirements are not included for medium density or terraced housing.

Mixed use.

2-4 story mixed use commercial, office and residential buildings.
No site coverage restriction.

Lifestyle to cluster housing.

Residents purchase or lease single house residence on large, grassed lots with the understanding that within a specified time frame, these lots will transition into co-housing clusters of 4 – 8 houses and most of the lot will be revegetated via gorse into native forest.
Lots will come with vegetation covenants, which outline a list of native species that can be planted by residents anywhere within the site; as well as a distance restriction of 20m from the housing in which the residents are allowed to plant non-list species, including exotics, providing they are non-invasive species.

Tiny house lots to buy or rent.

Local commercial centres.

These are small areas of local amenities (convenience stores, cafe, etc) reflective of surrounding building types. This includes housing with ground level shops and private residents above. No site coverage restrictions. External space may be paved for parking with porous paving or gravel.

TAUPO SWAMP NEIGHBOURHOOD

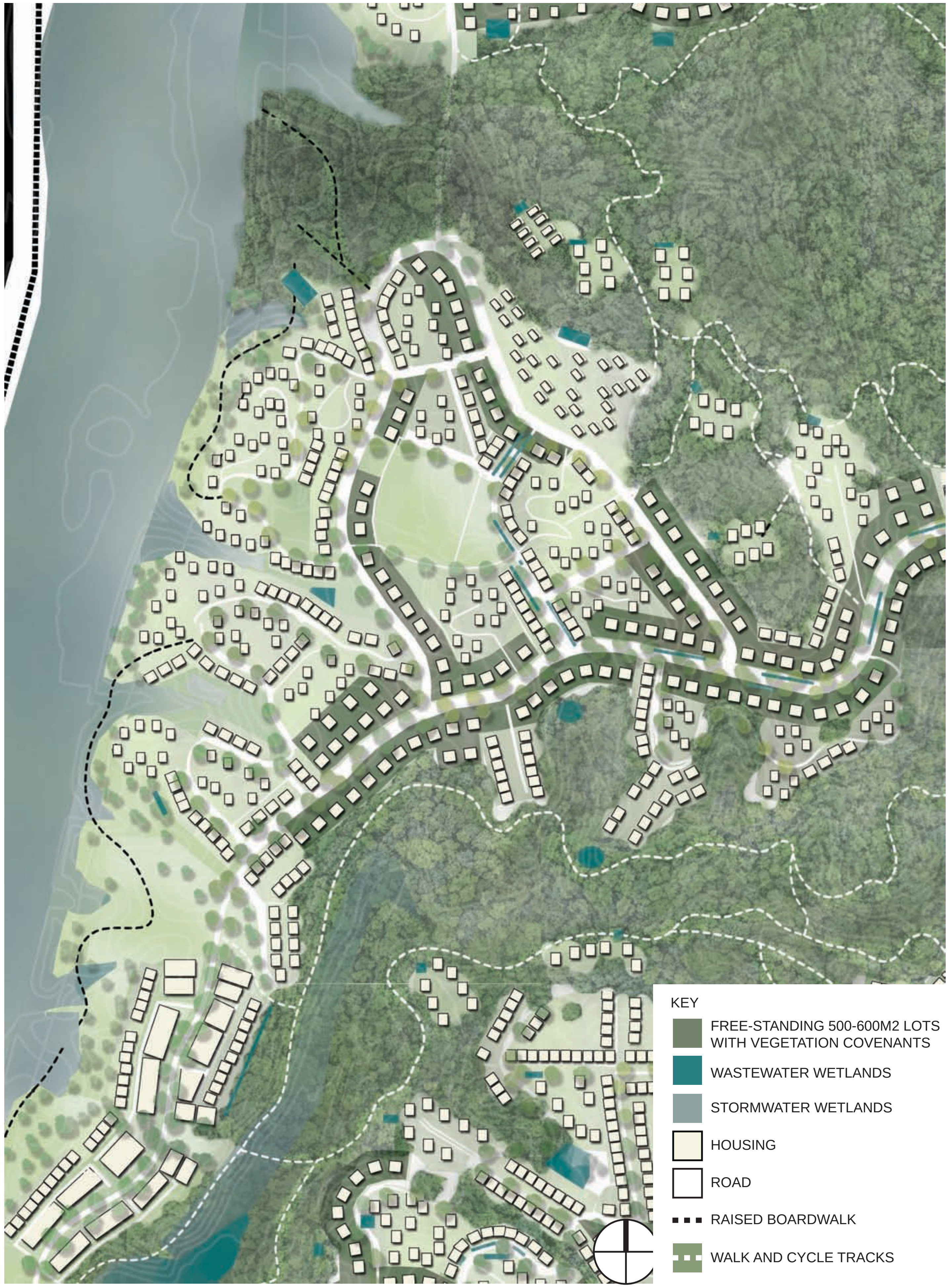


Figure 179. Zoom Area 1

SCALE 1:5,000

This area is designed to encourage walking and exploration. There are many shared roads that lead users through the site towards the swamp edge. The dense vegetation of co-housing combines with street trees and public spaces to bring biodiversity into residential areas, and blur the boundary of public and private along the swamp edge.

Figure 180. Zoom Area 1 – Housing Layout

Street frontage is varied, with some housing facing the street mixed with internally focused co-housing for a more enjoyable walking experience that gives users a sense of walking through nature while still feeling overlooked and safe.

Figure 181. Zoom Area 1 – Street Frontage

Figure 182. Medium Density Providing Active Street Front

Figure 183. Co-housing with Internal Housing Orientation

HILLTOP NEIGHBOURHOOD

Figure 184. Zoom Area 2

SCALE 1:5,000

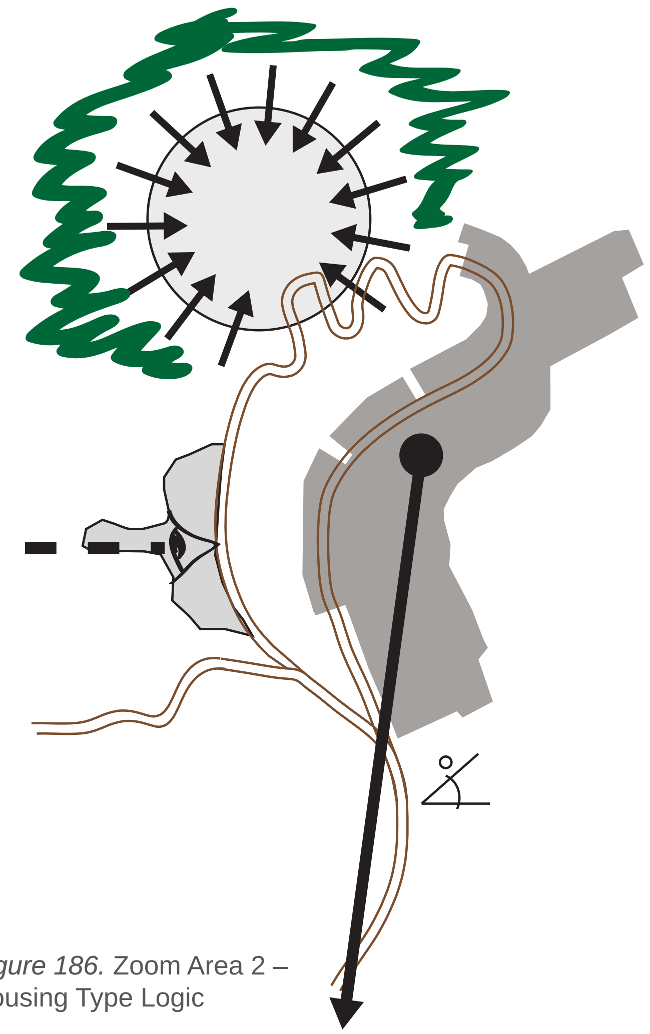
KEY
- FREE-STANDING 500-600M2 LOTS WITH VEGETATION COVENANTS
- WASTEWATER WETLANDS
- STORMWATER WETLANDS
- HOUSING
- ROAD
- RAISED BOARDWALK
- WALK AND CYCLE TRACKS

In this section, house types are grouped to suit the site conditions. Low density, vegetation covenant lots with car access are the main typology, as this area of the site is at a high elevation and distance from the site entrance making walking more challenging.

Figure 185. Zoom Area 2 – Housing Layout

KEY
- FREE-STANDING 500-600M2 LOTS WITH VEGETATION COVENANTS
- CO-HOUSING
- MEDIUM DENSITY DETACHED
- TERRACED HOUSING
- LIFESTYLE BLOCKS TRANSITIONING TO CLUSTER HOUSING

Co-housing and cluster housing are located to the north of the site, surrounded by bush. These lots have lower site coverage and limited car use so to encourage cohabitation and bird life in this area. Terraced housing is located to the west, where residents will enjoy a view looking down over the vegetated gully. This location is close to the town centre (approx. 15min walk through forested areas).



KEY
- VEGETATION PATCHES
- COMMUNITY LIVING
- DIRECT CAR ACCESS LOW DENSITY LIVING
- TERRACED HOUSING

Figure 186. Zoom Area 2 – Housing Type Logic

Figure 187. Vegetation Covenant Axonometric

FOREST PARK NEIGHBOURHOOD

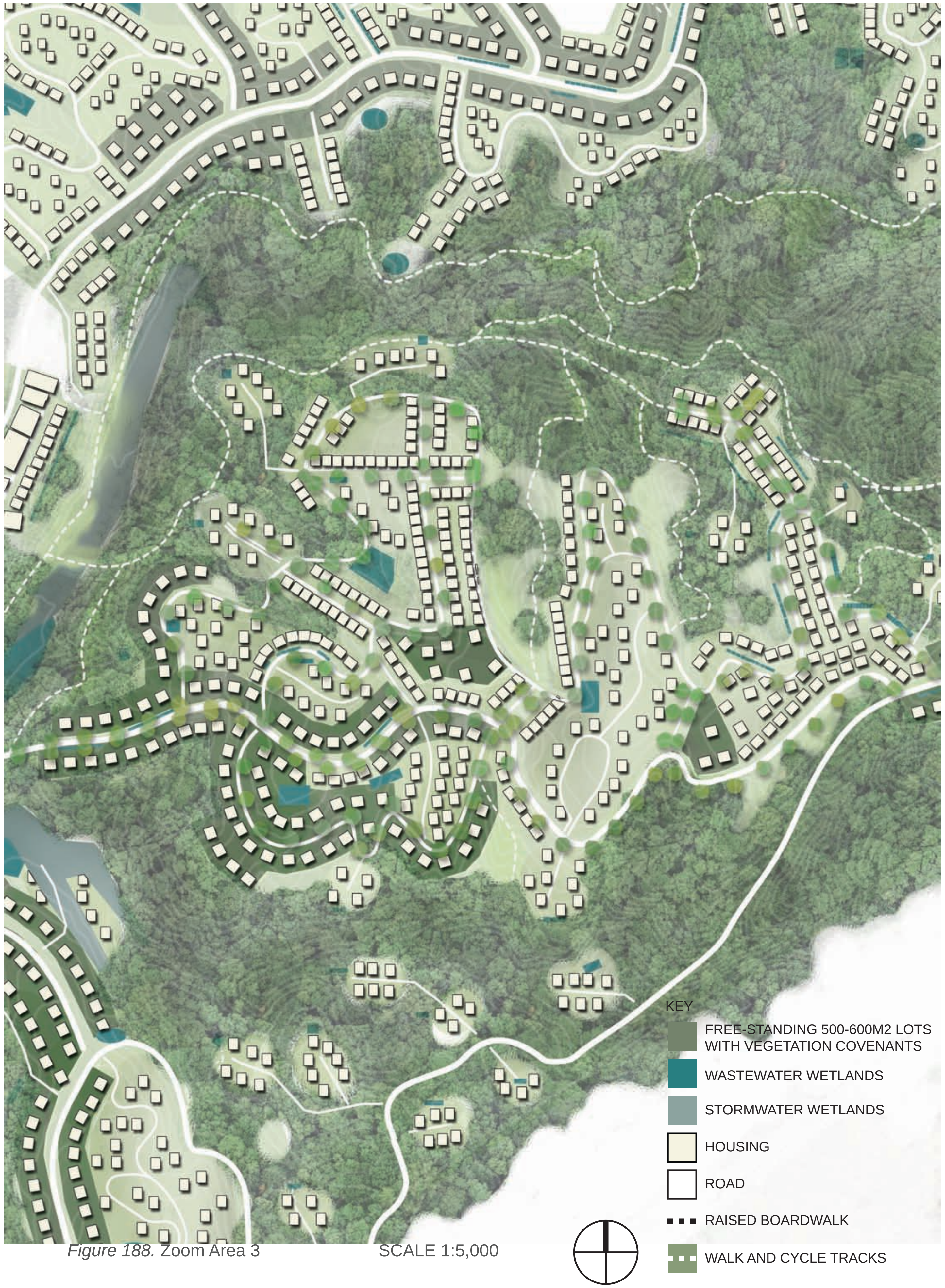


Figure 188. Zoom Area 3

SCALE 1:5,000

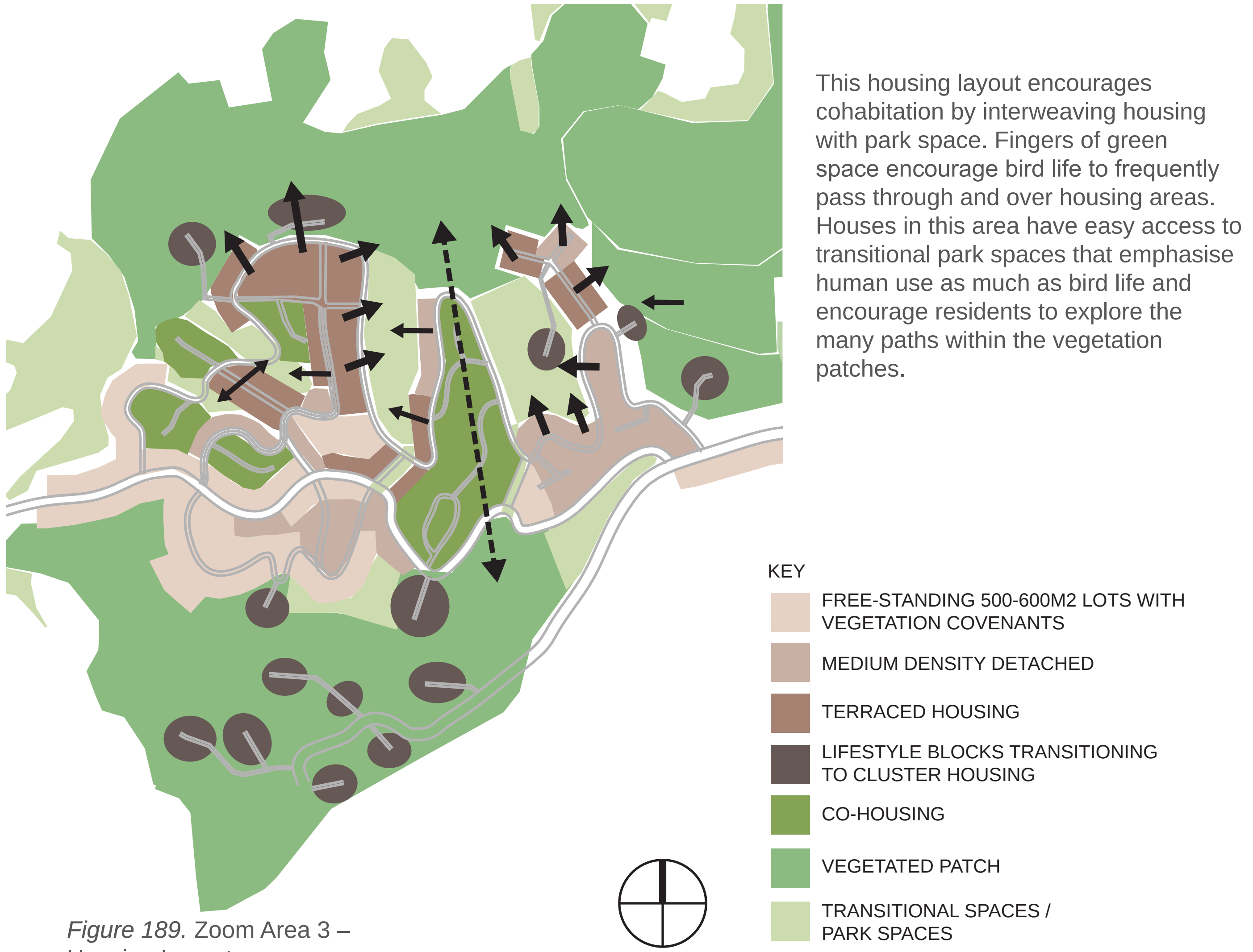


Figure 189. Zoom Area 3 – Housing Layout

This housing layout encourages cohabitation by interweaving housing with park space. Fingers of green space encourage bird life to frequently pass through and over housing areas. Houses in this area have easy access to transitional park spaces that emphasise human use as much as bird life and encourage residents to explore the many paths within the vegetation patches.

Shared roads are located closest to park spaces where their use is expected to lessen over time.

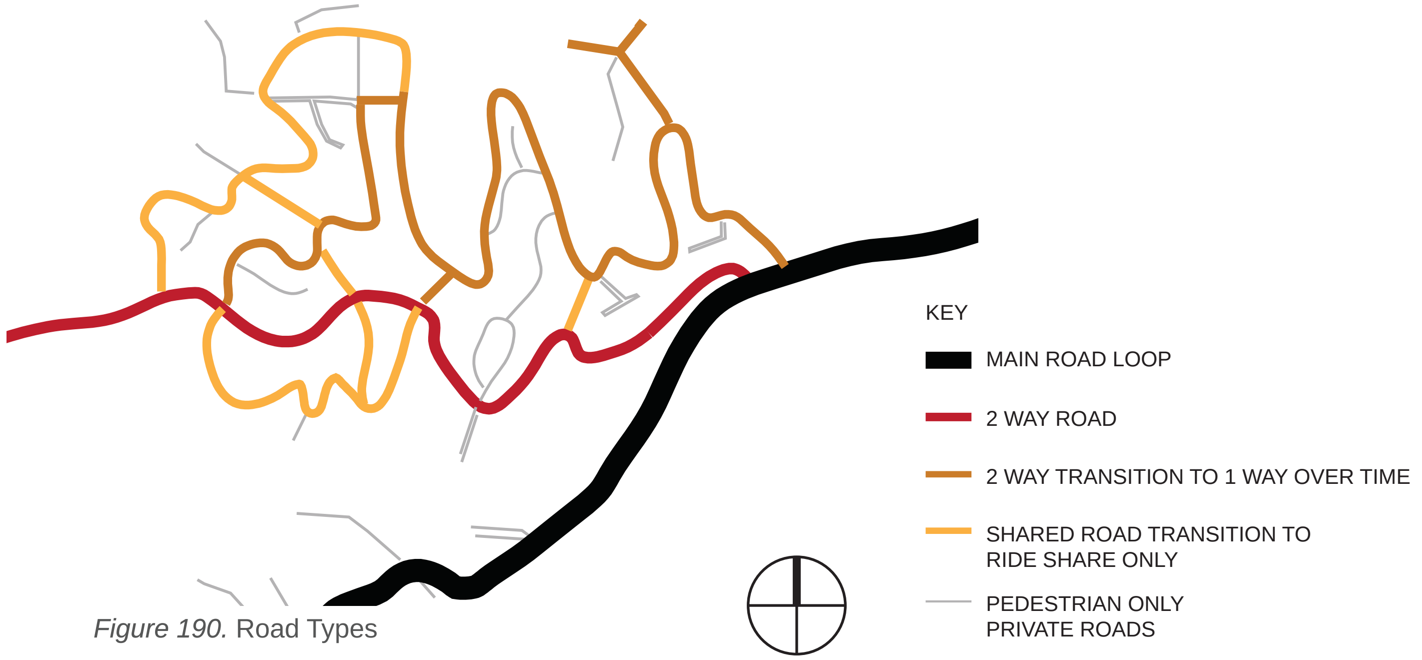


Figure 190. Road Types

Figure 191. One Way Road Before Transition

Figure 192. After Transitioned to Shared Road

VEHICLE CIRCULATION

The road layout utilises both ridgelines and contours to minimise earthworks. The main road is located the furthest distance from vegetated areas, with slow or shared roads closer to vegetation. Housing is on mostly looped roads with little through-traffic to minimise road noise.

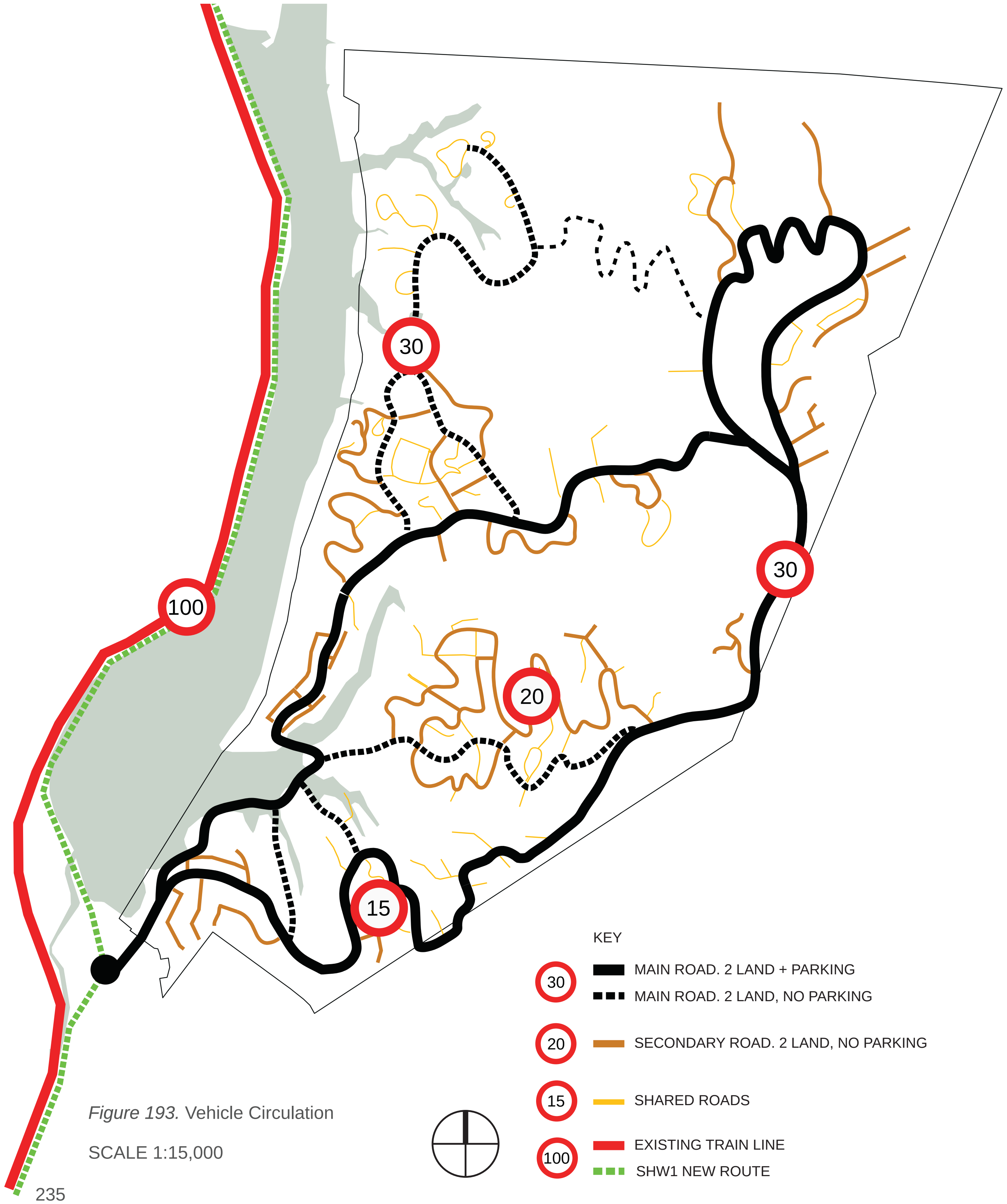


Figure 193. Vehicle Circulation

SCALE 1:15,000

PUBLIC TRANSPORT ROUTE

The Public transport/minivan route is on the faster 30kmh road loop around the site. This route means the majority of houses have a minivan stop within a five minute walk radius of their house which will take them past the central shopping area to the train station where a new bus terminal could be installed.

The school has been located in close proximity to entry/exit of site means

- Children can easily be dropped off/picked up by parents who use private vehicles to commute. Location also lends itself to ride-sharing.
- Children can easily be dropped off/picked up by parents who use the park and ride train system.
- Older children can take the proposed min-van public transit system.

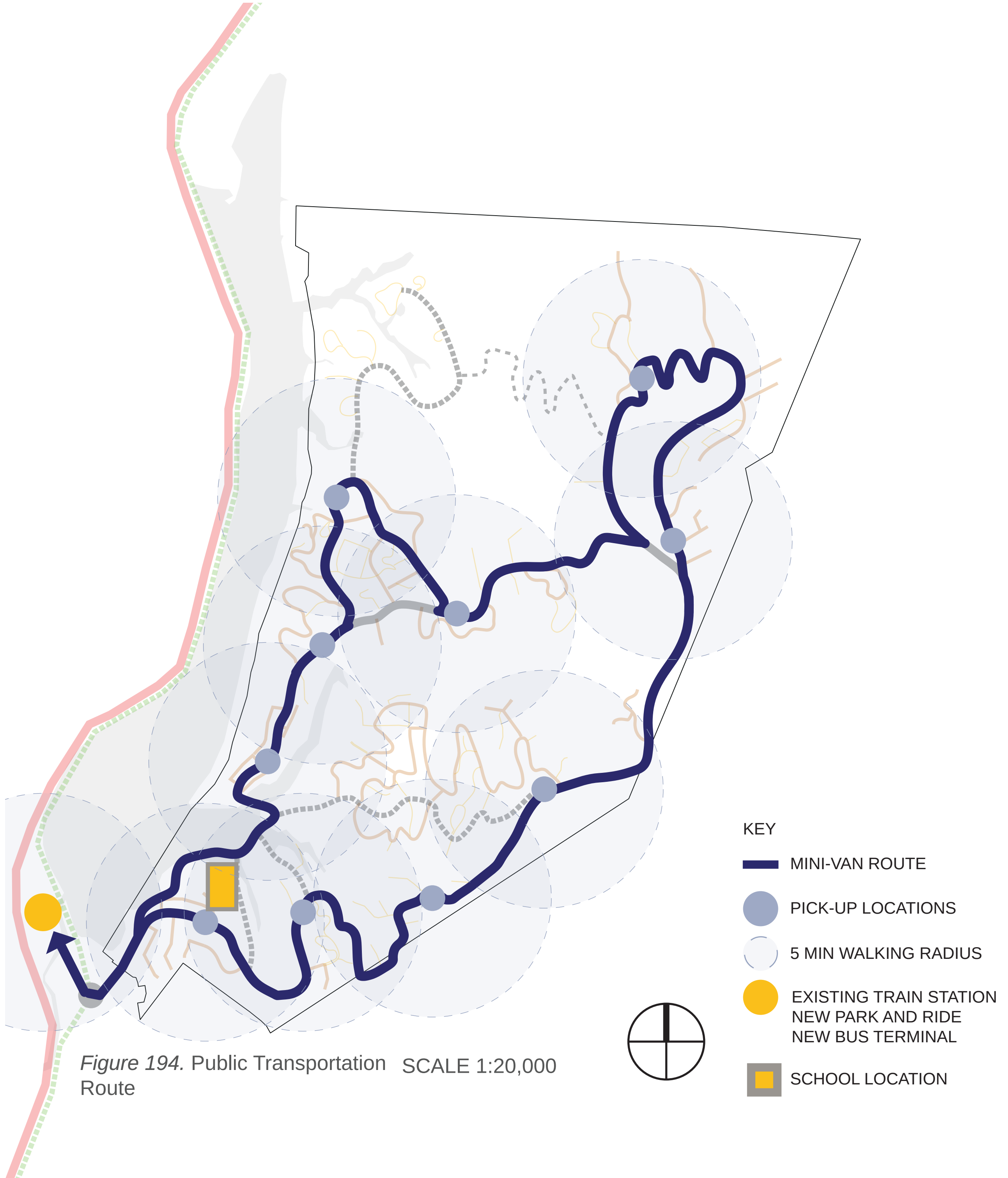


Figure 194. Public Transportation Route

SCALE 1:20,000

MAIN ROAD - 2 LANE + PARKING

Within the development, speeds will be limited to 30kmh and below. Slower speeds allow roads to be narrower thereby reducing the amount of earthworks required. Lower speeds also decreases car noise and improve pedestrian experience.

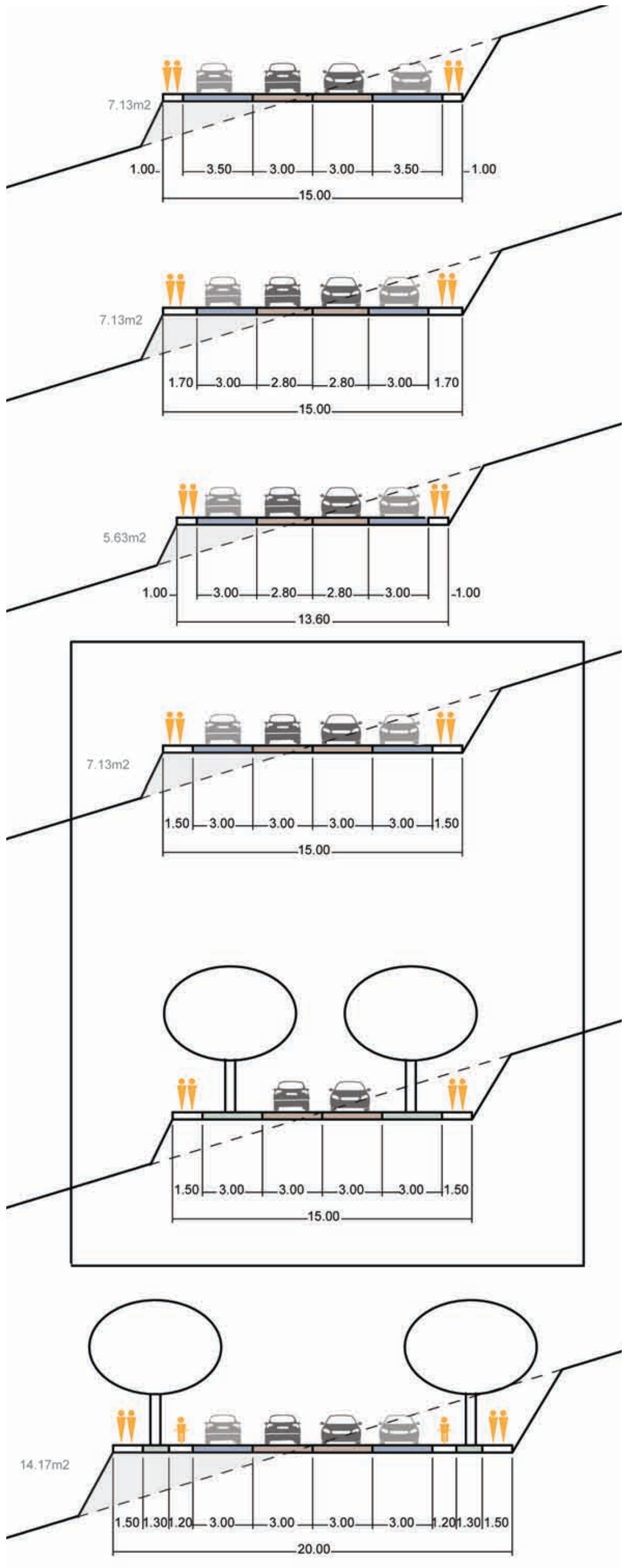


Figure 197. Road Width Exploration

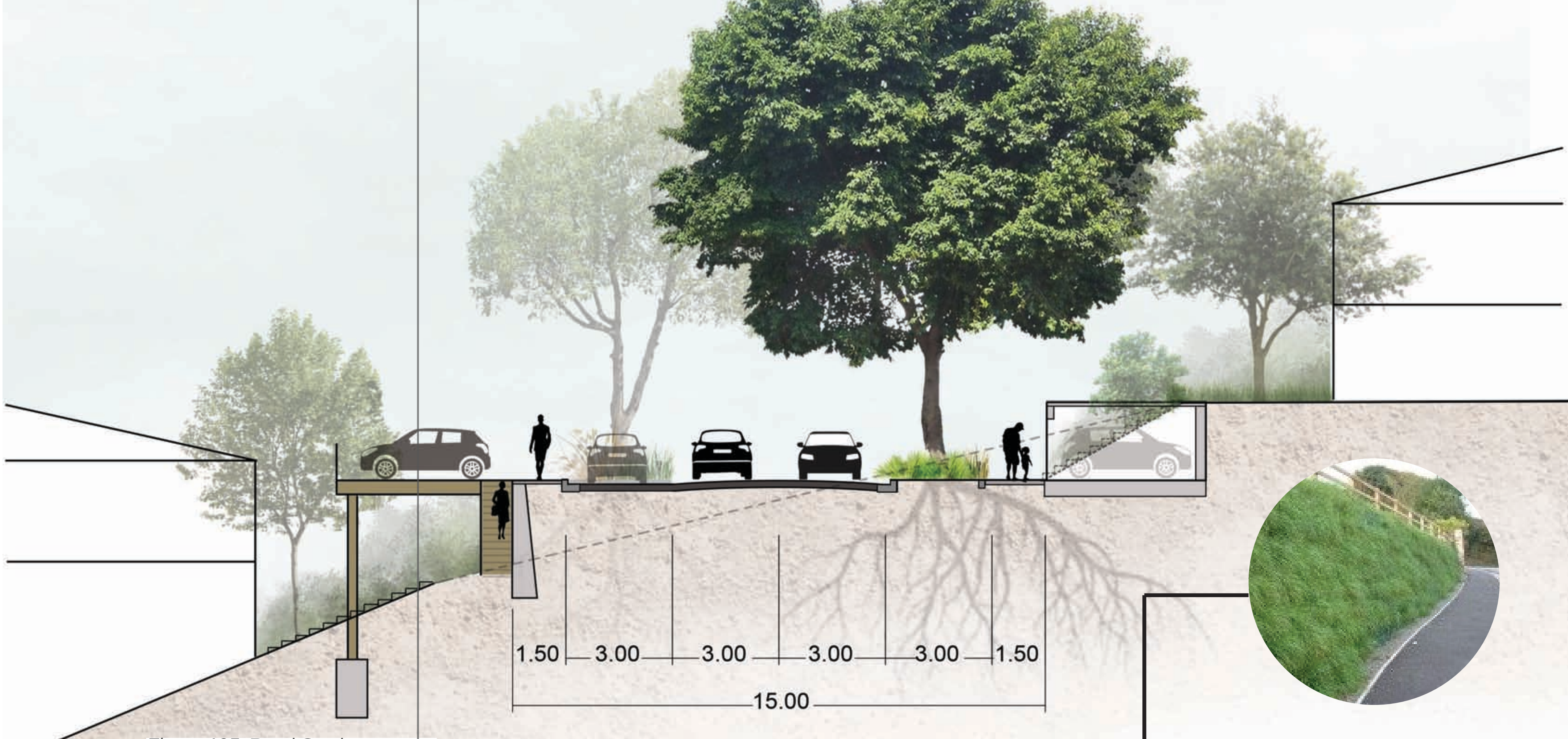


Figure 195. Road Section

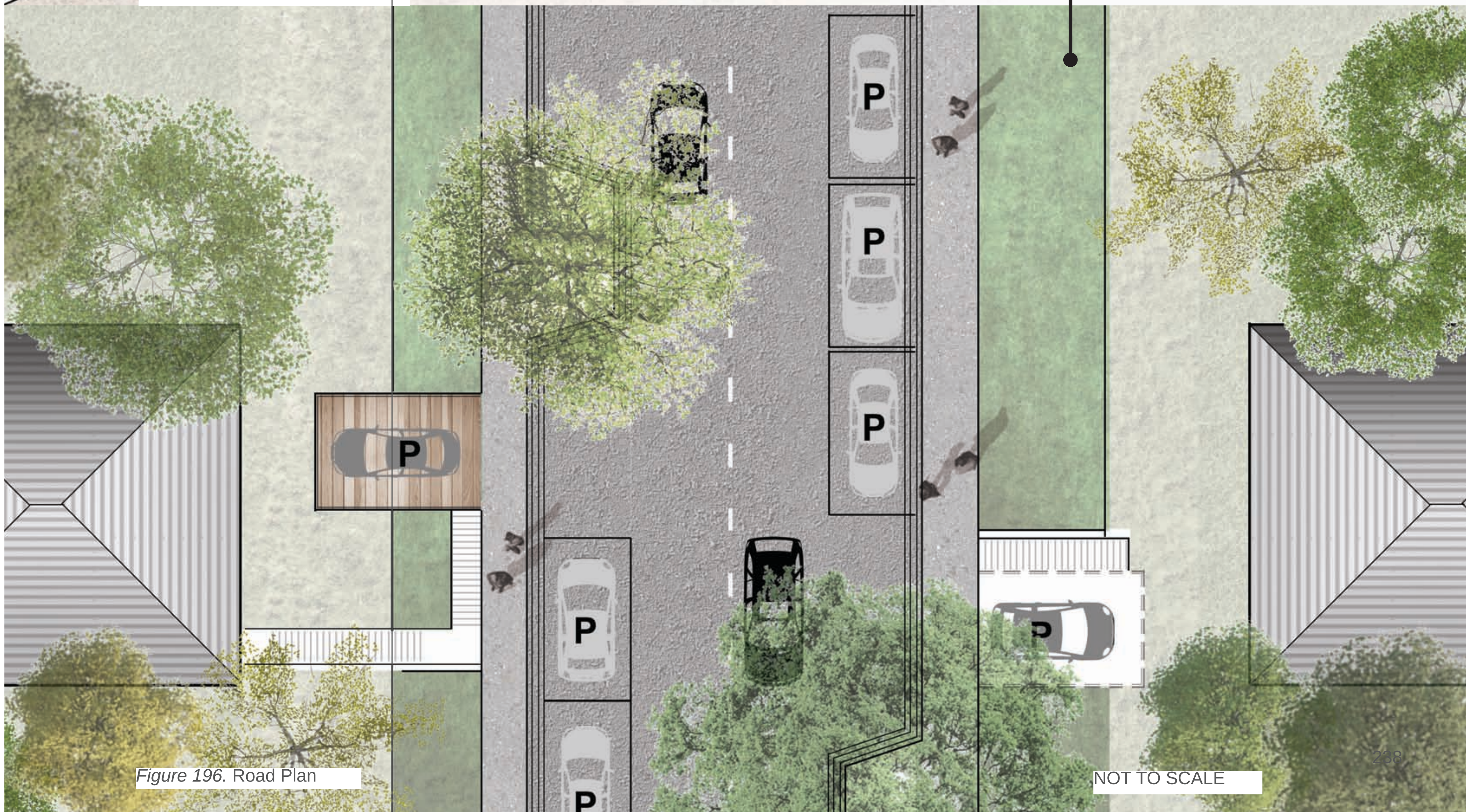


Figure 196. Road Plan

NOT TO SCALE

MAIN ROAD - 2 LANE, NO PARKING

This road type typically follows the ridgelines resulting in a gentler cross section and more accessible off-road parking. These roads do not include street planting as most are only lined with one lot depth of housing and do not present much of a barrier for bird life to cross.

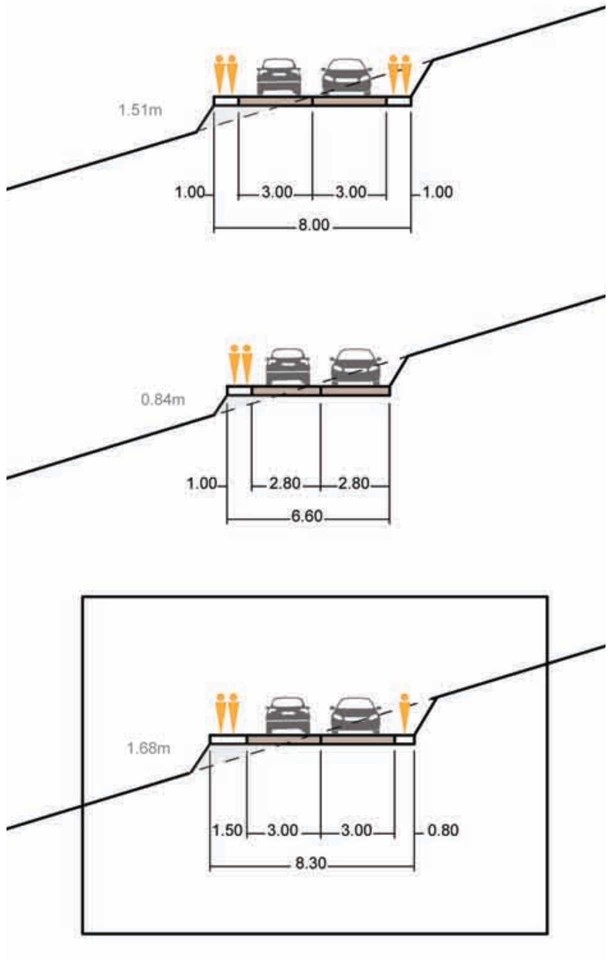


Figure 200. Road Width Exploration

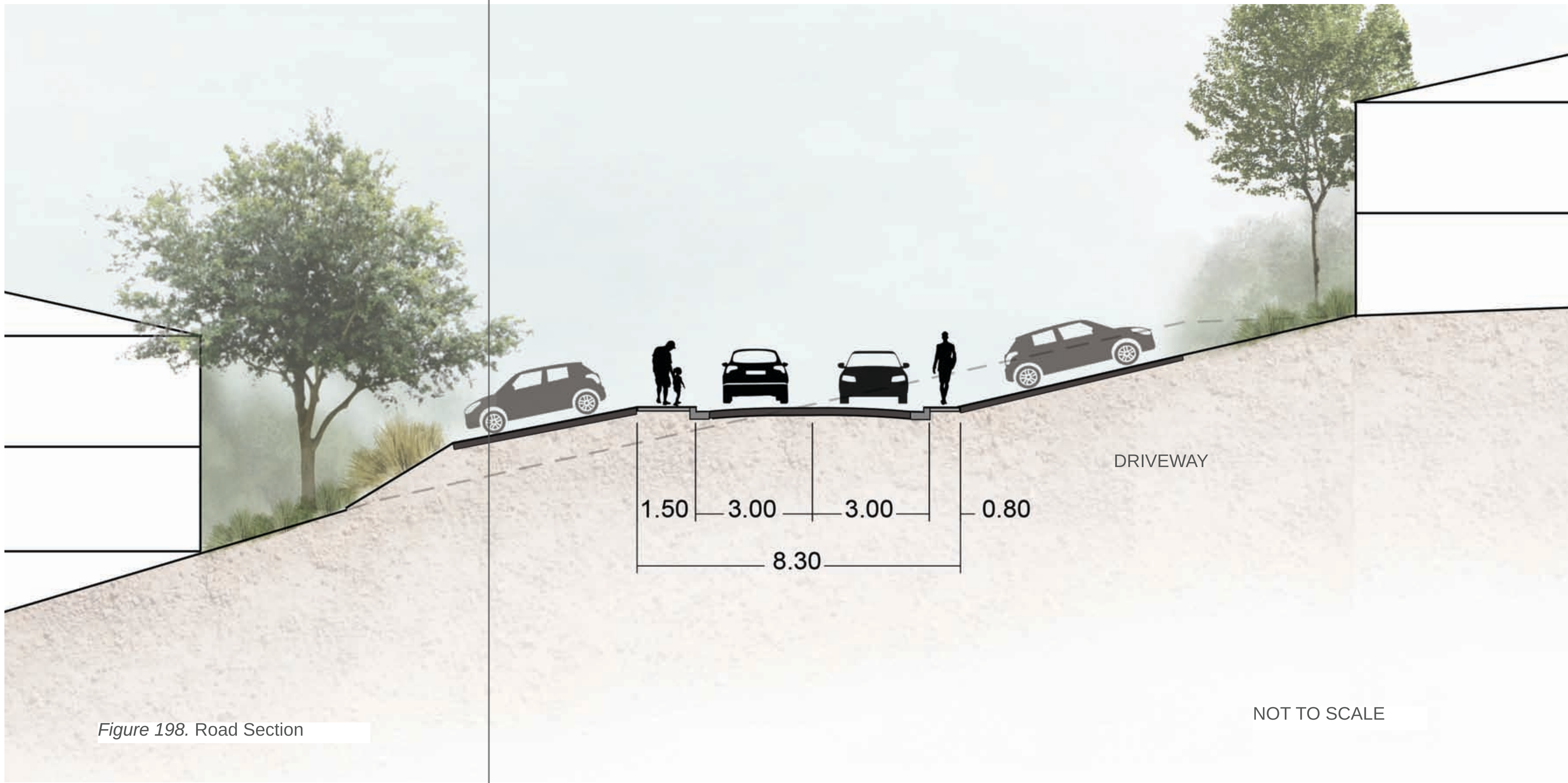


Figure 198. Road Section

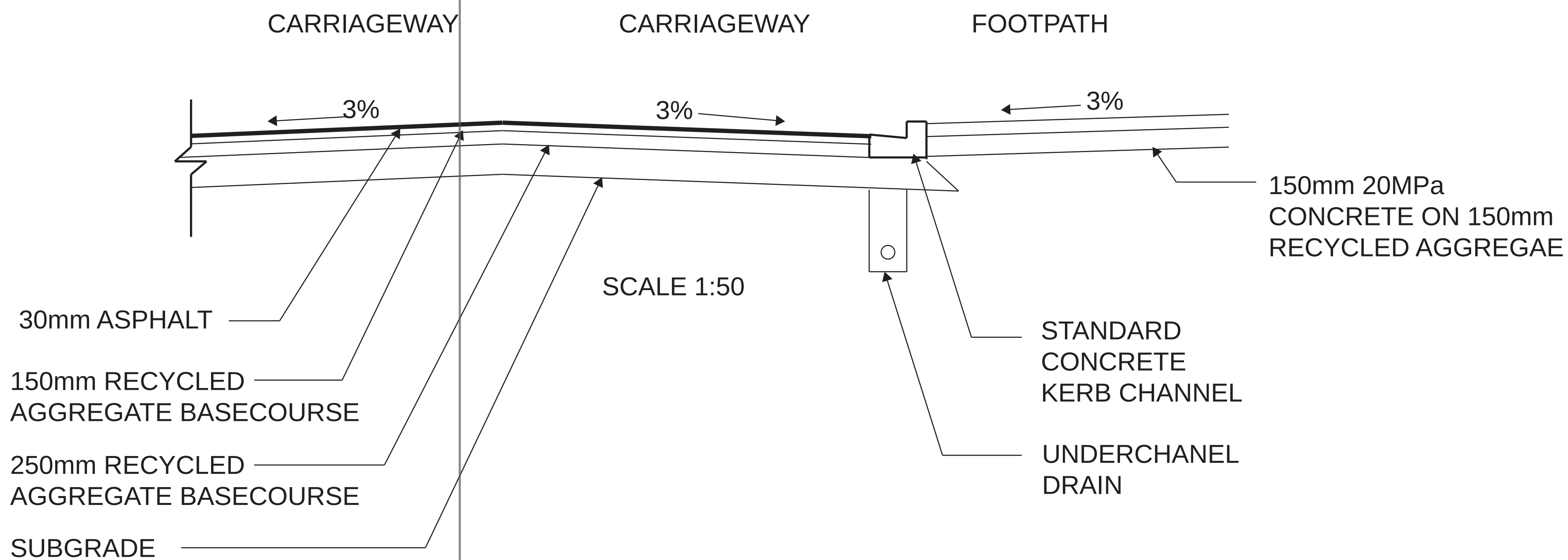


Figure 199. Example Road Makeup and Gutter Detail

SCALE 1:50

SECONDARY ROAD - 2 LANE, NO PARKING

These roads will begin as slow, local roads, with the possibility of becoming shared roads or restricted to rise-share cars in the future as car reliance drops.

Street vegetation should have a thick understory for insect abundance and winter food sources for birds (seeds, nectar, berries). Variety of tree species along the roadside will support a wider range of birds. Canopy complexity is shown to make a difference to bird abundance in urban areas. Larger canopy trees are preferable to narrow trees such as cabbage trees or nikau palms (Cavin & Kull, 2017).

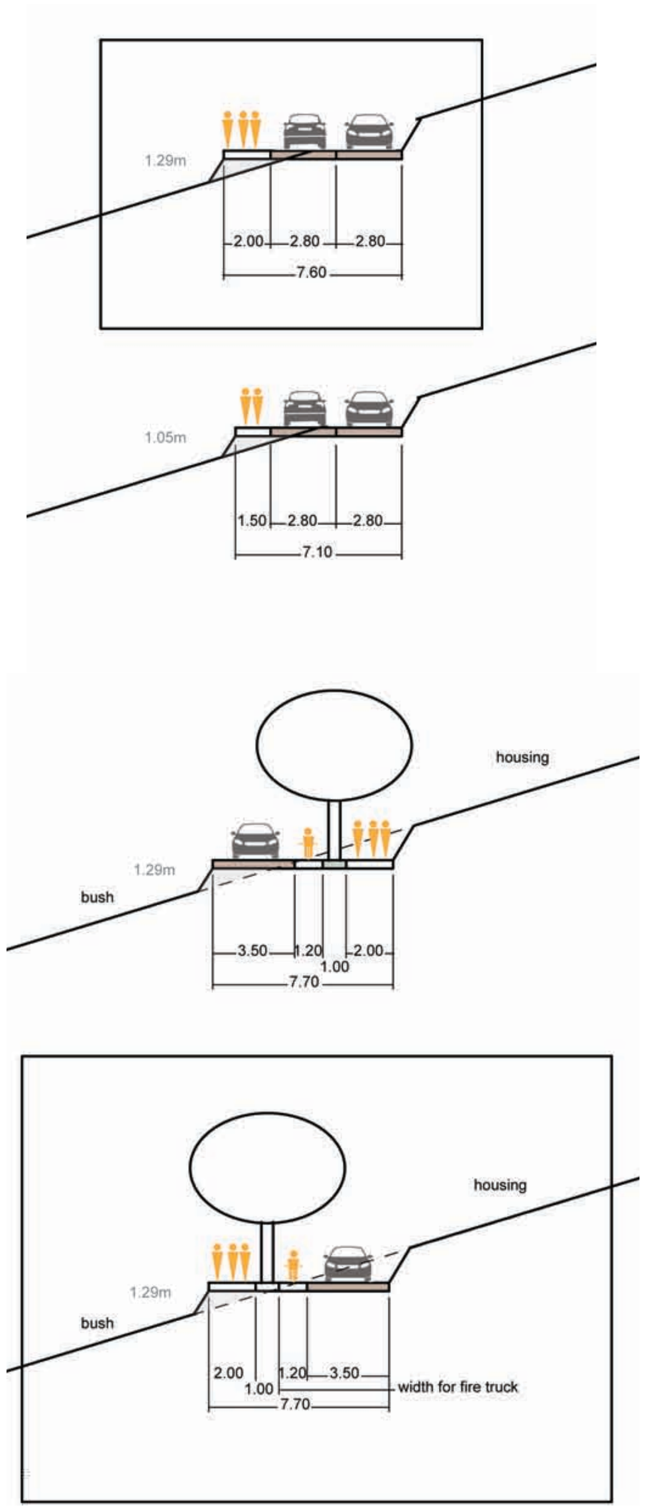


Figure 203. Road Width Exploration

Titoki

Kowhai

Putaputaweta

Karaka

Puriri

Gaura 'Sparkle White'

Phormium tenax

Libertia peregrinans

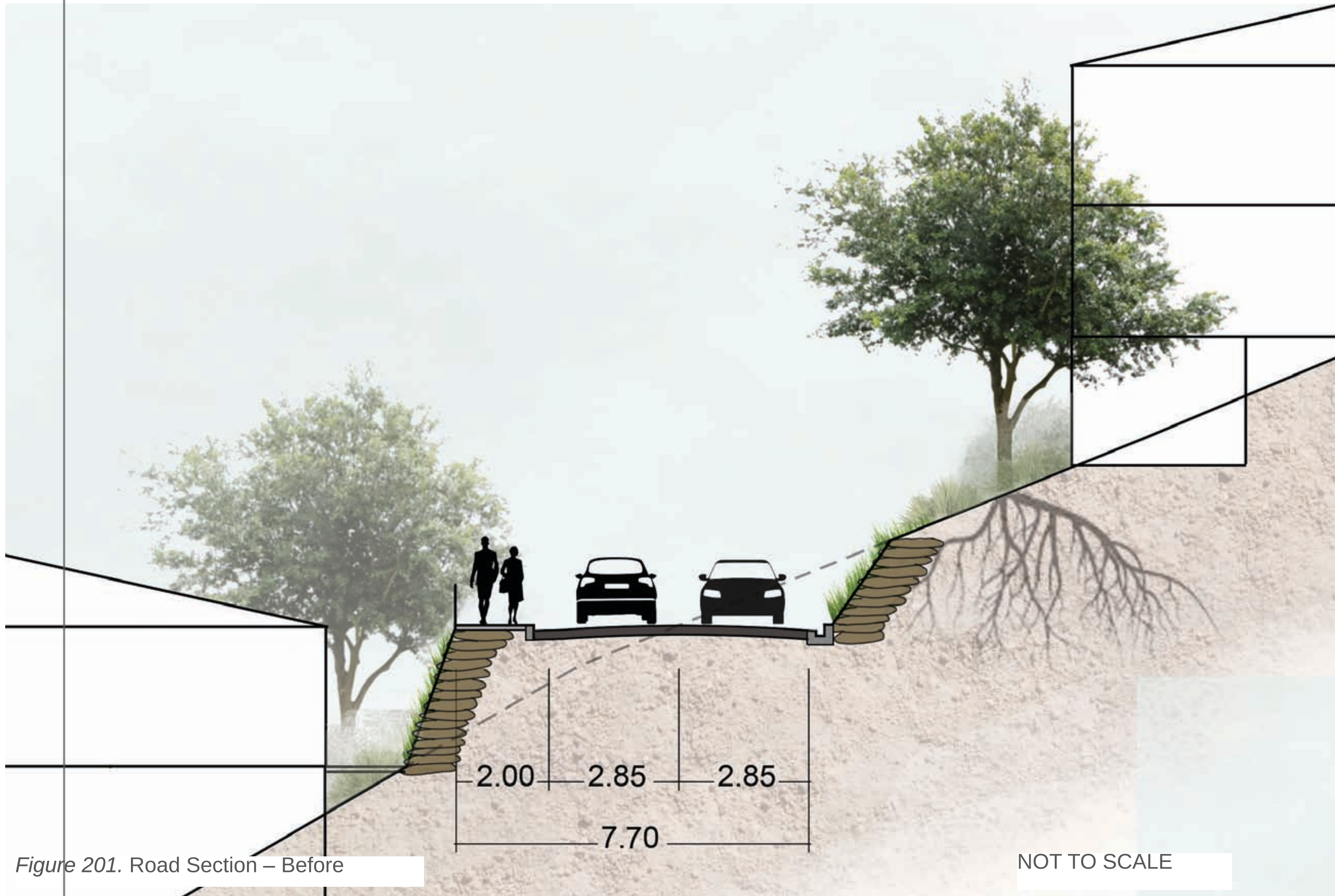


Figure 201. Road Section – Before

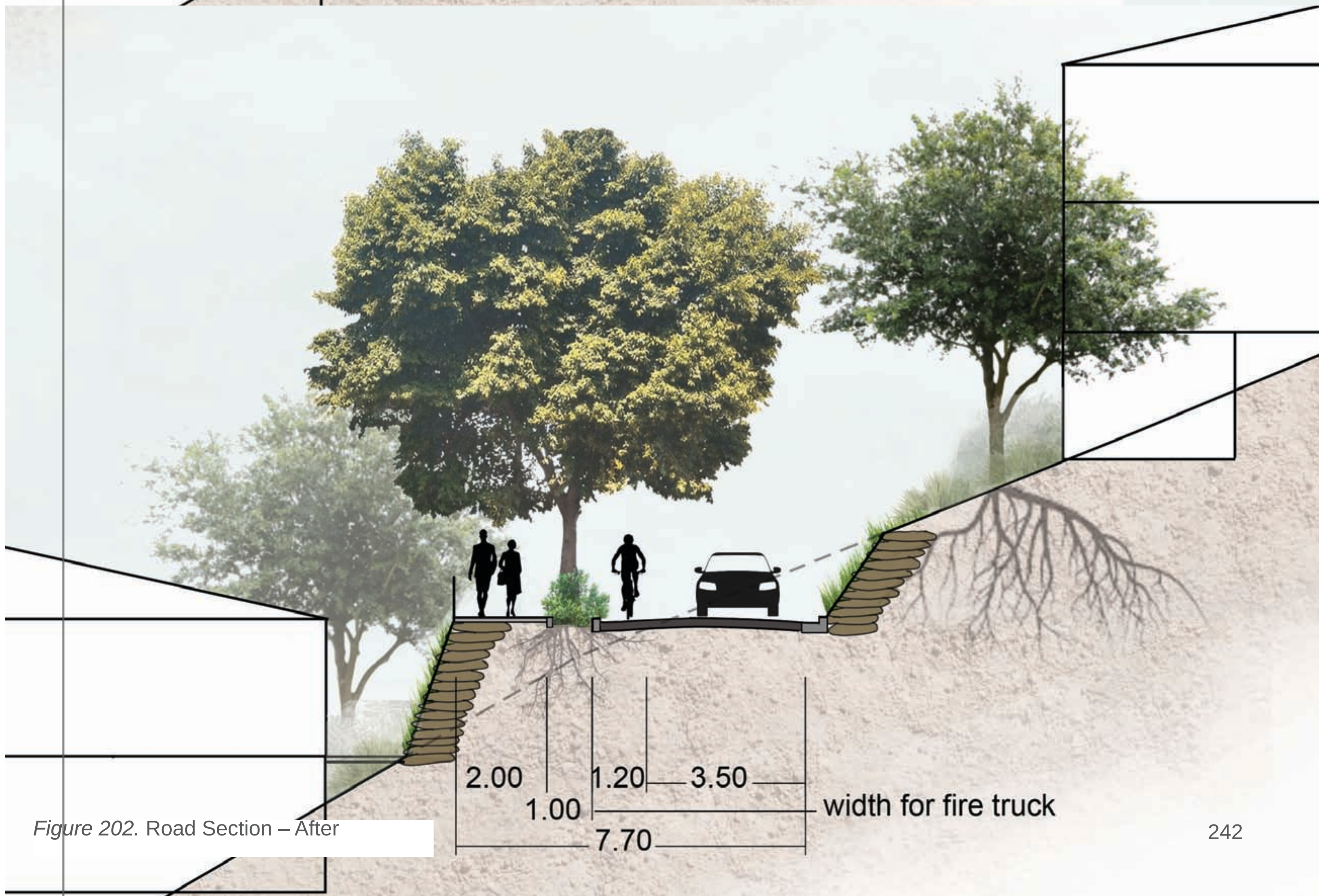


Figure 202. Road Section – After

SHARED ROAD

Shared roads will have paving that slows cars and encourages pedestrian use.

As car use decreases, seating and plant boxes can be placed on the street providing adequate clear width for emergency vehicles is retained.

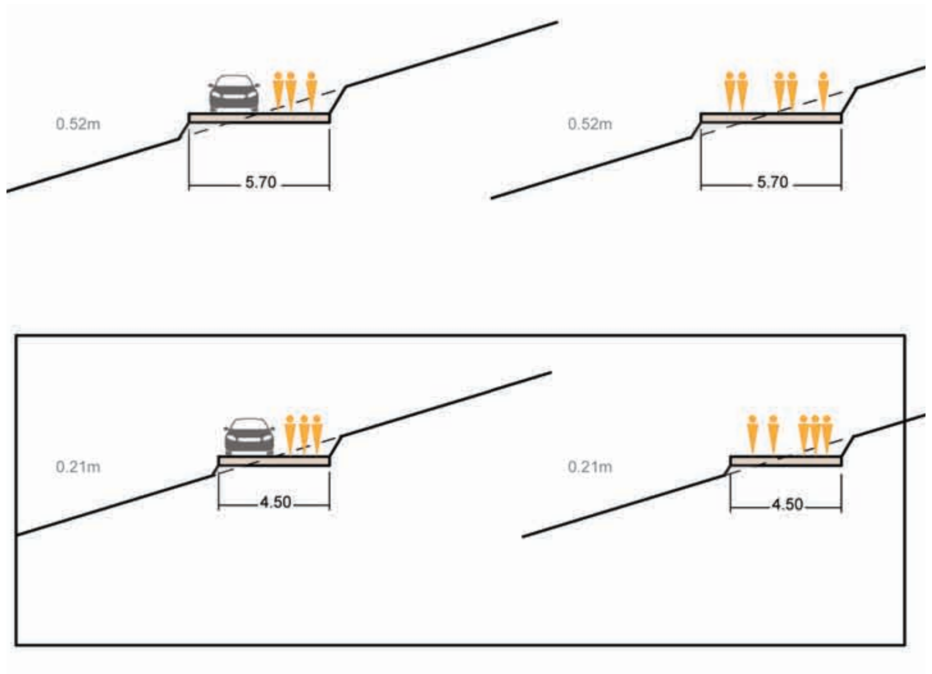
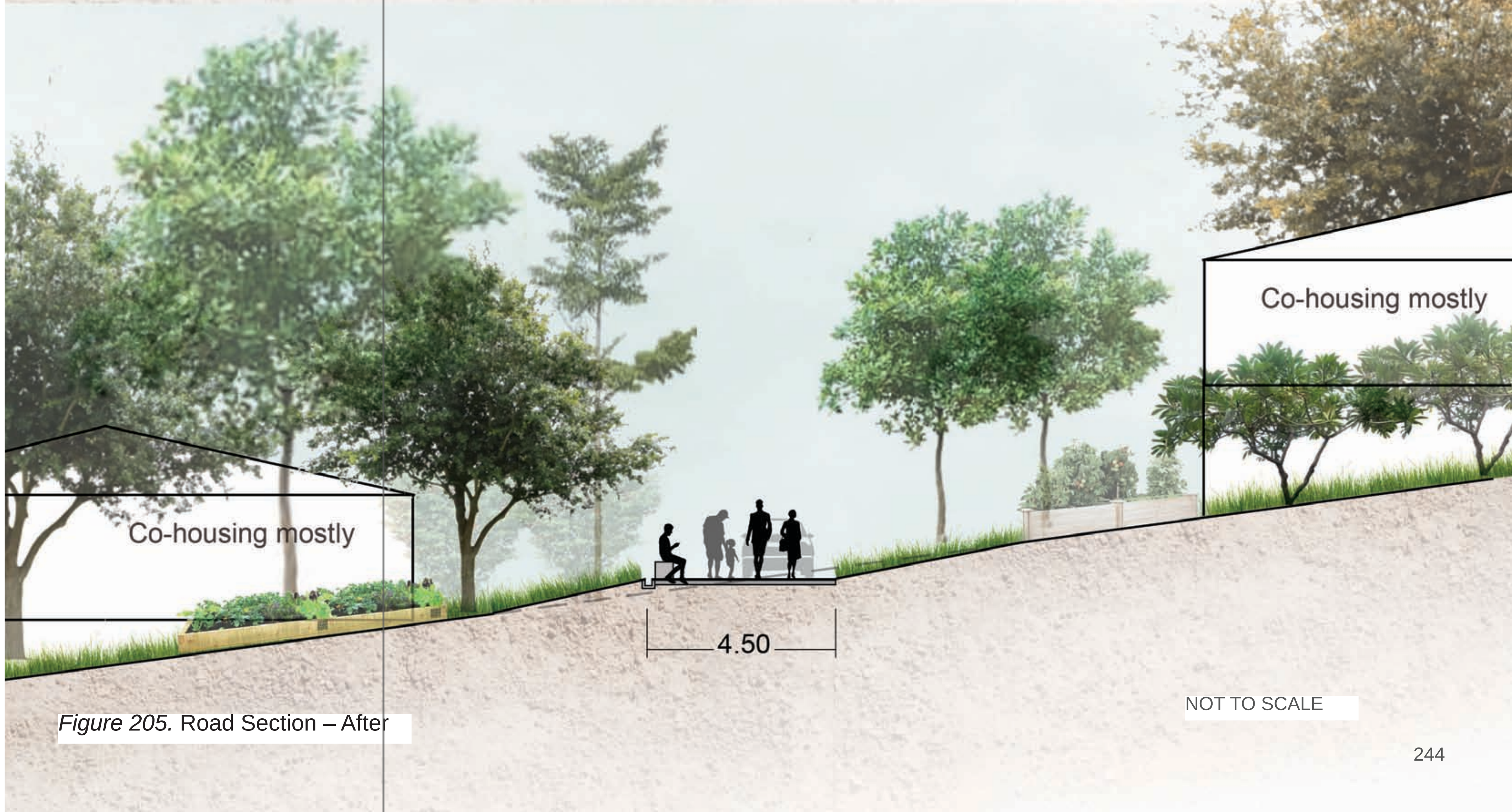


Figure 206. Road Width Exploration

Shared roads will have paving that slows cars and encourages pedestrian use.

Figure 204. Road Section – Before



NOT TO SCALE

Figure 205. Road Section – After

OFFLINE WATER STRATEGY

Water pollution was identified as a key threat to wildlife. An offline water strategy that collects (and re-uses) rainwater for human use will decrease stormwater runoff and prevent further demand on fresh water sources (the Hutt River for the Porirua region).

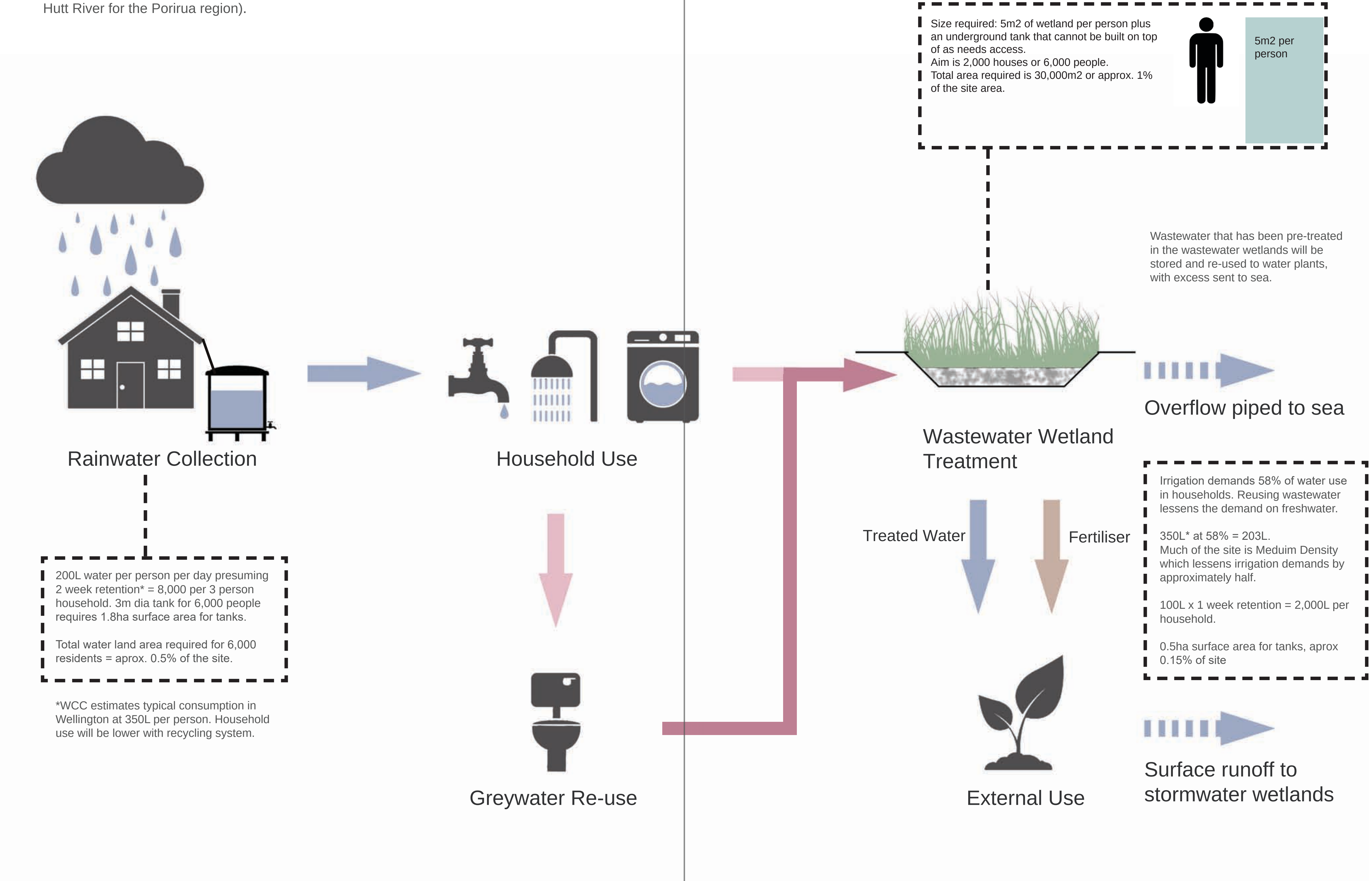


Figure 207. Offline Water Strategy

WASTEWATER STRATEGY

The sites soil type has risk of erosion and tunnel gullying meaning traditional septic tanks with infiltration systems are not suitable. Wastewater wetlands are the most suitable on-site waste solution as they typically have a liner to prevent infiltration.

The suggested solution has localised infiltration (rather than a single, large wastewater wetland) in order to;

- Encourage residents to take responsibility in flushing only appropriate waste into the system as they can easily see the resulting effect.
- Reduce the amount of piping required to transport waste.
- Reduce the amount of water consumption used locally for irrigation, as residents will have easy access to the treated water.

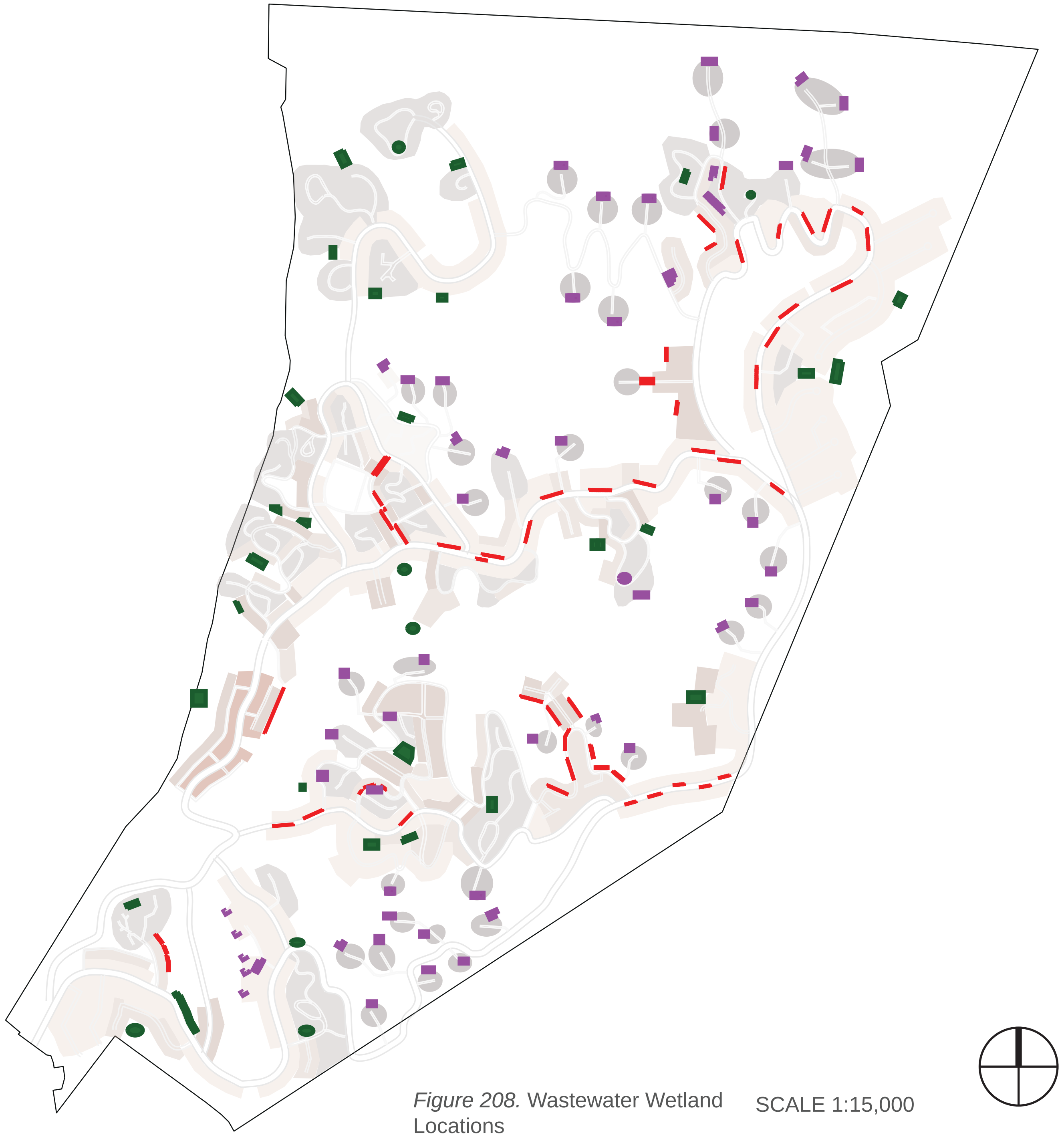


Figure 208. Wastewater Wetland Locations

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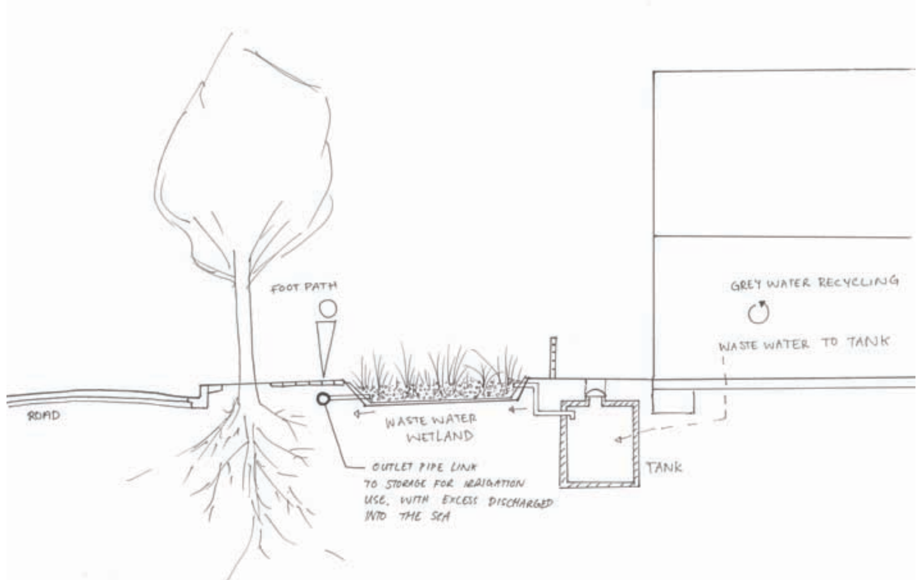


Figure 209. Street Side Wetlands. Household/ small clusters utilising wetlands as street side planting providing privacy to houses and amenity and biodiversity value to streets.

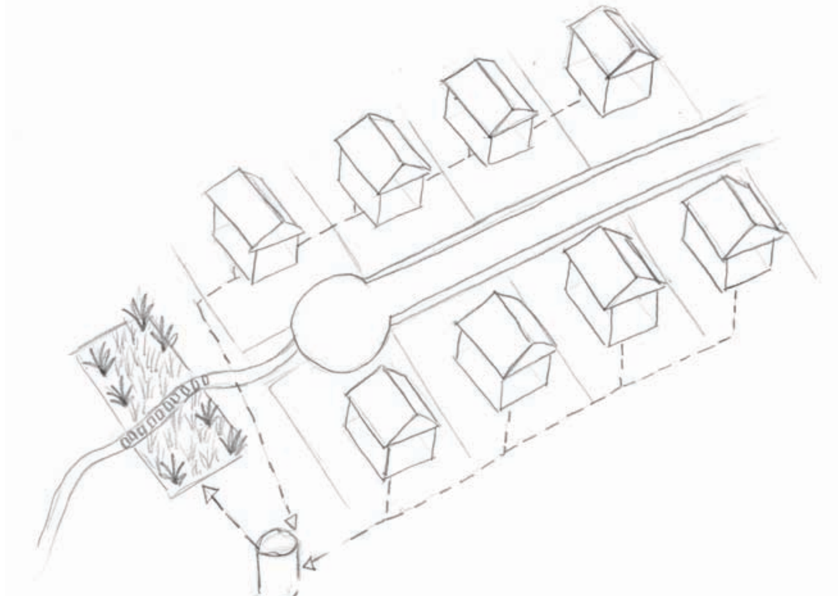


Figure 210. Cluster Housing Wetlands. Cluster housing will have small wetlands sized to suit the small group of 5-10 houses

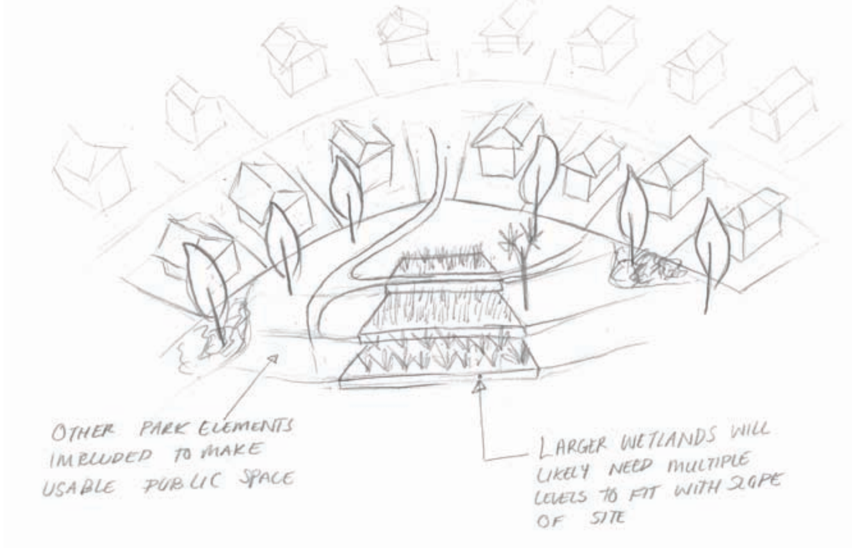


Figure 211. Larger Localised Wetlands. Service between 20 and 100 houses

PLANTING PALLET

Carex virgata

Carex apressa

Apodasmia similis

Juncus Edgariae

Baumea articulata

Carex Secta

Eleocharis sphacelata

Schoenoplectus tabernaem

Typha orientalis (raupo)

STORMWATER RUNOFF

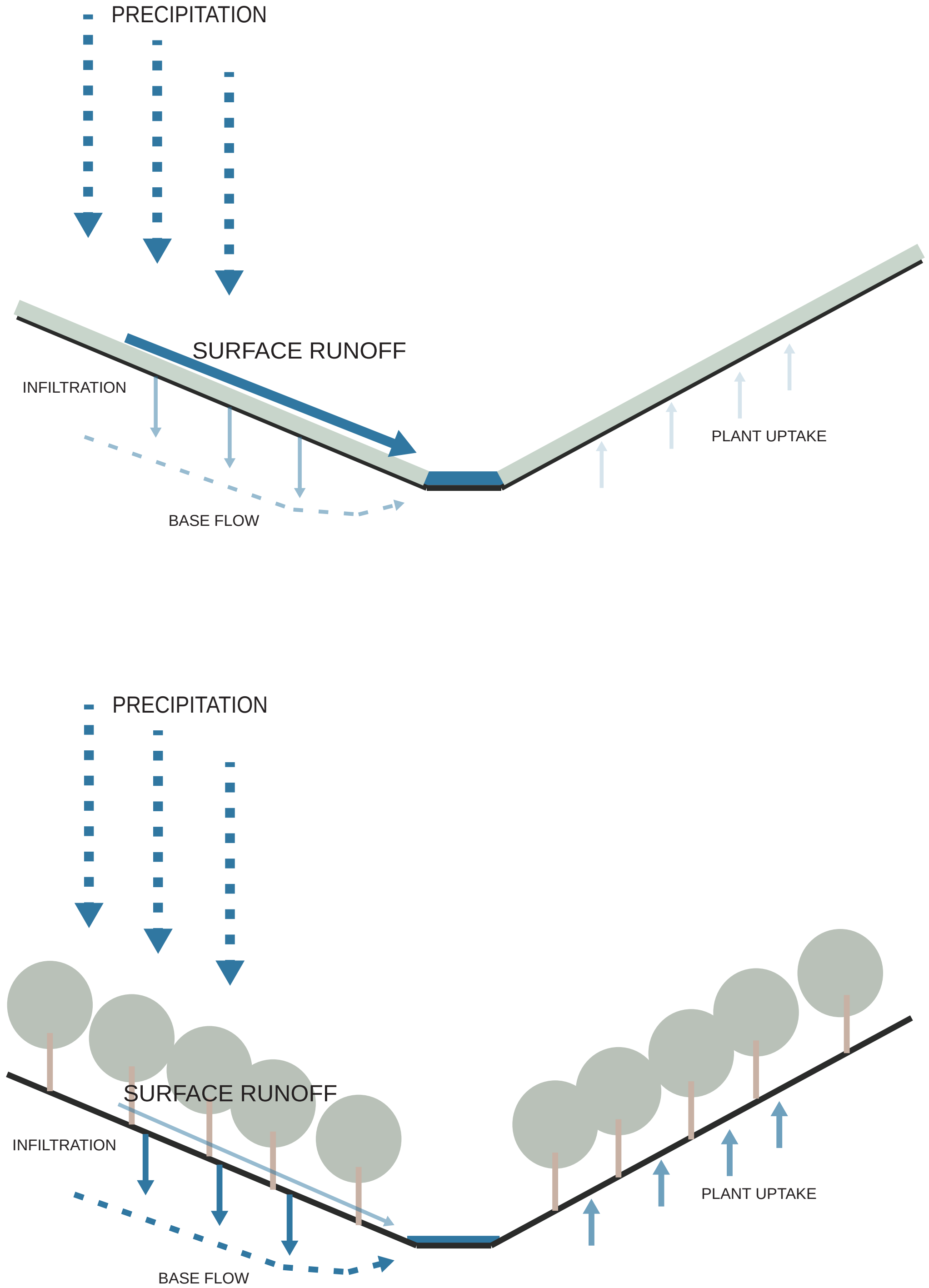


Figure 212. Surface Runoff Decreases As Landcover Converts From Farmland To Forest, Reducing Size Requirements of Stormwater Wetlands

As established in the earlier phases of design, the steep topography and limited areas of low lying land indicate wetlands are best suited at the bottom of the site.

These areas also hold a flood risk and the expansion of Taupo Swamp will effectively solve both the flooding issue and provide adequate space to treat the sites stormwater runoff before it enters the Porirua Harbour.

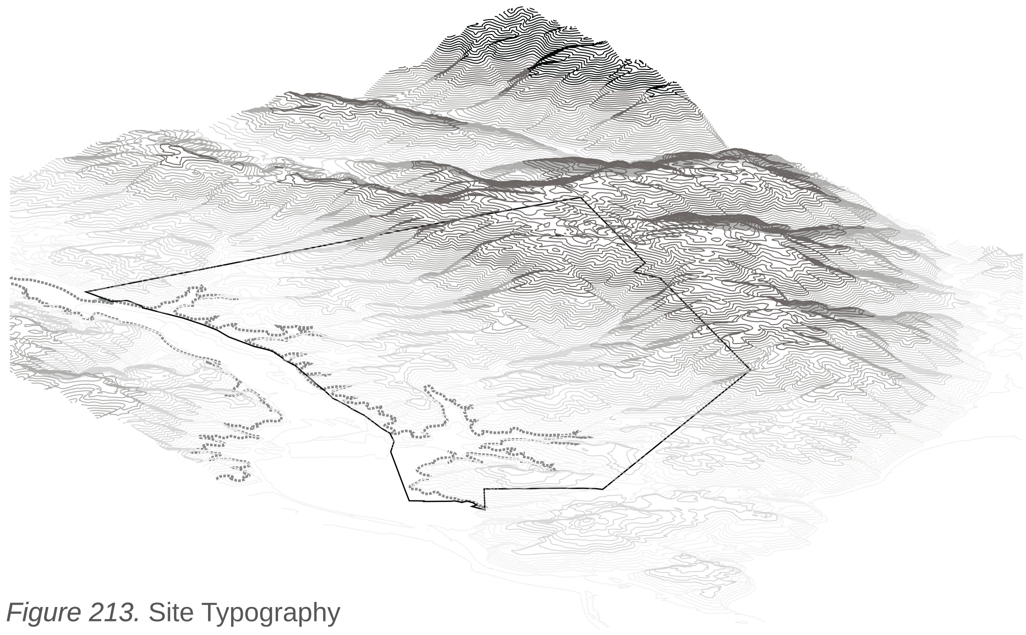


Figure 213. Site Typography

Figure 214. Photo of Taupo Swamp

STORMWATER WETLAND CALCULATIONS

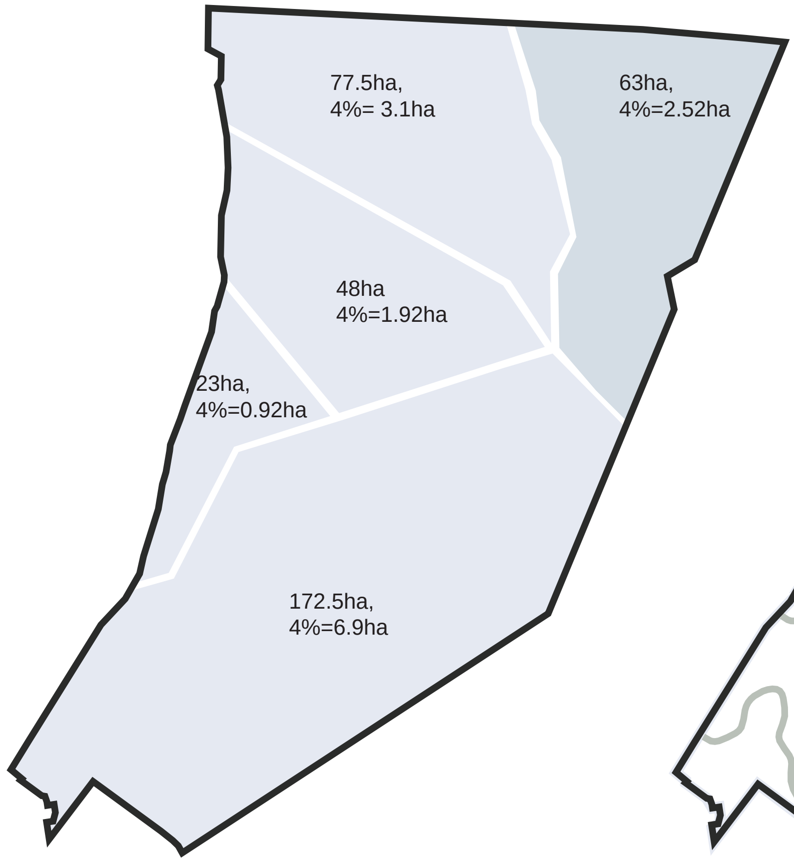


Figure 215. Stage 1. Land cover will be primarily impervious surfaces (eg roads) or exotic grassland. These surfaces have low infiltration levels and high amounts of surface runoff, requiring approximately 4% of the catchment to be wetlands for adequate treatment.

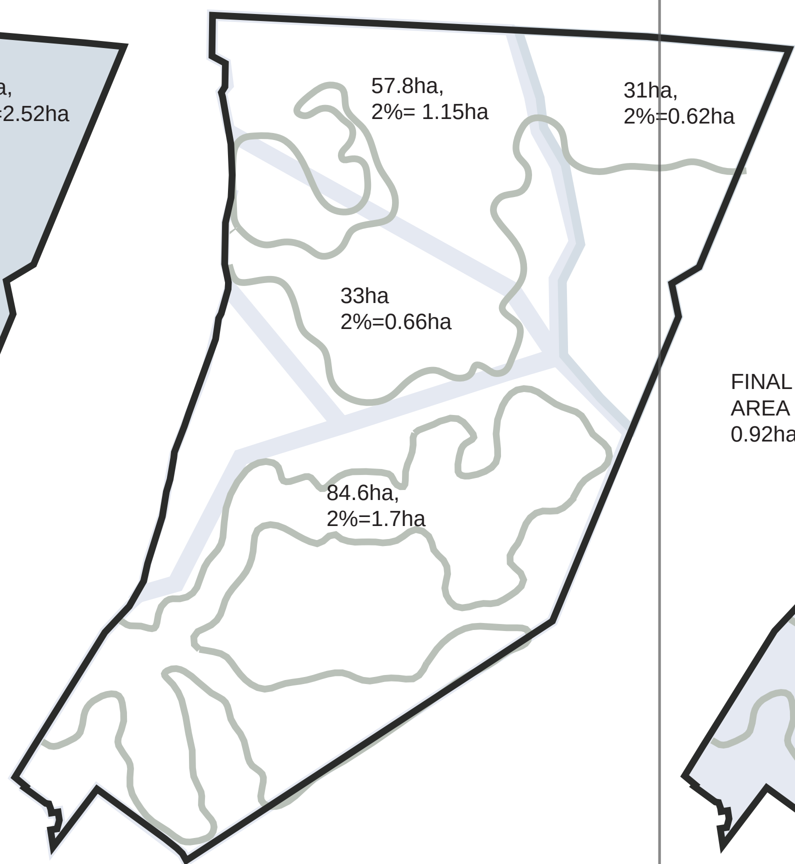


Figure 216. Stage 2. Forest cover established. Vegetation slows the runoff allowing it to infiltrate into the soil. Plants catch water on their leaves encouraging evoptranspiration before water has a chance to hit the ground. Plants also absorb water for their own use, resulting in less surface runoff. Once forest cover is established, areas that are forested will only require 2% of the area for wetland.

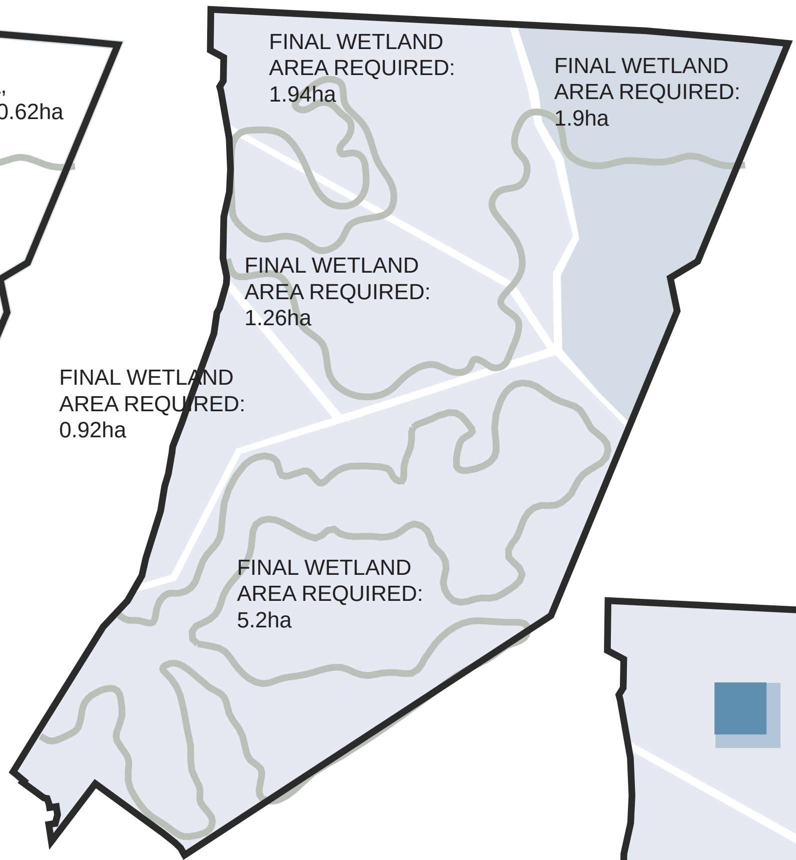
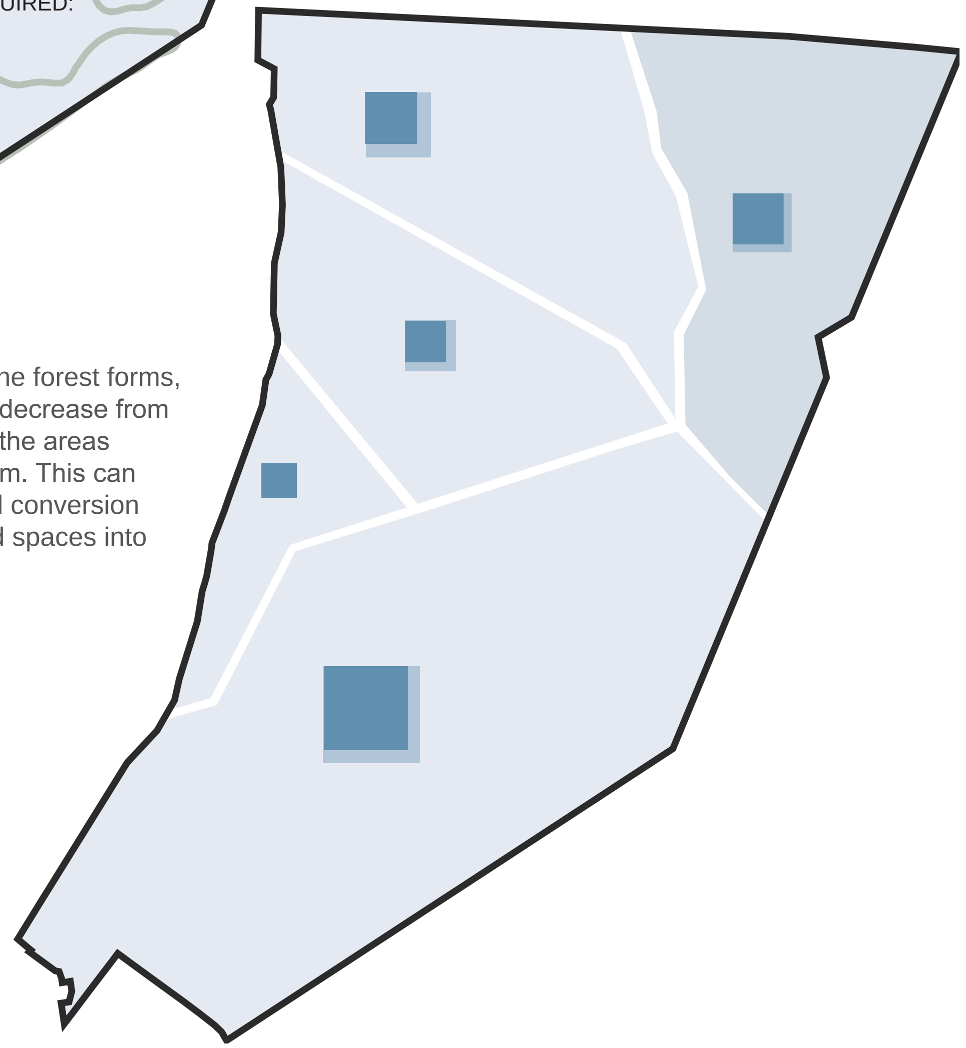


Figure 217. Final Stage. As the forest forms, required area of wetland will decrease from areas specified in stage 1 to the areas specified in the above diagram. This can mean a natural shrinking and conversion of a proportion of the wetland spaces into other land use.



NOT TO SCALE

PROPOSED WETLAND LOCATIONS CONCEPT 1

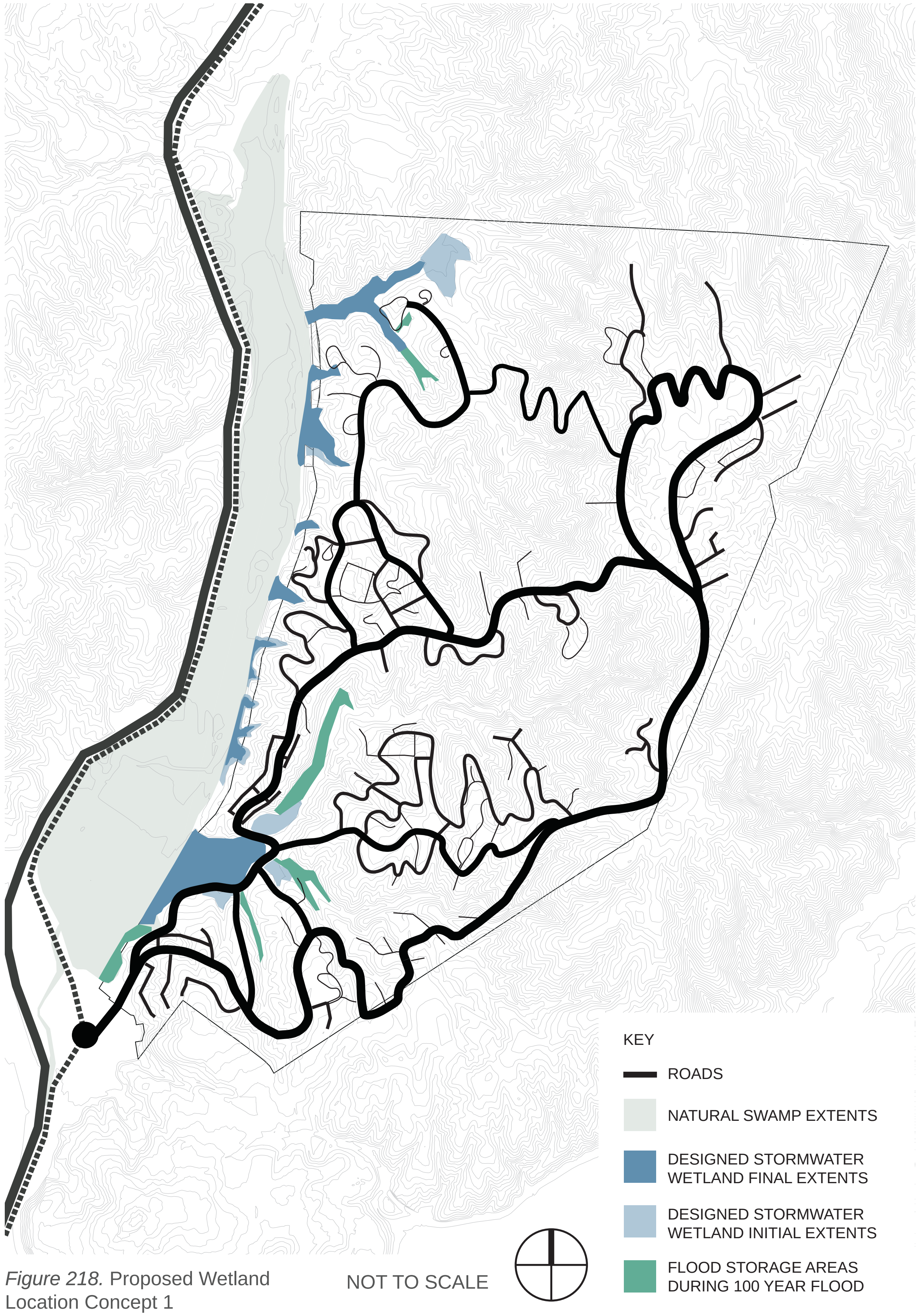


Figure 218. Proposed Wetland Location Concept 1

NOT TO SCALE

Wetlands should utilise natural edges with gentle gradients that will allow for an easy reduction of water levels and transition of planting from wetland species flood tolerant plant species in the future.

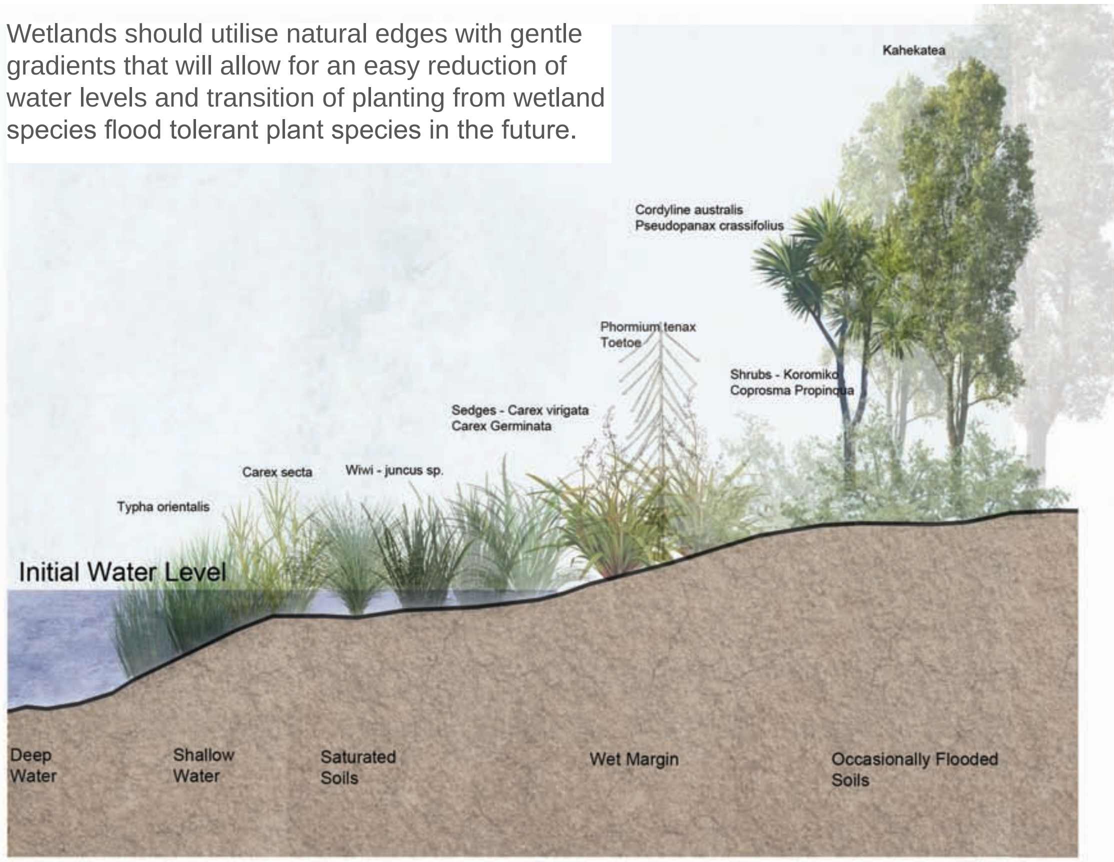


Figure 219. Initial Water Level

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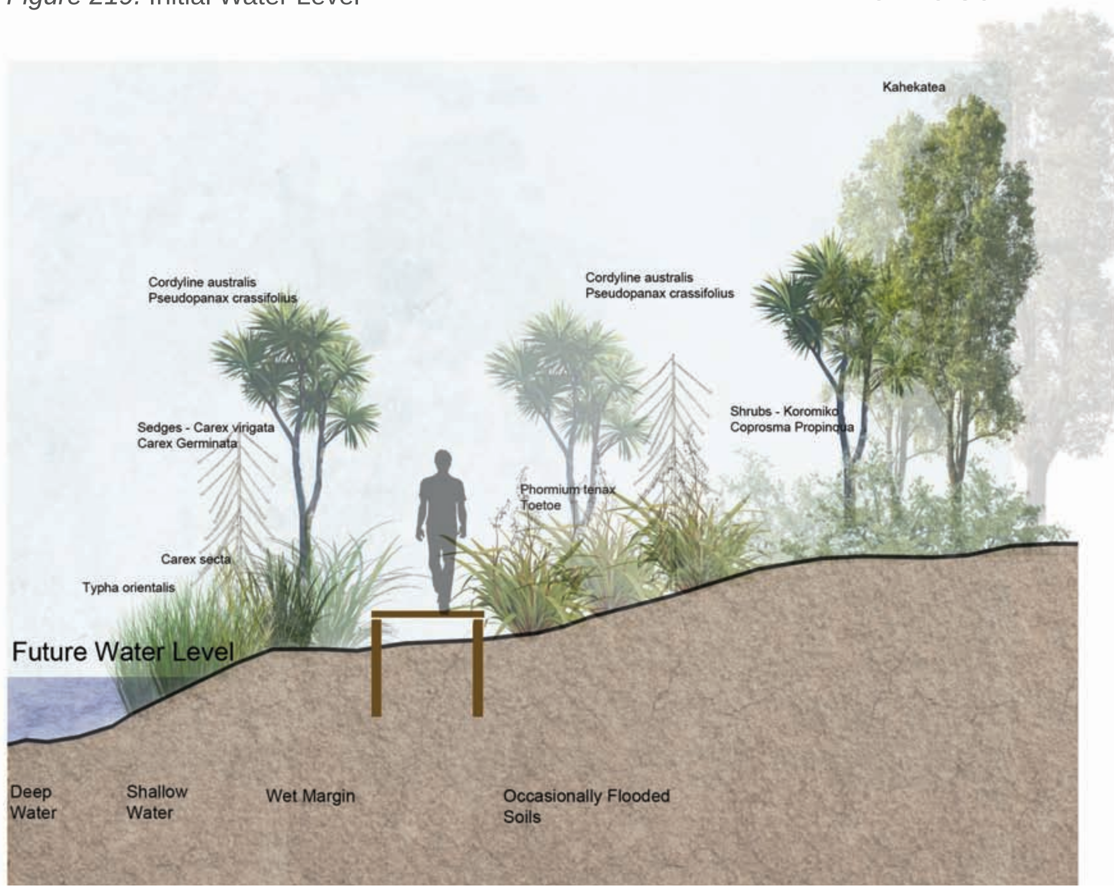

Figure 220. Future Water Level

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PROPOSED WETLAND LOCATIONS CONCEPT 2

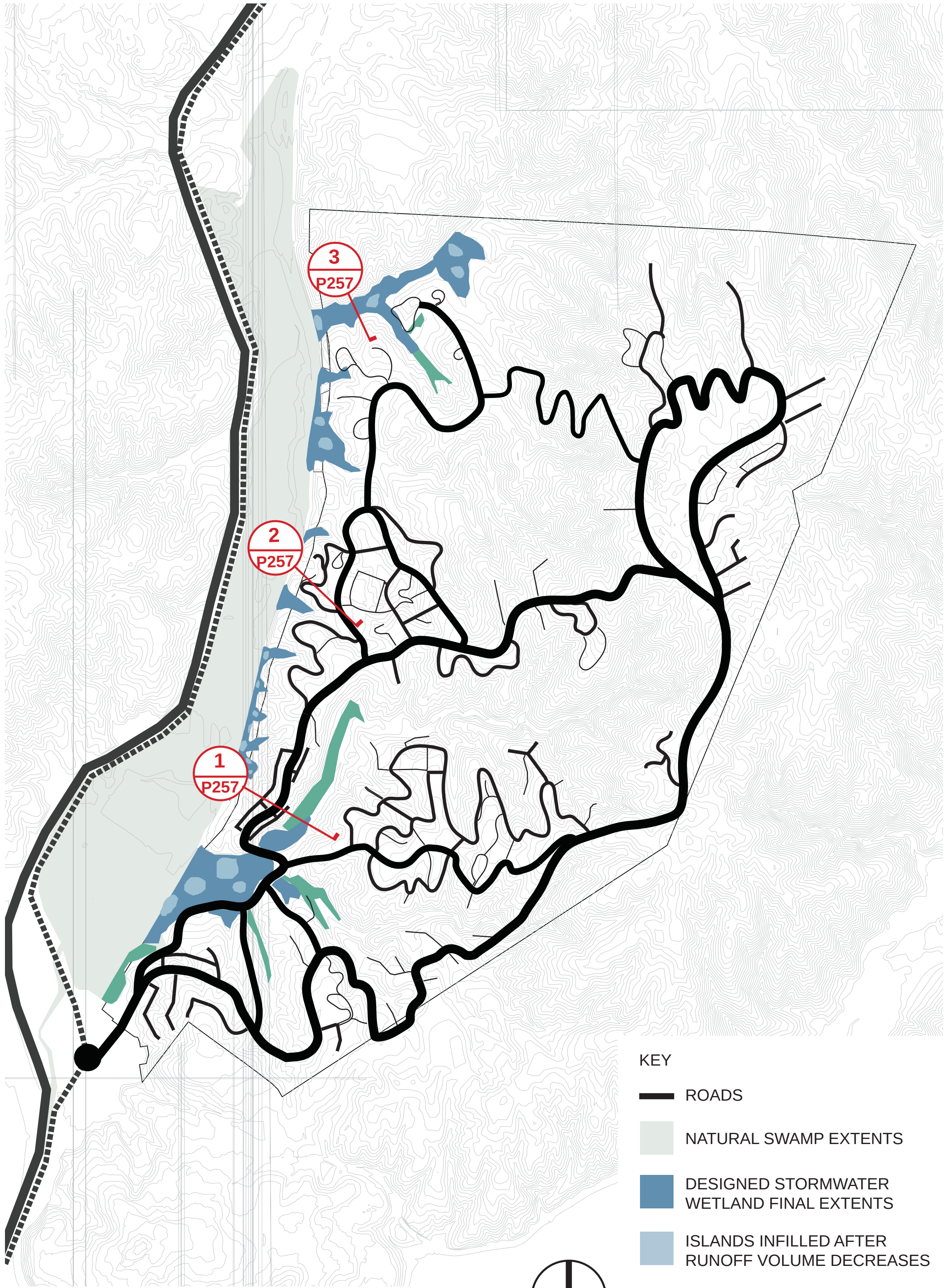

Figure 221. Proposed Wetland Location Concept 2

NOT TO SCALE

As sediment bays need emptying, the waste can be used to create islands within the shallower pools that act as bird nesting habitats.

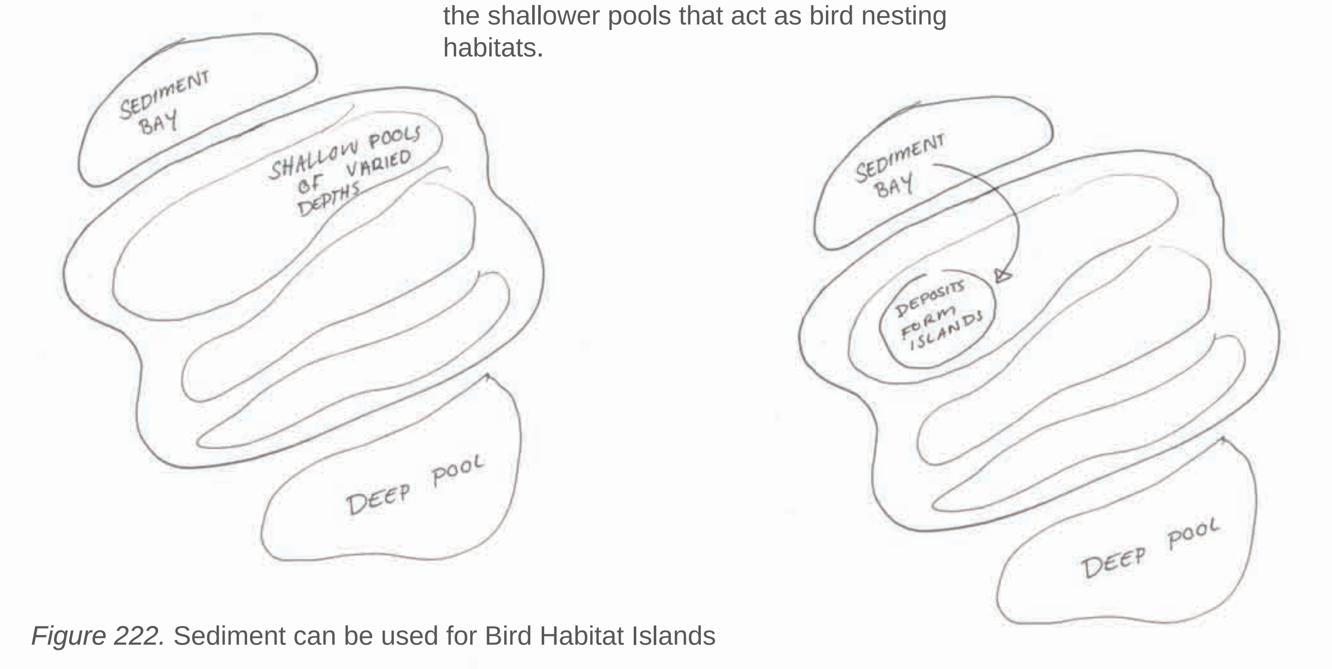

Figure 222. Sediment can be used for Bird Habitat Islands

The highway currently cuts off water flow between Taupo Swamp and my site. In order to create a connection between the two, sections of the highway can be removed to allow water flow while other sections can be repurposed for habitat islands.

Some of these islands could be accessible via boardwalks.

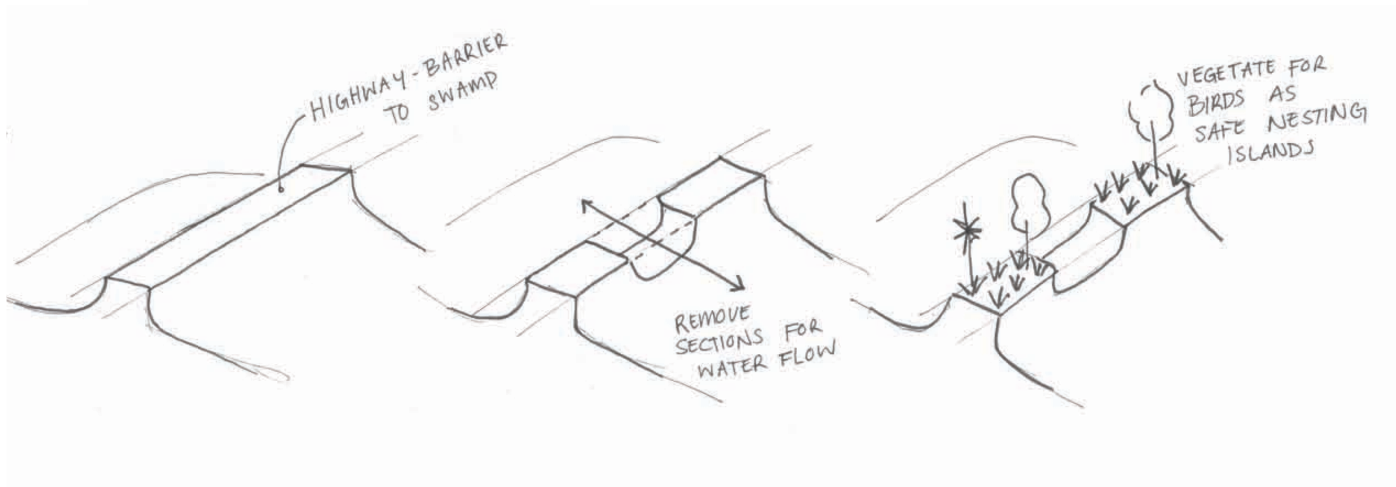

Figure 223. Highway Removed for Water Flow

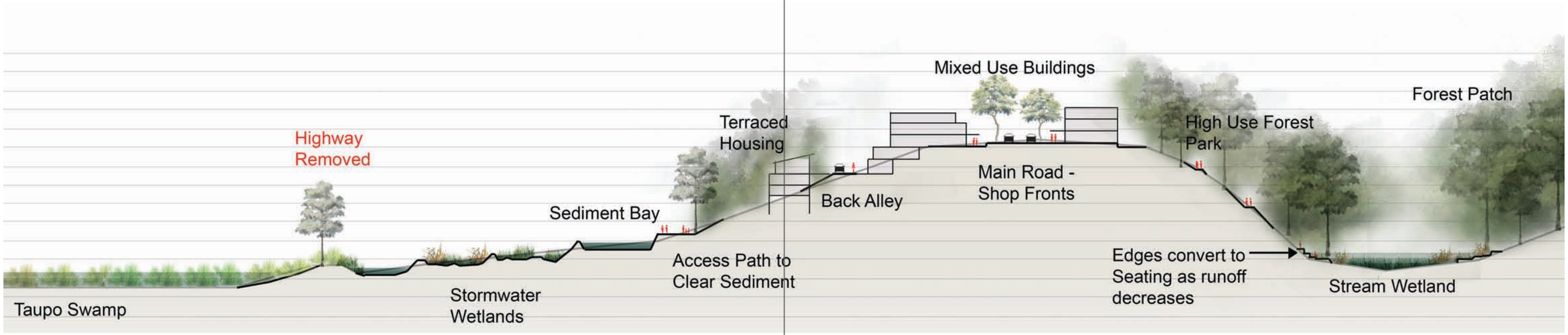

Figure 224. Section 1. Relationship Between Stormwater Wetlands and Town Centre

SCALE 1:1000

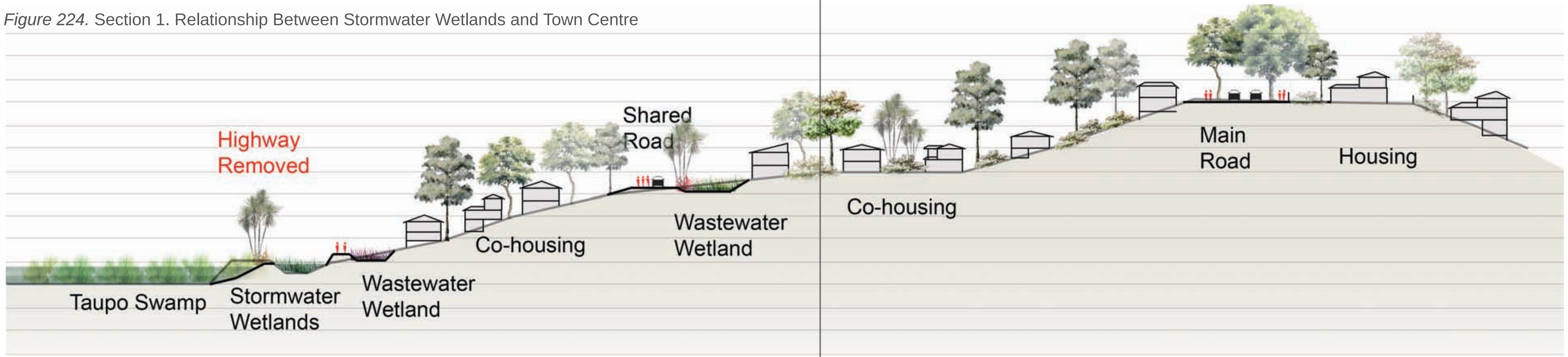

Figure 225. Section 2. Relationship between Stormwater Wetlands and Co-Housing

SCALE 1:1000

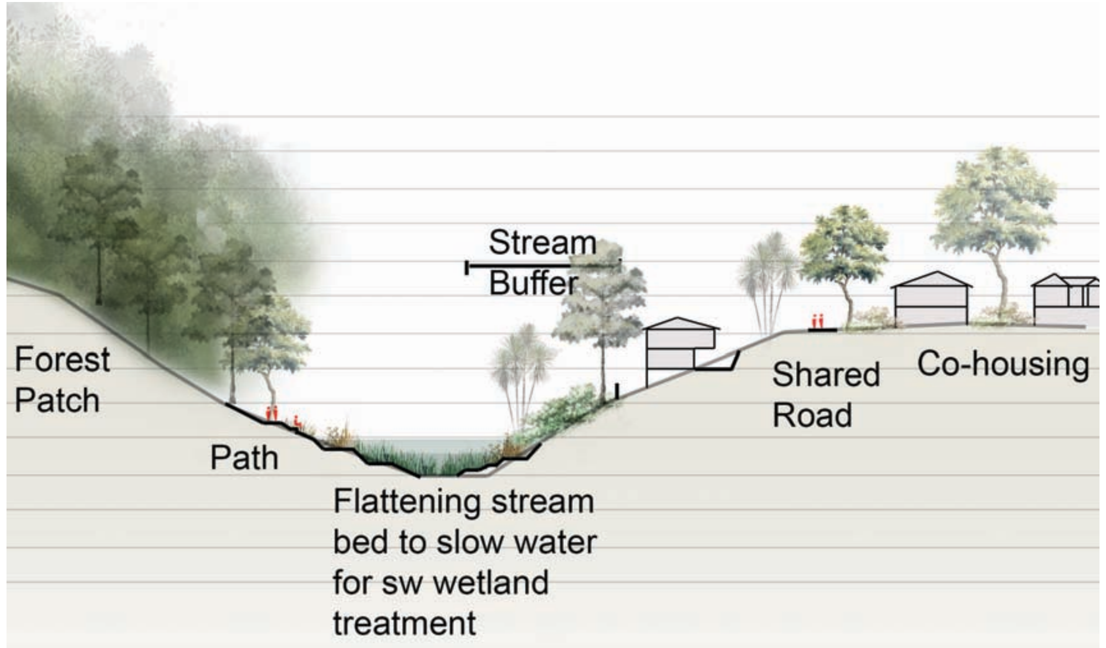

Figure 226. Section 3. Streams as Stormwater Wetland

SCALE 1:1000

STRATEGIES FOR SAFE FISH PASSAGE

Occasionally stream paths will need to be controlled for road crossings or housing. At these points, fish-friendly culverts should be implemented that maintain (or mimic) a naturalised stream base and velocity that allows for safe passage for fish to travel both up and down stream.

THIS IMAGE IS UNAVAILABLE DUE TO COPYRIGHT.

Figure 227. Fish Friendly Stream Crossing.

National Institute of Water & Atmospheric Research Ltd. (2018). *New Zealand Fish Passage Guidelines.* Retrieved from https://niwa.co.nz/static/web/freshwater-and-estuaries/NZ-FishPassageGuidelines-upto4m-NIWA-DOC-NZFPAG.pdf

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Figure 228. Fish Barrier.

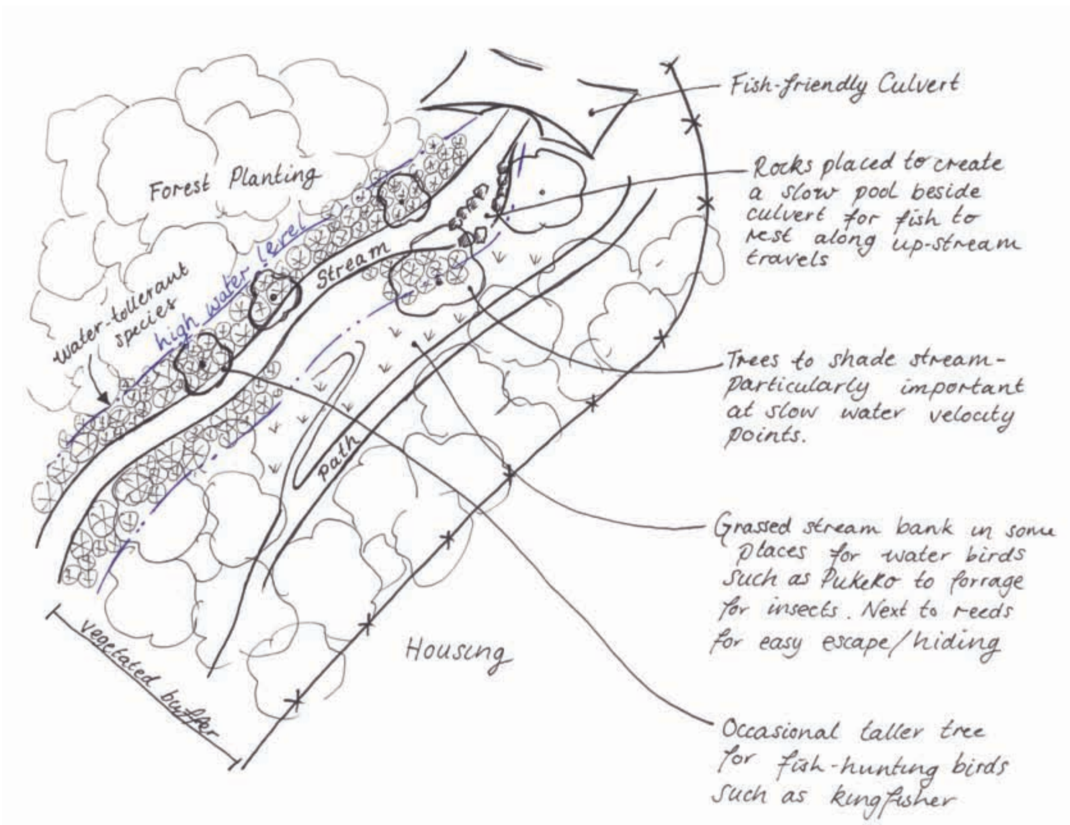

Figure 229. Example of a Fish-Friendly Stream Design

POWER STRATEGIES

Around 80% of New Zealand's electricity currently comes from renewable resources (Stephenson, 2020), with the Government aiming for 100% renewable energy by 2035 (Woods, 2019).

With this in mind, there seems little need to aim for an off-grid infrastructure system, however there is potential for renewable resources to be implemented to the design that lessen demand on the grid.

Renewable growth is expected to mainly come from wind and solar generation as these are the most affordable options for electricity use (Stephenson, 2020).

Solar panels can be placed on most houses as they have been located for maximum yearly sunlight.

Wind turbines are unsuitable for cohabitation through the risk of bird strike, however future implementation of emerging technologies such as windbelts could use wind energy in a bird-friendly way. These would likely be implemented in the lookout park at the north-east of the site.

THIS IMAGE IS UNAVAILABLE DUE TO COPYRIGHT.

Figure 230. Humdinger Windbelt

Wolt: An Innovative Project to Harness Wind Energy in Vineyards. (n.d.). Retrieved From https://ecofriend.com/wolt-innovative-project-harness-wind-energy-vineyards.html

FOREST REGENERATION PHASING

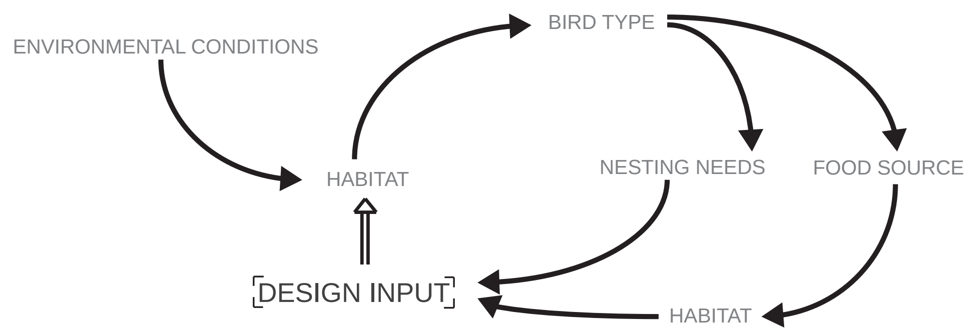

Figure 231. The Role of Design in Habitat Creation

Figure 232. Forest Regeneration Phase 1

Refer to chapter 7.1 species lists:
Wetland
Riverine
Grassland
Urban

Figure 233. Forest Regeneration Phase 2

Refer to chapter 7.1 species lists:
Wetland
Riverine
Grassland
Scrubland
Urban

NOT TO SCALE

Figure 234. Forest Regeneration Phase 3

Refer to chapter 7.1 species lists:
Wetland
Riverine
Scrubland
Forest
Urban

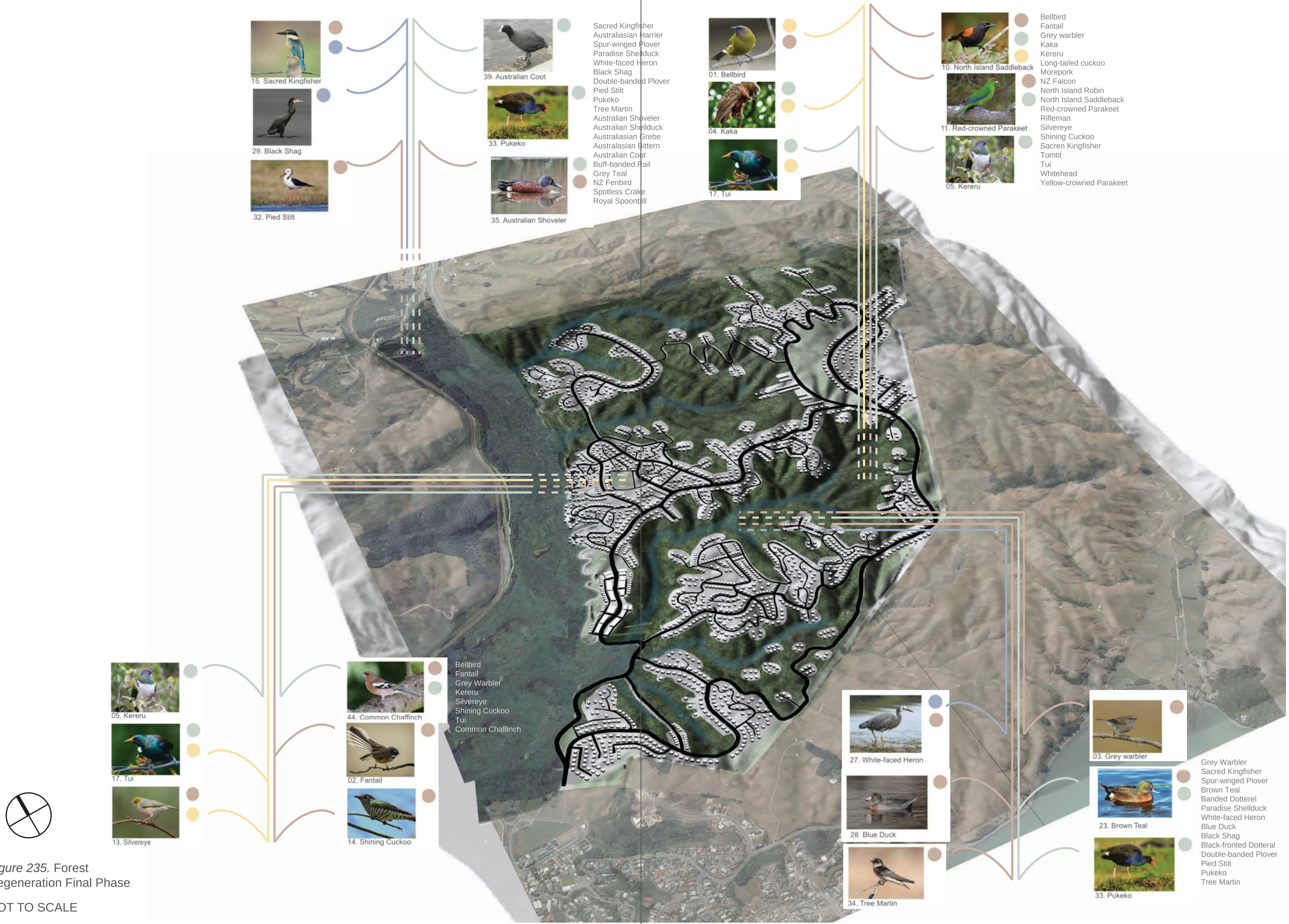

Figure 235. Forest Regeneration Final Phase

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PHASING OUTLINE

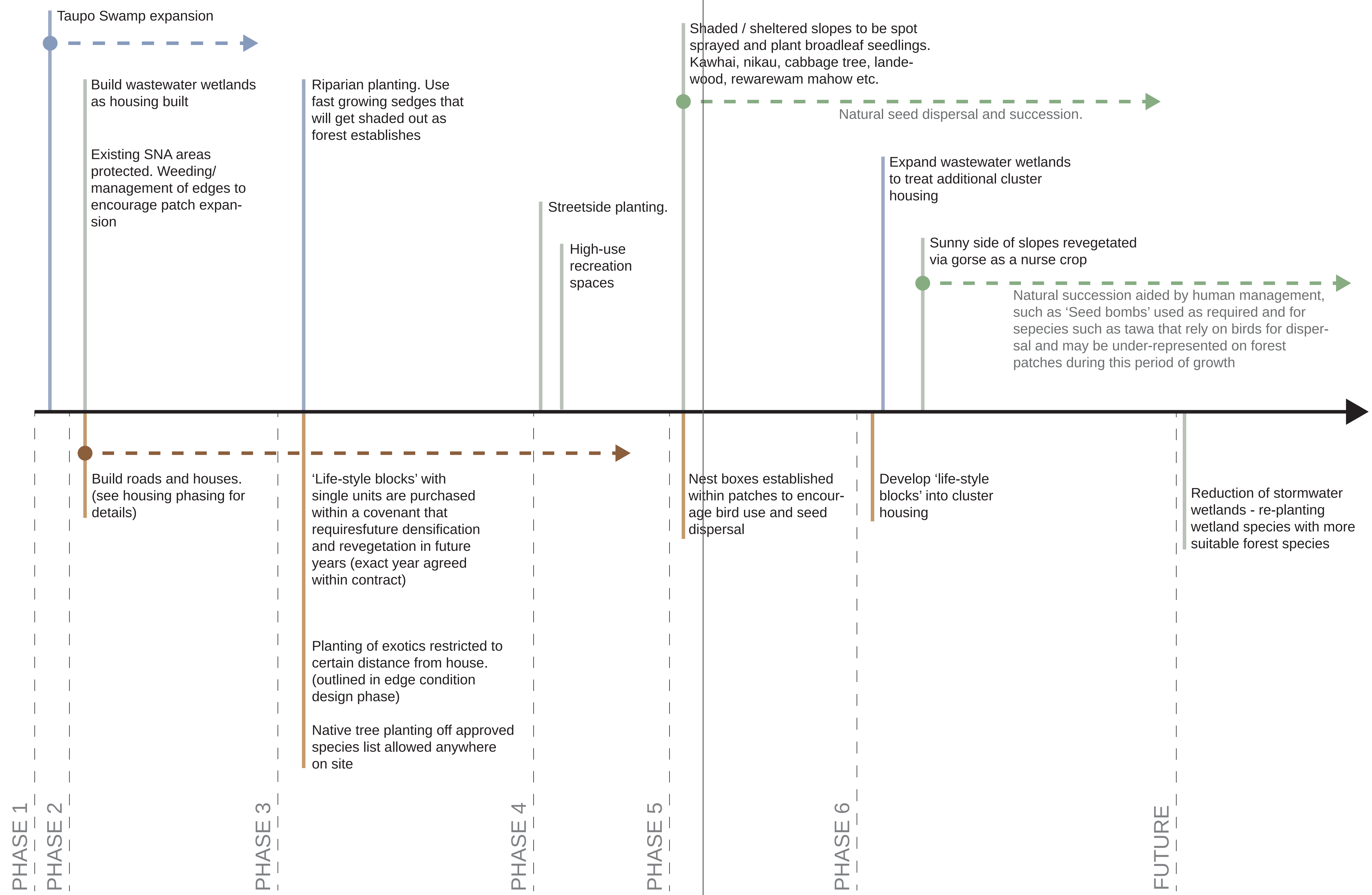


Figure 236. Phasing Outline

ECOSYSTEM PHASING DIAGRAMS

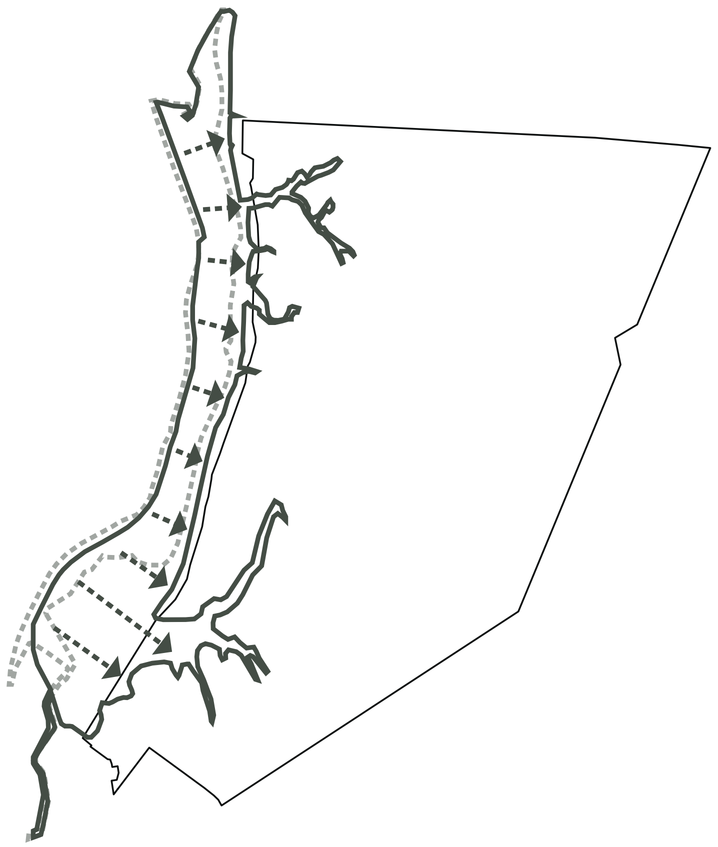


Figure 237. Phase 1 - Taupo Swamp Expansion

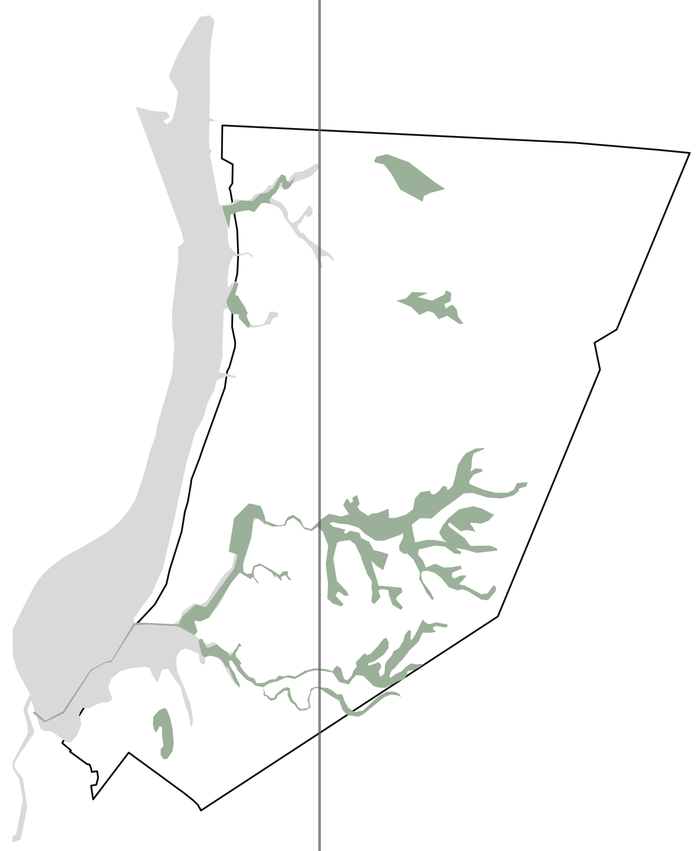


Figure 238. Phase 2 – Protection of Existing SNA Areas During Housing Construction

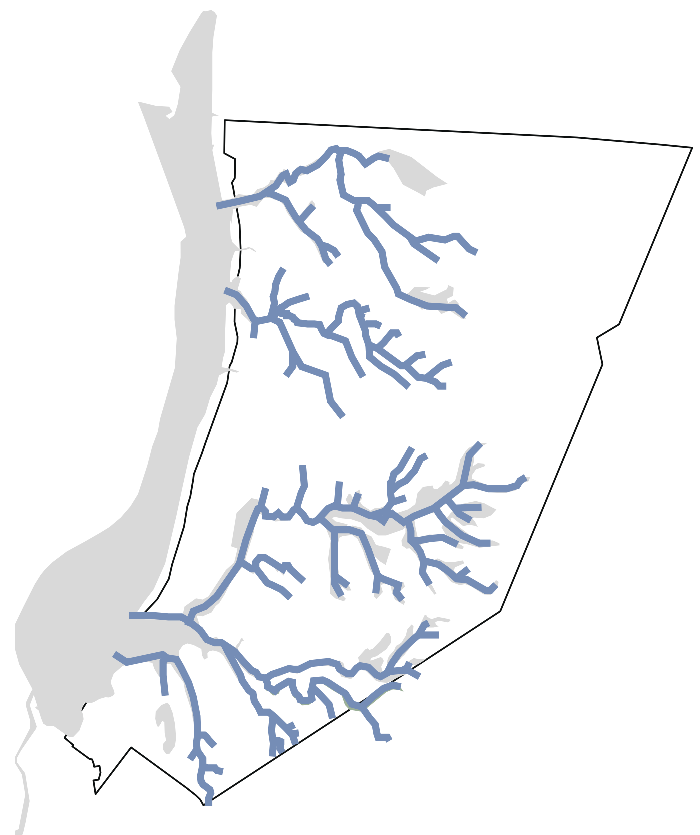


Figure 239. Phase 3 – Riparian Planting to Protect Waterways

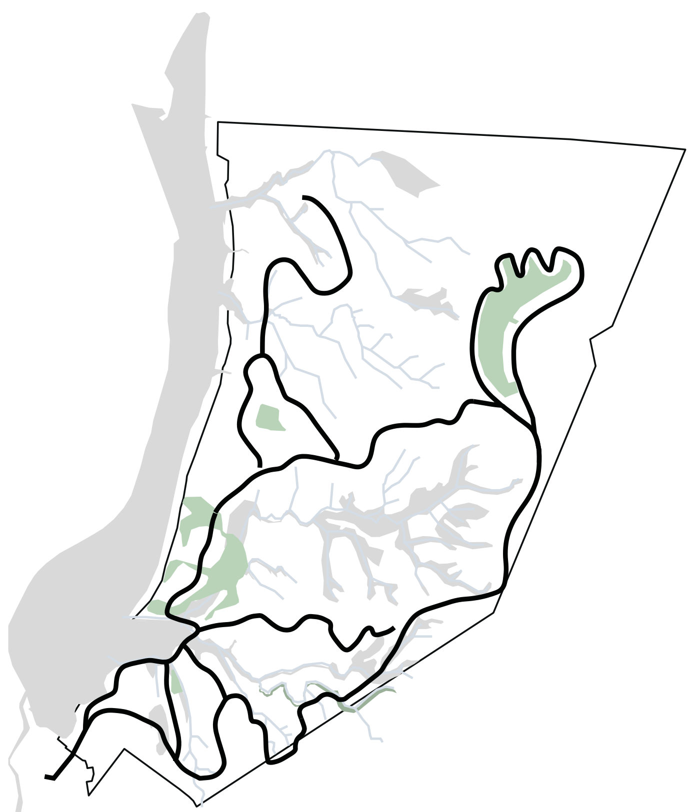


Figure 240. Phase 4 – Roadside Planting. Key Public Space Planting

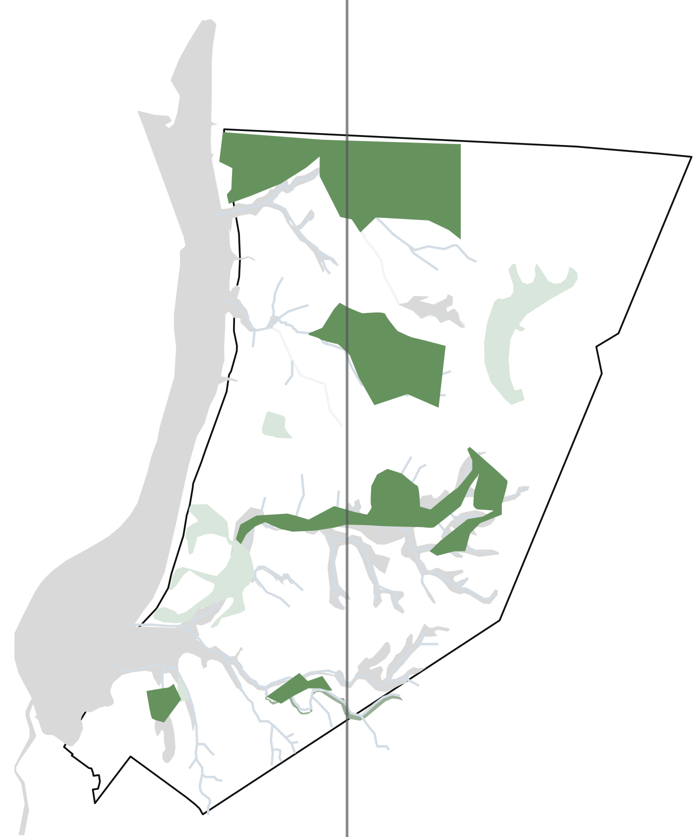
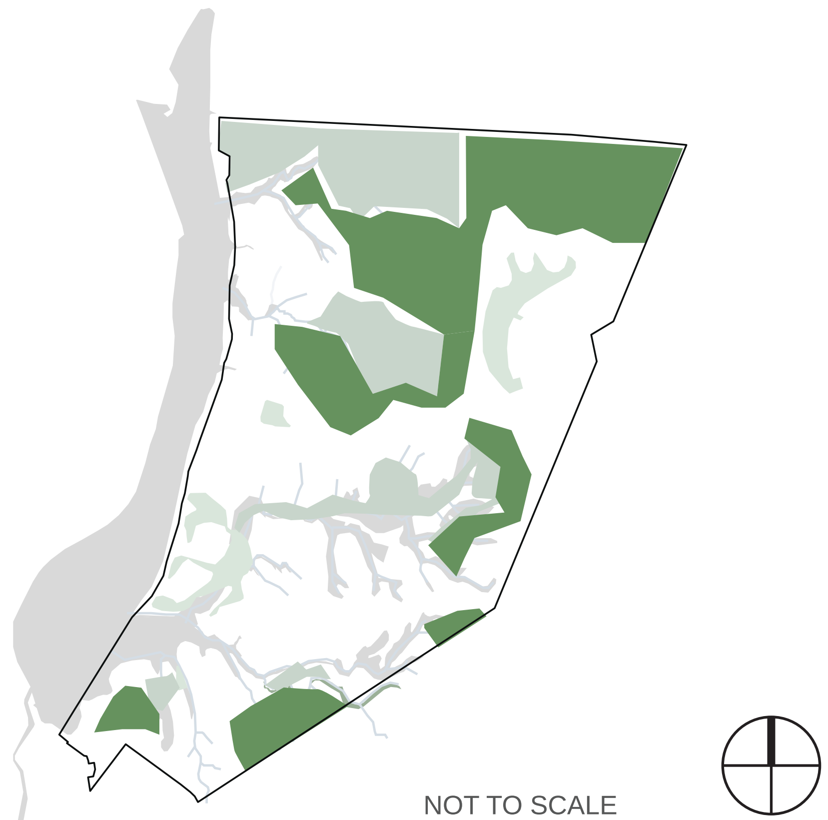
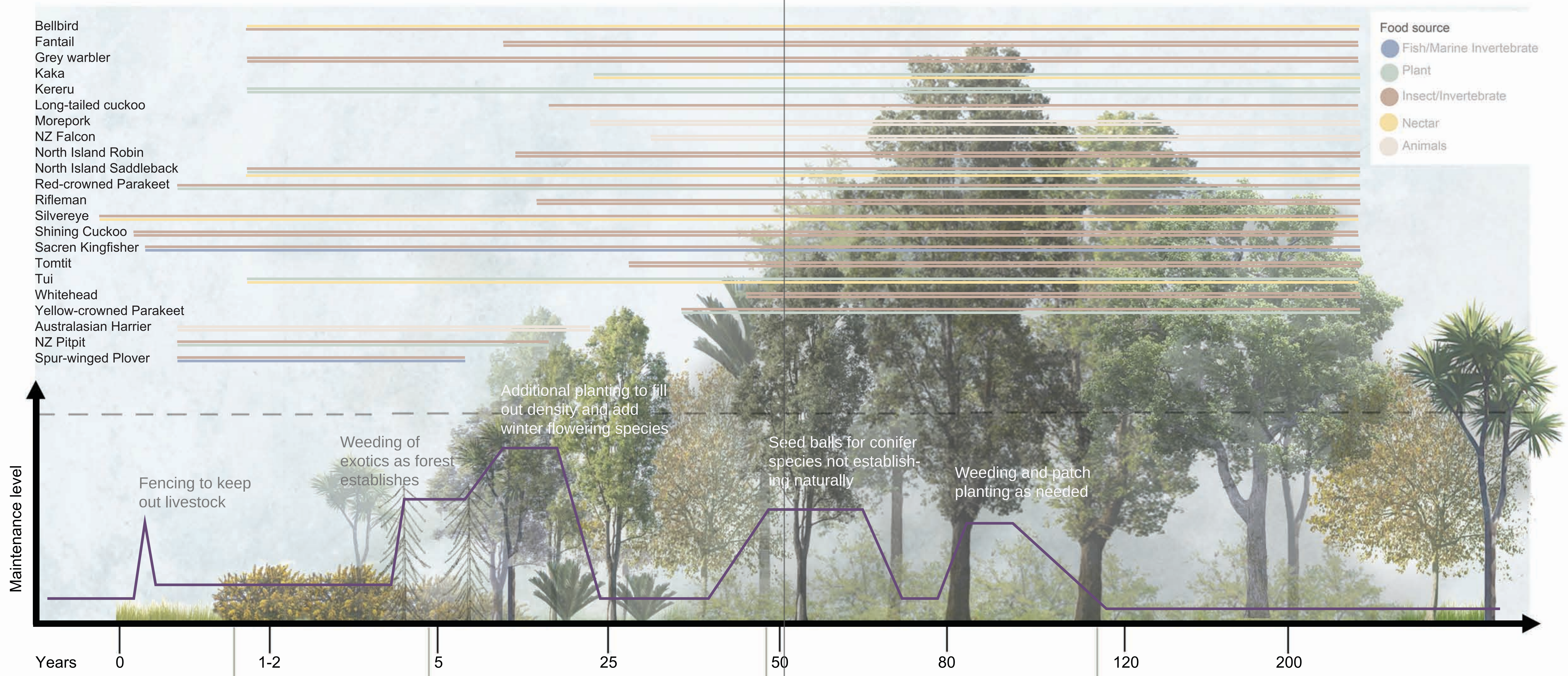


Figure 241. Phase 5 – Sheltered Areas Revegetated Via Spot Spray and Seedling Transplantation



NOT TO SCALE

Figure 242. Phase 6 – Revegetate Lifestyle Block Sections Through Gorse, Natural Seed Dispersal and Seed Balls as Required



Current - exotic grass

Gorse as nurse crop

Additional plant species

Gorse - Ulex europaeus

Early establishing broadleaf Gorse shaded out

Existing SNA species

Manuka - Leptospermum scoparium
Kanuka - Kunzea ericoides
Karamu - Coprosma robusta
Taupata - Coprosma repens
Muehlenbeckia australis
Kohekohe
Kaikomako - Pennantia corymbosa
Tītoki - Alectryon excelsus
Lancewood - Pseudopanax crassifolius
Karaka - Corynocarpus laevigatus
Kōhūhū - Pittosporum tenuifolium
Coprosma areolata
Wharangi - Melicope ternate
Mahoe - Melicytus ramiflorus

Additional plant species

Kowhai - Sophora tetraptera
Nikau - Rhopalostylis sapida
Karo - Pittosporum crassifolium
Maupo - Myrsine australis
Puriri - Vitex lucens
Akeake - Dodonaea viscosa
Cabbage tree - Cordyline australis
Horopito - Pseudowintera colorata
Wineberry - Aristotelia serrata
Koromiko - Hebe stricta

Conifers establishing

Existing SNA species

Kanuka - Kunzea ericoides
Kiokio - Parablechnum procerum
Kohekohe
Kaikomako - Pennantia corymbosa
Tītoki - Alectryon excelsus
Lancewood - Pseudopanax crassifolius
Karaka - Corynocarpus laevigatus
Kōhūhū - Pittosporum tenuifolium
Wharangi - Melicope ternate
Black tree fern - Cyathea medullaris
Mahoe - Melicytus ramiflorus

Additional plant species

Additional plants determined by the success of species naturally regenerat-ing. Likely need additional conifer planting due to the need for bird dispersal and current reduction in keystone species such as Kereru

Transition into mature

Existing SNA species

Kahikatea - Dacrycarpus dacrydioides
Tawa - Beilschmiedia tawa
Tōtara - Podocarpus tōtara
Mātai - Prumnopitys taxifolia
Kiokio - Parablechnum procerum
Kohekohe
Kaikomako - Pennantia corymbosa
Tītoki - Alectryon excelsus
Lancewood - Pseudopanax crassifolius
Karaka - Corynocarpus laevigatus
Kōhūhū - Pittosporum tenuifolium
Wharangi - Melicope ternate
Black tree fern - Cyathea medullaris
Mahoe - Melicytus ramiflorus

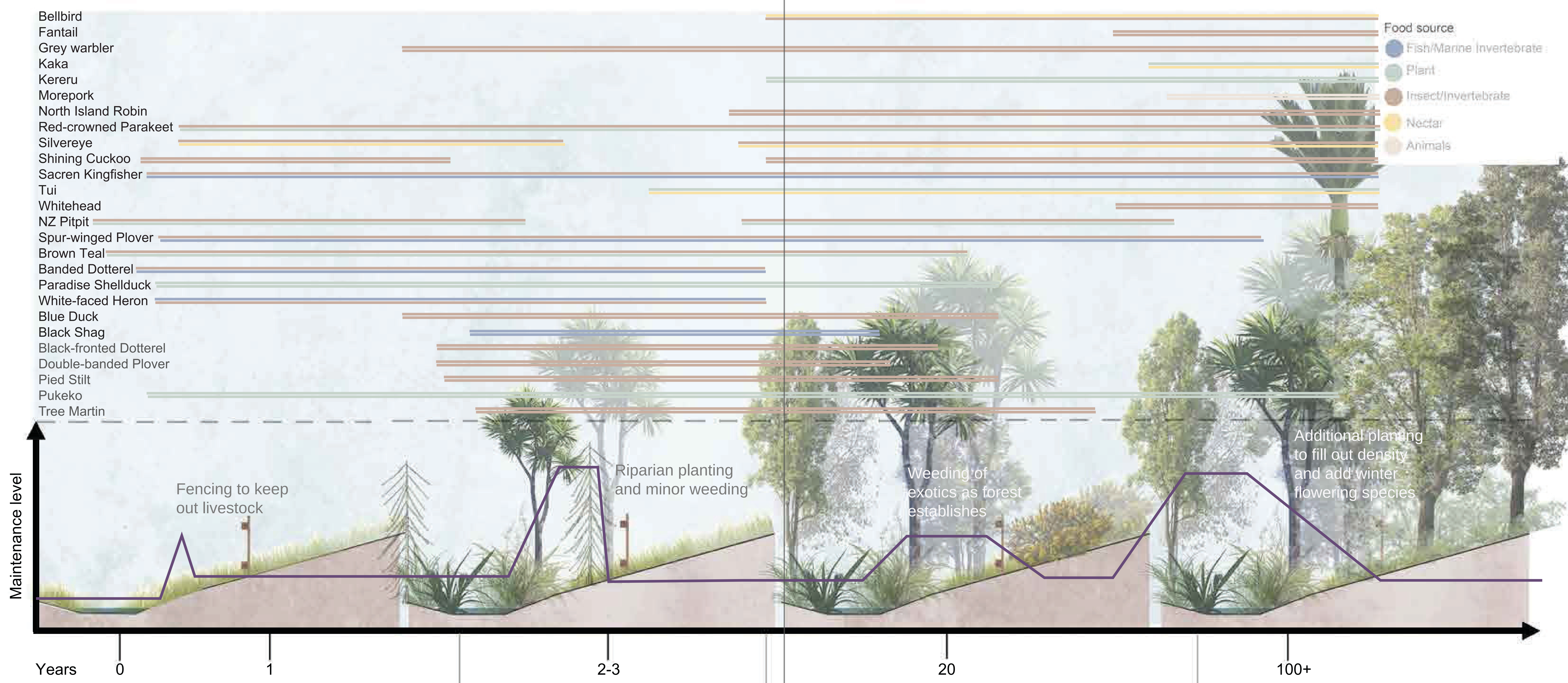
Additional plant species

Additional plants determined by the success of species naturally regenerat-ing. Likely need additional conifer planting due to the need for bird dispersal and current reduction in keystone species such as Kereru

Edge species reflective of establishing broadleaf species

Figure 243. Revegetation Process on Exposed Sites

NOT TO SCALE



Neighbouring land is used as lifestyle blocks

Figure 244. Revegetation Process of Riparian Edges

NOT TO SCALE

Buffer planting streamside

Additional plant species

Carex virgata
Carex apressa
Apodasmia similis
Juncus Edgaraire
Baumea articulata
Carex Secta
Eleocharis sphacelata
Schoenoplectus tabernaemontani
Typha orientalis
Cabbage Tree
Lancewood
Mahoe - Melicope ternate
Phormium Tennax
Raupo - Typha orientalis
Carex dissita

Neighbouring land begins gorse phase of succession (refer forest successsion for more detail)

Existing SNA species

Manuka - Leptospermum scoparium
Kanuka - Kunzea ericoides
Karamu - Coprosma robusta
Taupata - Coprosma repens
Muehlenbeckia australis
Kohekohe
Kaikomako - Pennantia corymbosa
Titoki - Alectryon excelsus
Lancewood - Pseudopanax crassifolius
Karaka - Corynocarpus laevigatus
Kōhūhū - Pittosporum tenuifolium
Coprosma areolata
Wharangi - Melicope ternate
Mahoe - Melicytus ramiflorus

Additional plant species

Kowhai - Sophora tetraptera
Nikau - Rhopalostylis sapida
Karo - Pittosporum crassifolium
Maupo - Myrsine australis
Puriri - Vitex lucens
Akeake - Dodonaea viscosa
Cabbage tree - Cordyline australis
Horopito - Pseudowintera colorata
Wineberry - Aristotelia serrata
Koromiko - Hebe stricta

Neighbouring land transitions into mature forest

Existing SNA species

Kahikatea - Dacrycarpus dacrydioides
Tawa - Beilschmiedia tawa
Tōtara - Podocarpus tōtara
Mātai - Prumnopitys taxifolia
Kiokio - Parablechnum procerum
Kohekohe
Kaikomako - Pennantia corymbosa
Titoki - Alectryon excelsus
Lancewood - Pseudopanax crassifolius
Karaka - Corynocarpus laevigatus
Kōhūhū - Pittosporum tenuifolium
Wharangi - Melicope ternate
Black tree fern - Cyathea medullaris
Mahoe - Melicytus ramiflorus

Additional plant species

Additional plants determined by the success of species naturally regenerating. Likely need additional conifer planting due to the need for bird dispersal and a current reduction in keystone species such as Kereru

VEGETATION SCALE OF SENSITIVITY

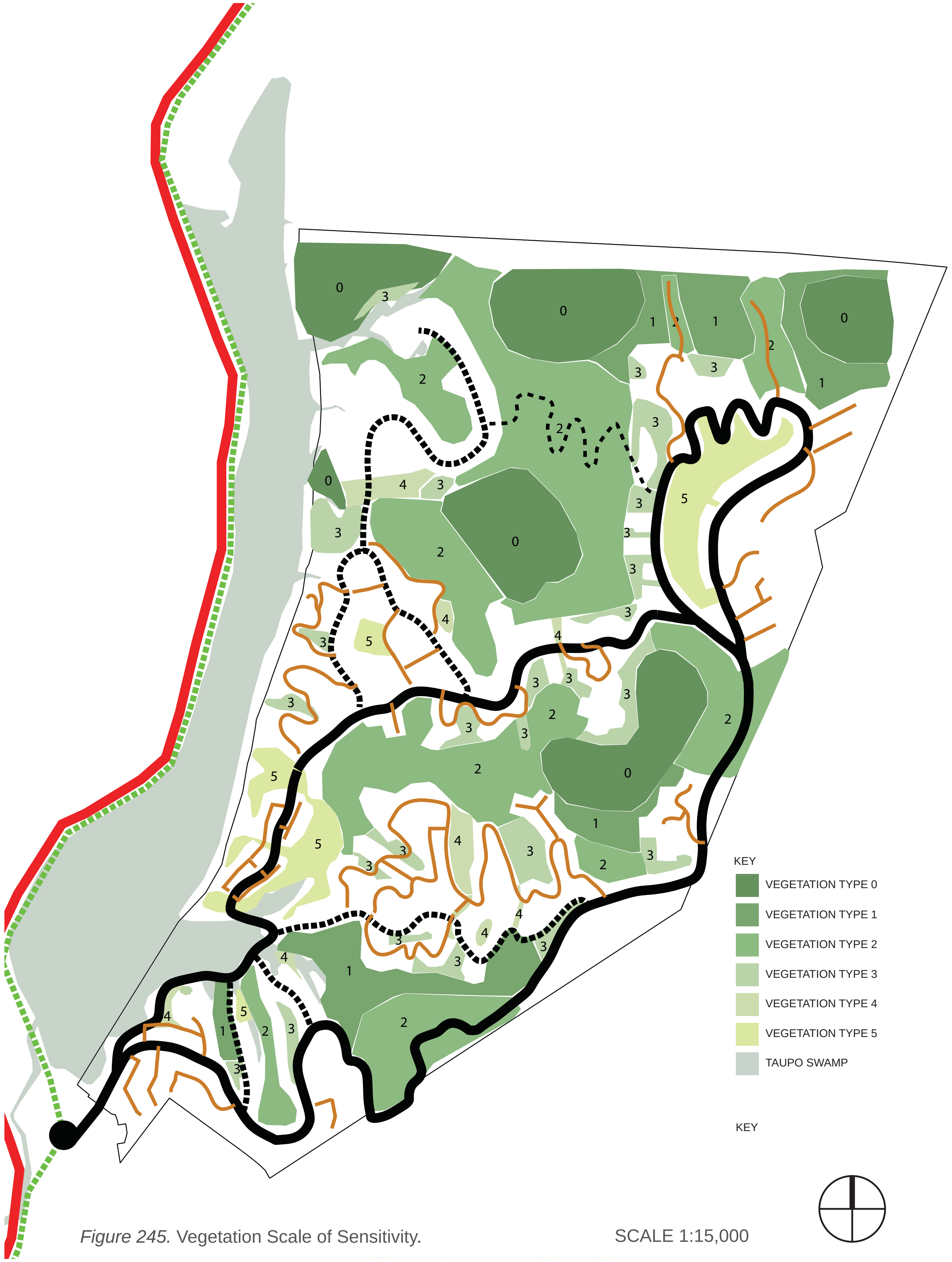


Figure 245. Vegetation Scale of Sensitivity.

SCALE 1:15,000

The scale of sensitivity concept is applied to vegetation patches as a guide to what types of human activity might be suitable in different areas. This approach will improve the suitability of habitat for birds as they will be able to habituate to human activity and depending on their sensitivity level, and inhabit areas that suit their needs. This scale includes areas with no human access at the centre of patches to provide space for nesting.

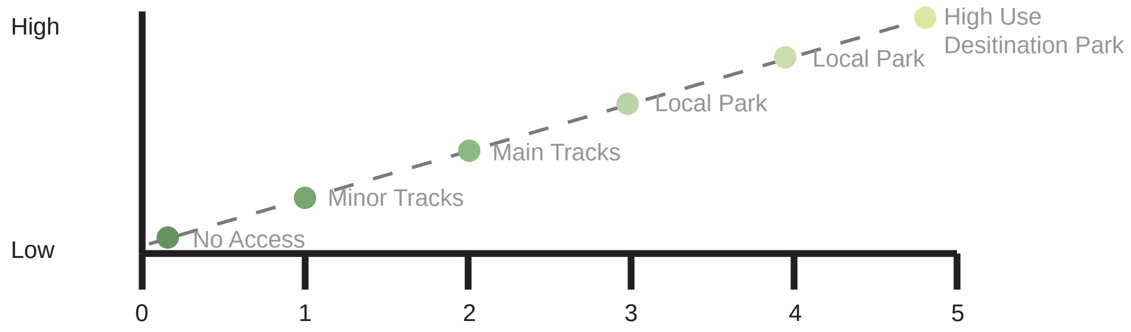


Figure 246. Human Presence

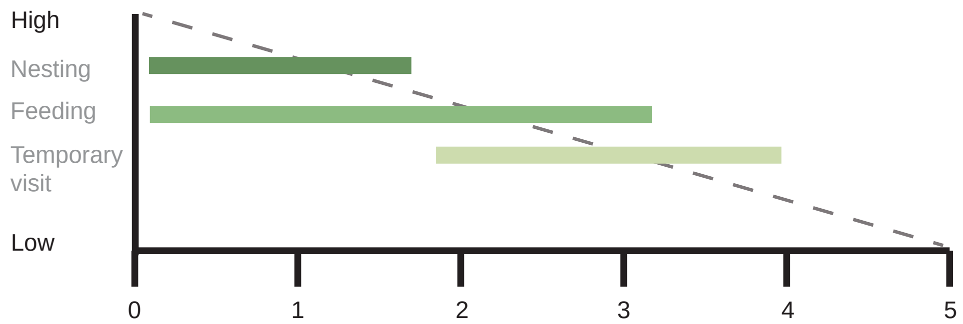


Figure 247. Bird Activity

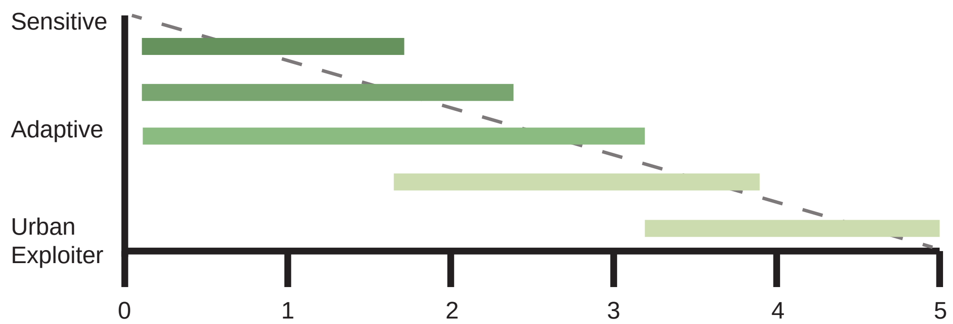


Figure 248. Bird Species Type

VEGETATION TYPES

VISUALISATION OF DIFFERENT GRADIENT USES

THIS IMAGE IS UNAVAILABLE DUE TO COPYRIGHT.

Figure 249. Vegetation Type 0 - Dense Native Forest, No Human Access

New Zealand Forest at Otari Wilson Bush. (n.d.). Retrieved from https://www.alamy.com/stock-photo/native-bush-forest-dense.html

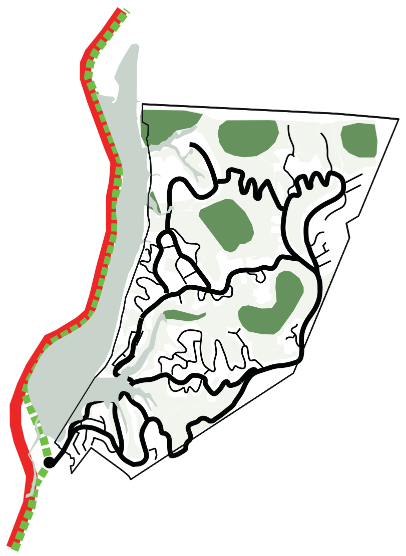


Figure 250. Vegetation Type 1 - Dense Native Forest, Tracks and Small Clearings

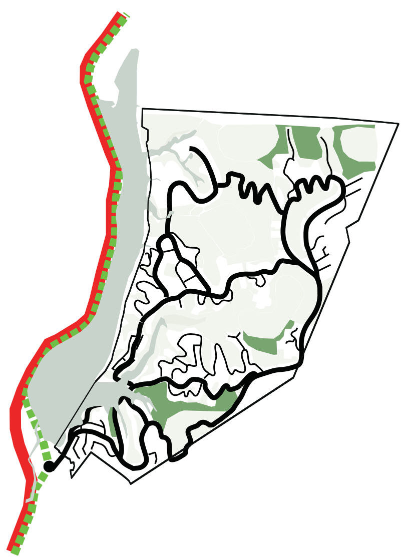


Figure 251. Vegetation Type 2 - Dense Native Forest, Tracks and Clearings for Larger Groups

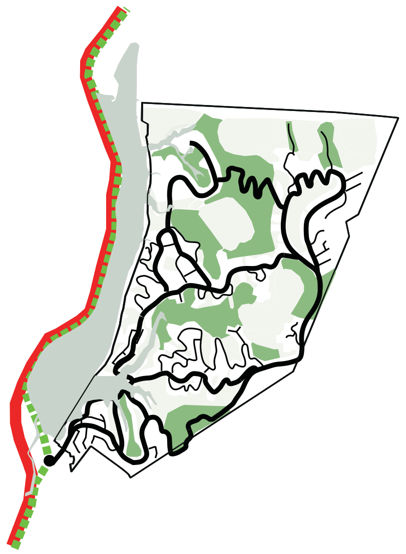


Figure 252. Vegetation Type 3 - Local Parks

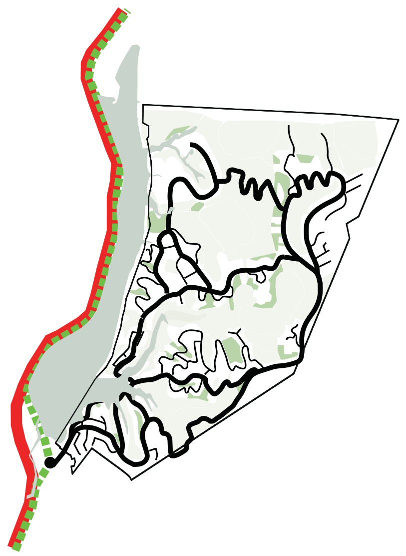


Figure 253. Vegetation Type 4 - Local Parks

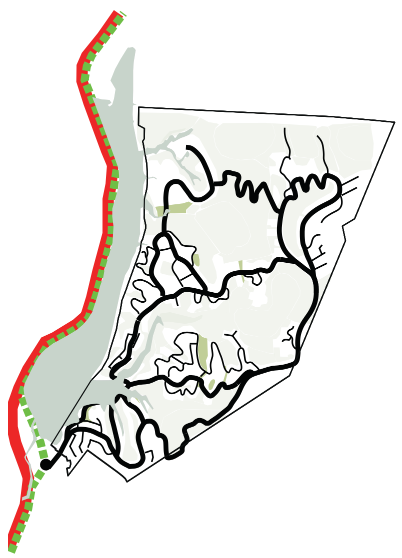
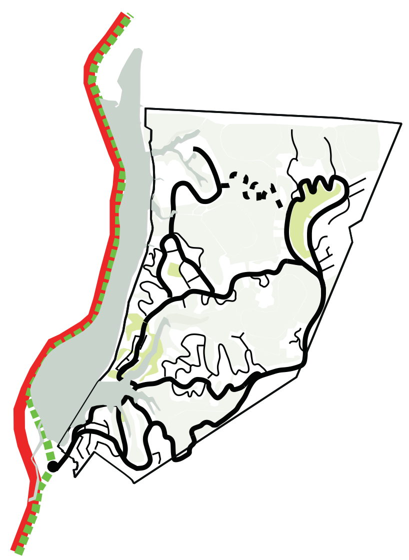


Figure 254. Vegetation Type 5 - High Use Destination Park



PEDESTRIAN CIRCULATION

The path network has been designed to work with the contours to ensure gentle slopes for easy use as well as minimising earth works. The path routes have been located to reflect the sensitivity scale of the vegetation patches. Main routes have wide paths and gentle slopes to encourage use, while others are reserved for walking only or having narrower and steeper paths that lowers the speed and frequency of use, reducing their disturbance impact.

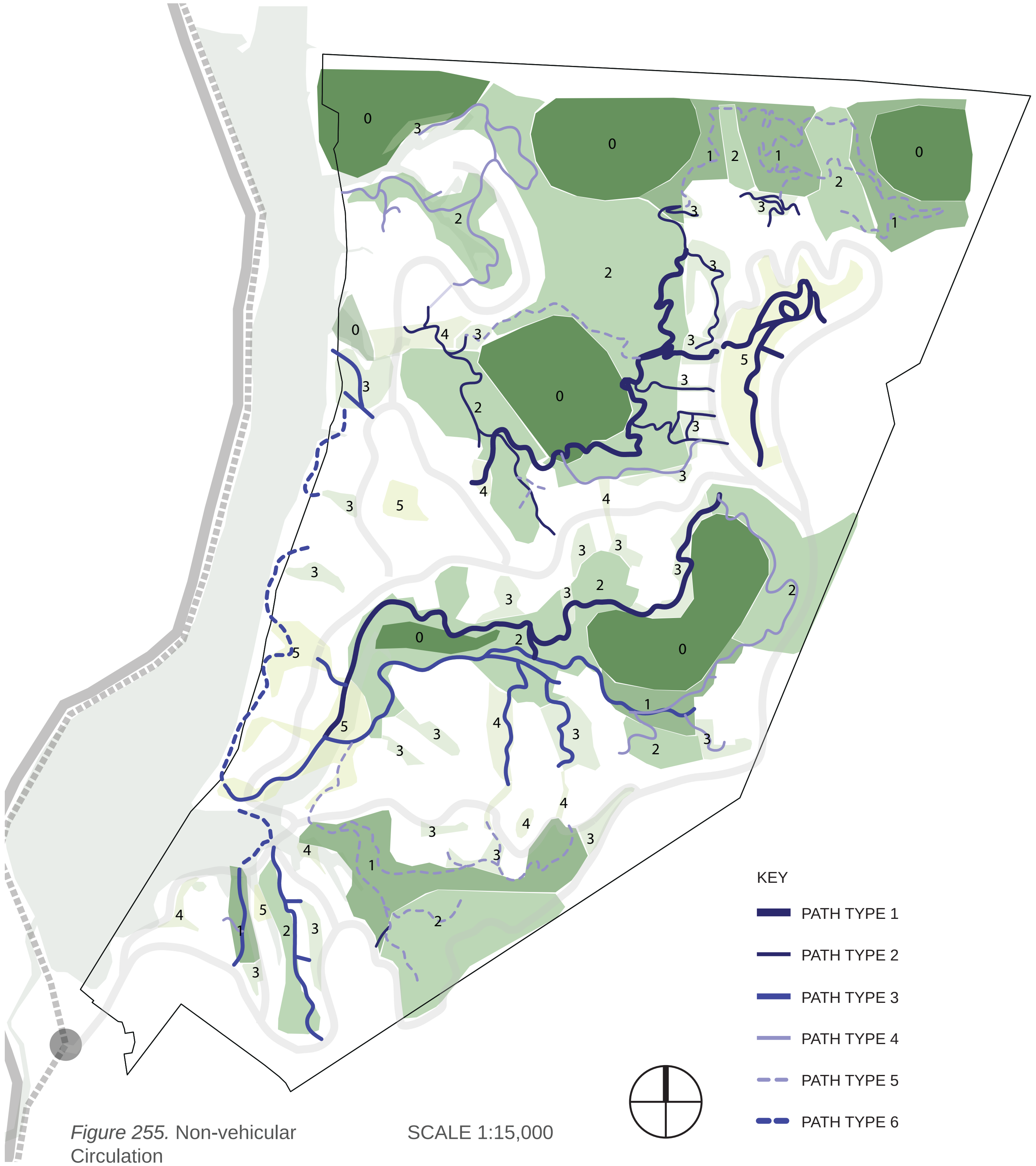


Figure 255. Non-vehicular Circulation

SCALE 1:15,000

This network is intended to be the primary circulation of pedestrians within the site, with roads being used at night when a lack of lighting will make the bush areas unsafe.
The paths are intended to function as both a recreational journey, providing multiple options of looped tracks for a variety of distances and user preferences, as well as a practical way for residents to get around the site.

The tracks all link around a primary loop that joins the highest point of the site – reserved as a high use park space and lookout, down and along the taupo swamp expansion, and back through the main shopping area with a second park and resting space beside one of the streams.

The path network also offers short cuts across the vegetated patches to other housing areas. The paths to the main shopping area have gentler gradients than the road network for comfortable walking.

Many of the paths are shared bike and walking paths to encourage all non-vehicular modes of transport, while others are walking only to minimise disturbance on bird life and offer a more peaceful route for residents. Other tracks prioritise bikes but allow walking. The north-east corner of the site has recreational mountain biking tracks that utilise the steeper slopes.

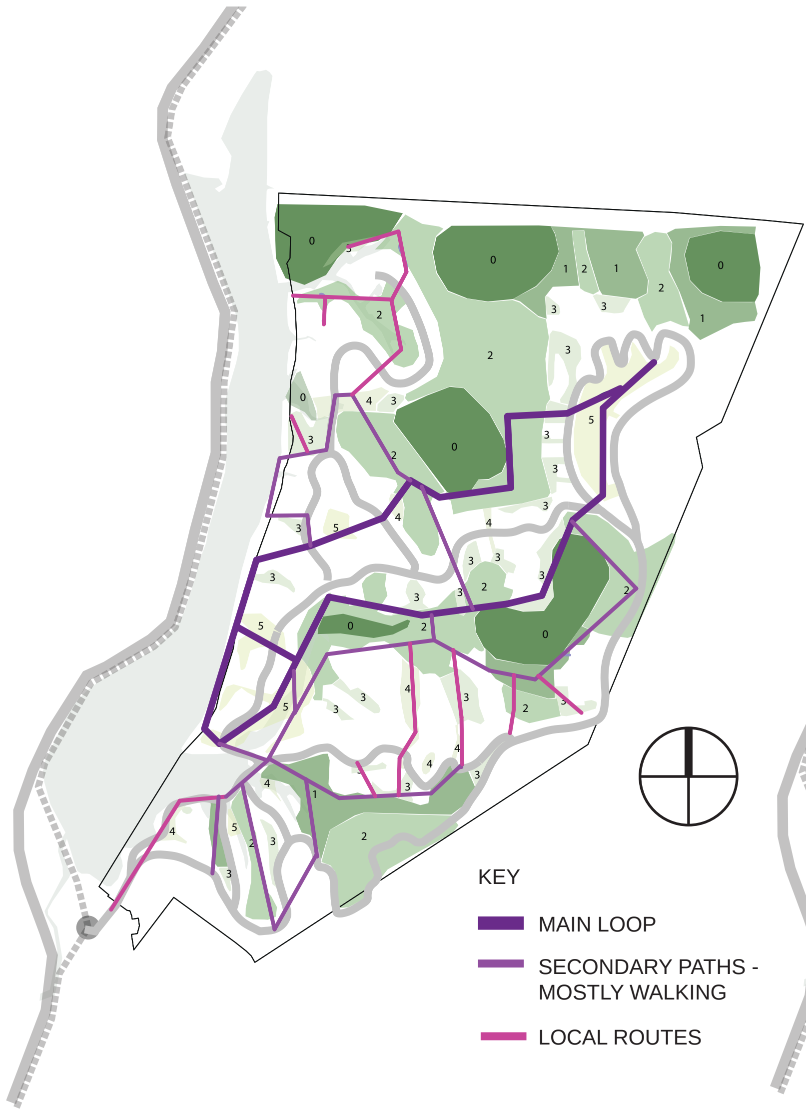


Figure 256. Pedestrian Circulation

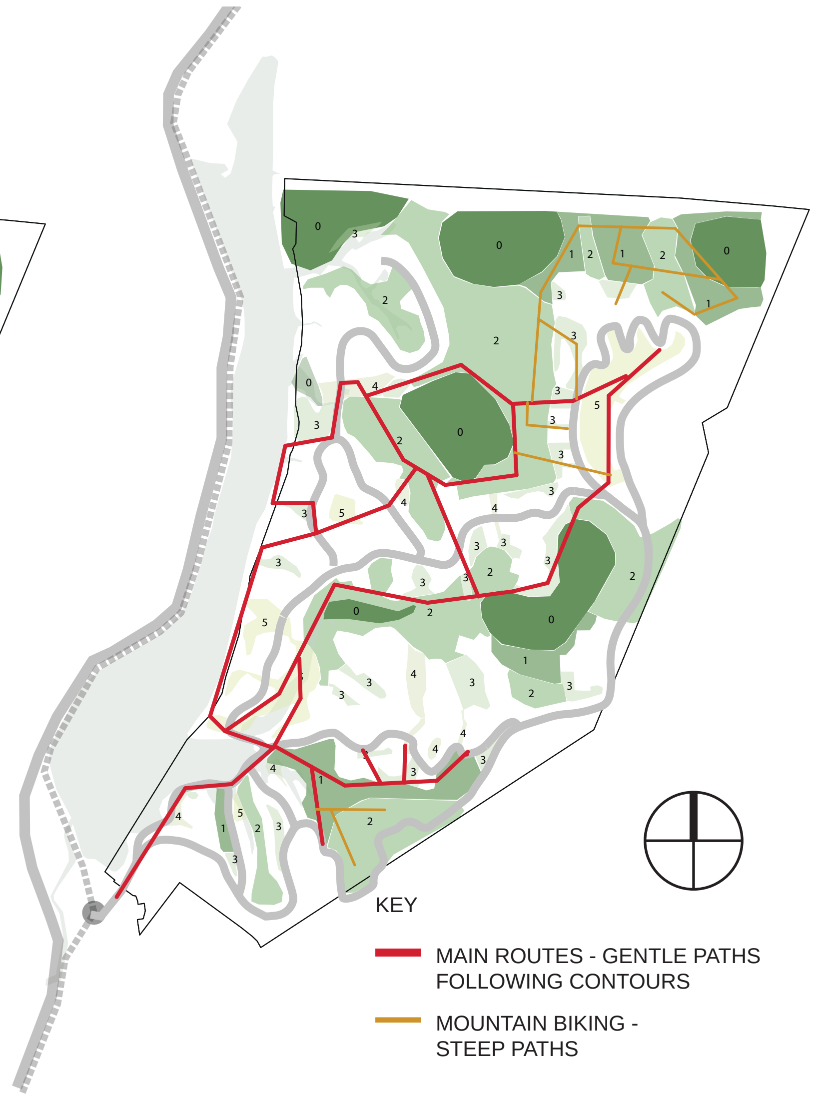


Figure 257. Bicycle Circulation

PEDESTRIAN PATH TYPOLOGIES

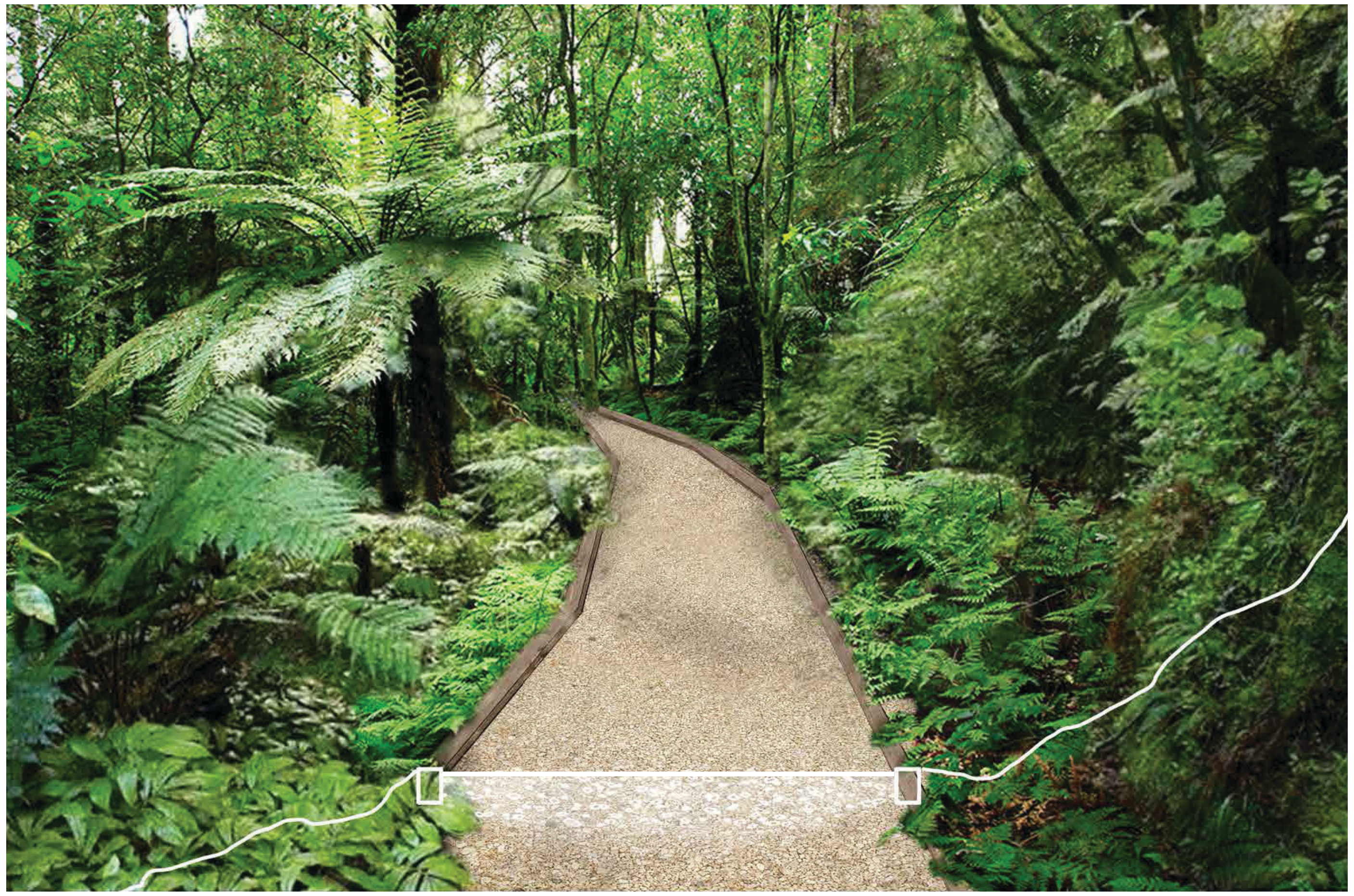


Figure 258. Path Type 1 - Crushed Gravel. 2m Wide. Walking and Cycling

Figure 259. Path Type 2 - Coarse Gravel. 1.5m Wide. Walking and Cycling.

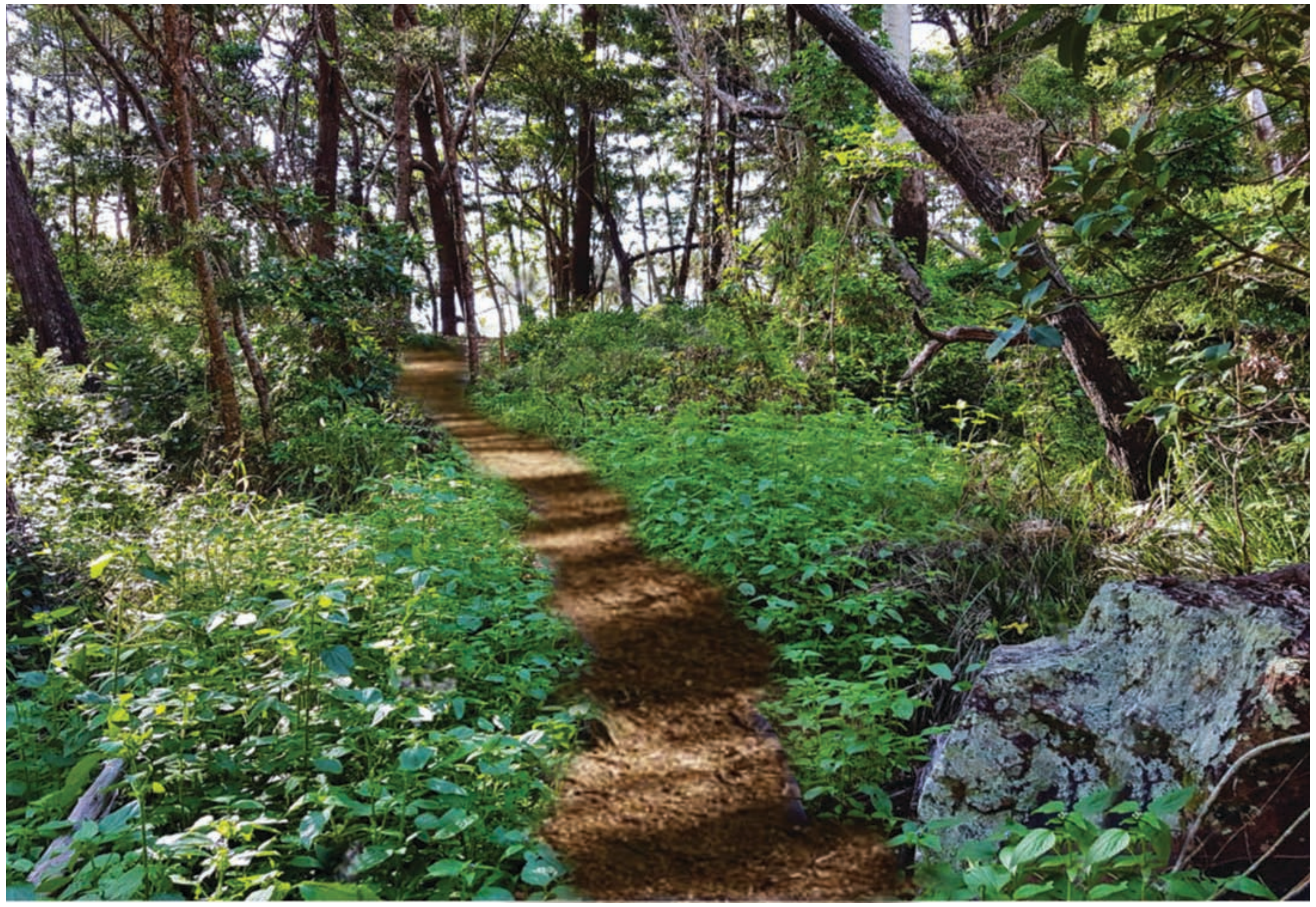


Figure 260. Path Type 3 - Mulch. 1.2m Wide. Walking Only

Figure 261. Path Type 4 - Trodden Dirt. 0.8m Wide. Walking Only.
Path Type 5 - Trodden Dirt. 0.8m Wide. Cycling Priority.

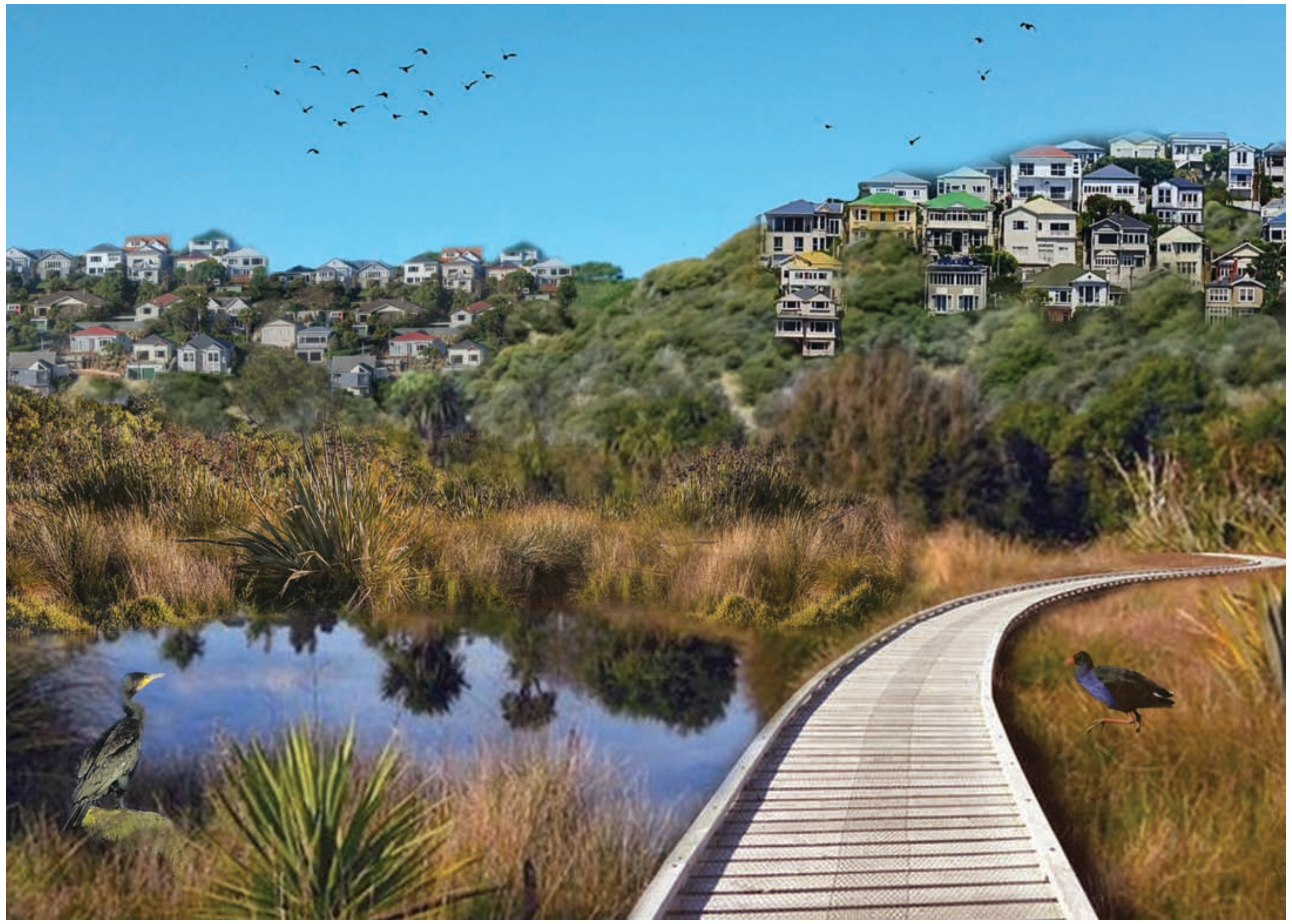


Figure 262. Path Type 6 - Wodden Broadwalk. 2.5m Wide. Walking and Cycling

DESTINATION POINTS

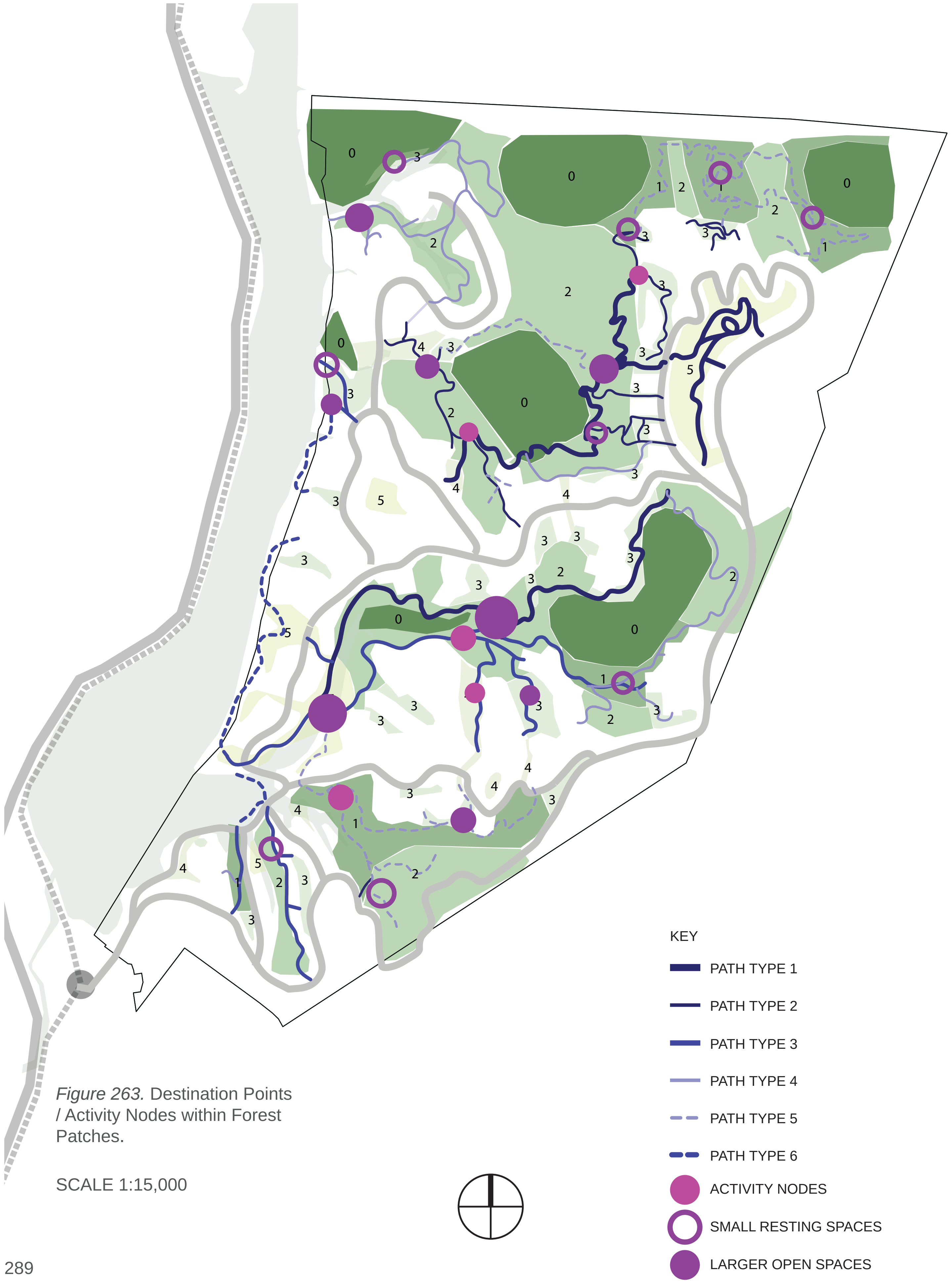


Figure 263. Destination Points / Activity Nodes within Forest Patches.

SCALE 1:15,000

The precedent Kurwaldpark placed a series of open spaces within a dense forest which encouraged people to use the space and enjoy the forest environment. These open spaces were located at intersections of paths so to increase their accessibility.

Destination points/ activity nodes will be located throughout the path network to encourage their use over roads. This will decrease car activity within the site, allowing roads to be narrower, reducing earthworks as well as noise disturbance and pollution.

A range of spaces can be provided, from activity spaces such as playgrounds and community gardens, to small clearings for resting and larger open spaces that provide access to sunlight, and opportunities for larger groups to rest or play. These spaces will reflect the vegetation scale of sensitivity plan.

Detailed design of these spaces is outside the scope of this project, and it would be expected that each space would be designed after the path network is lain out and a detailed/experiential site analysis could be undertaken. The following pages thus offer only loose suggestions of what these spaces might be.

ACTIVITY NODE EXAMPLES

Playgrounds

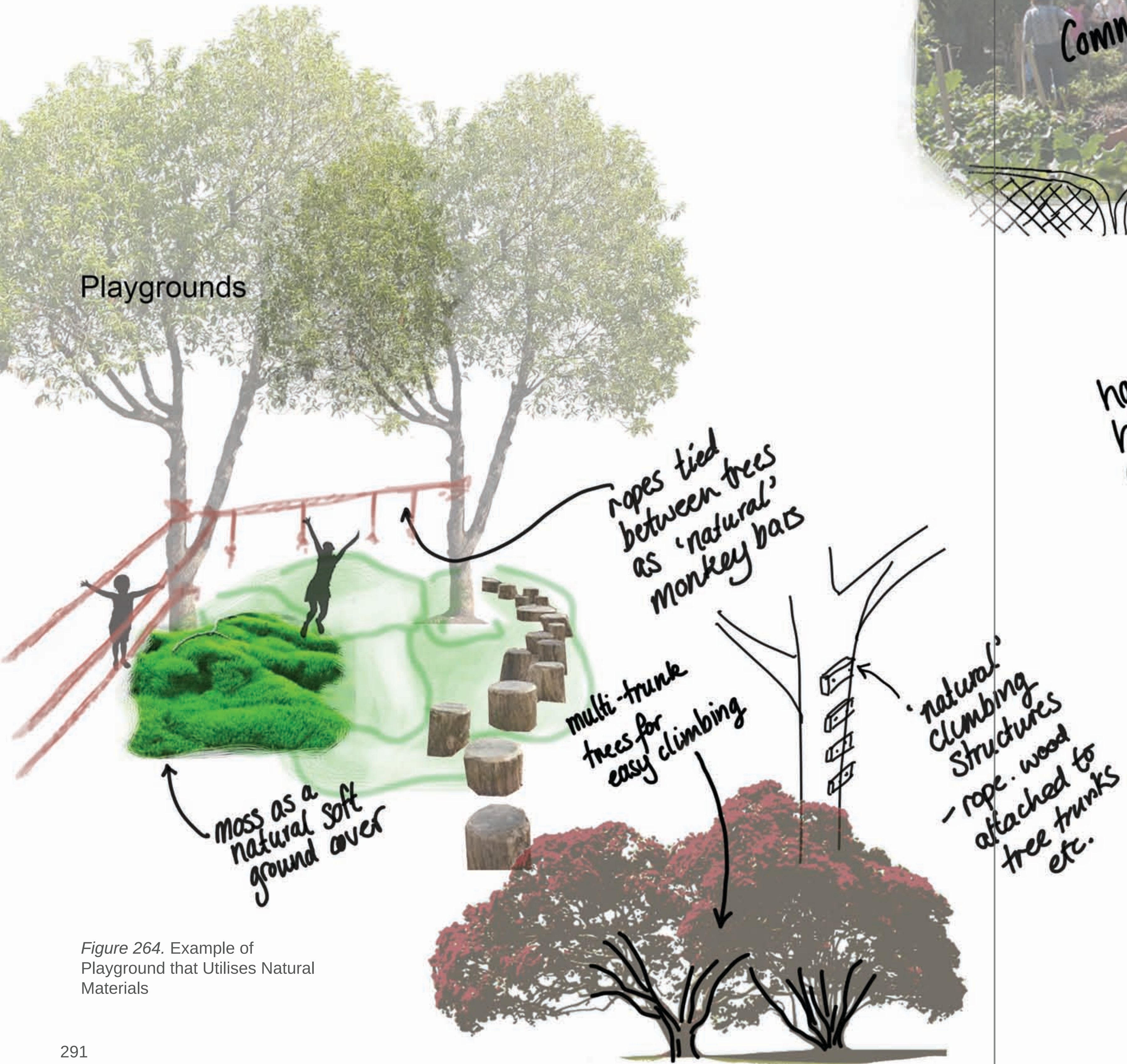


Figure 264. Example of Playground that Utilises Natural Materials

Communtiy Gardens

Figure 265. Example of Community Garden Elements

Figure 266. Trees Thinned to Allow Sunlight

Figure 268. Shelter for Bird Watching.

SMALL RESTING SPACE EXAMPLES

Figure 267. Utilising Viewshafts.

Figure 269. Open Spaces that Encourage Biodiversity Through Winter Food Sources and Dense Understory Planting.

LARGER OPEN SPACE EXAMPLES

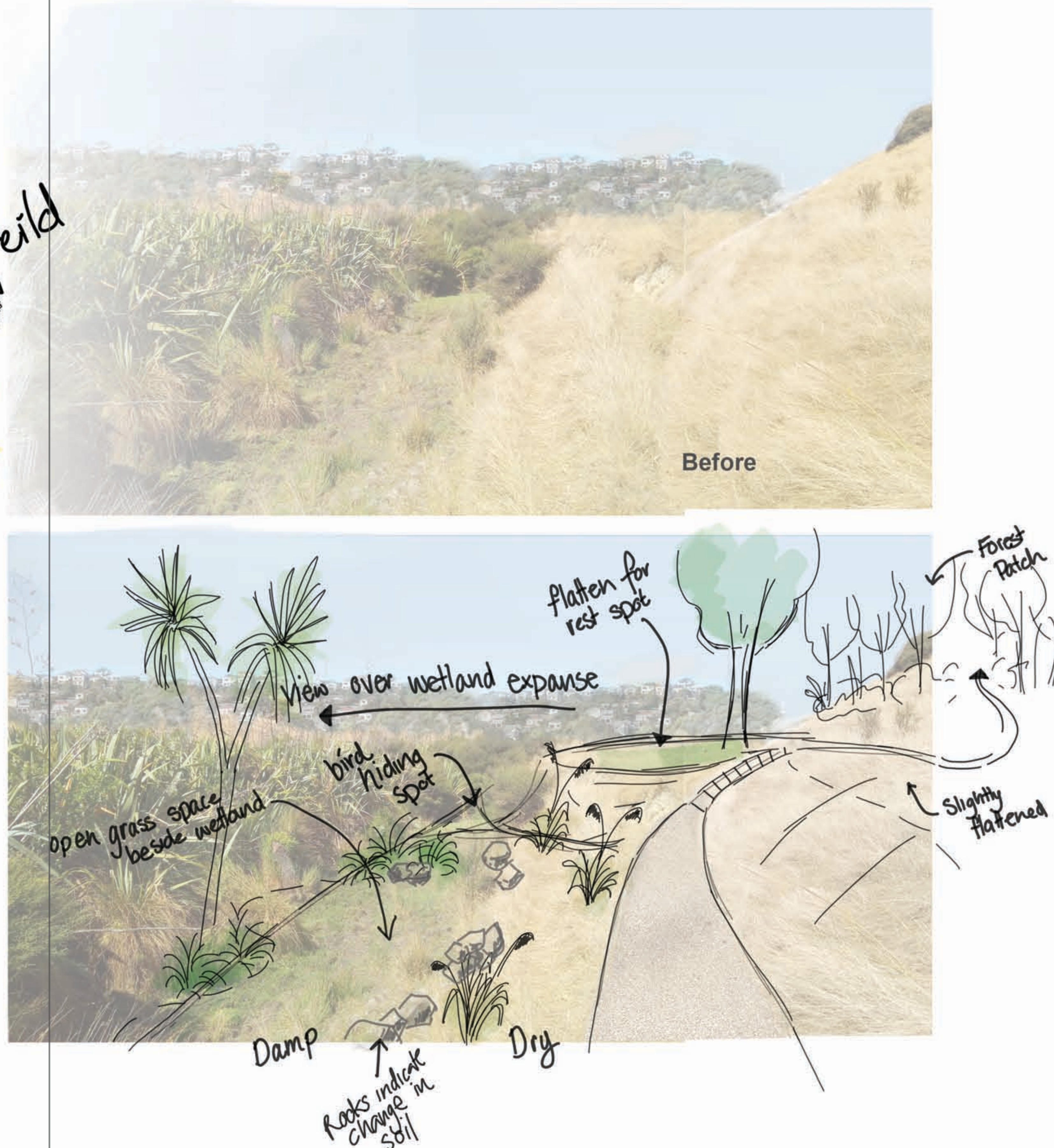


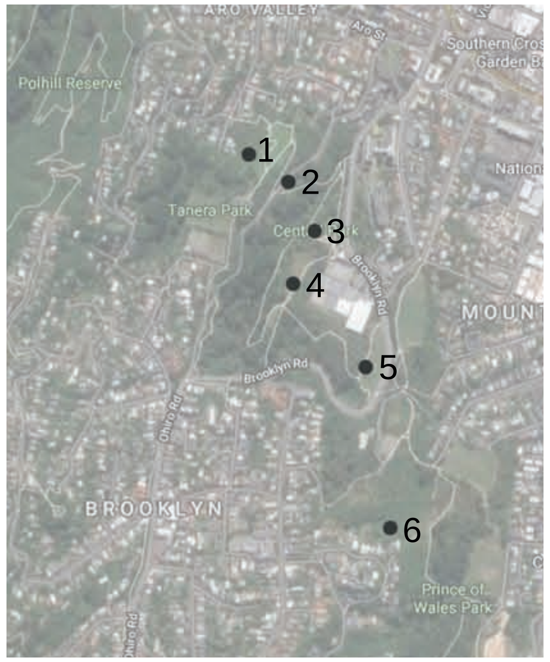
Figure 270. Small Changes that Highlight Existing Site Conditions

EDGE STUDY

Literature review highlighted the importance of edge conditions in the biodiversity level of vegetative patches. The author therefore undertook a study of local edge conditions around the Aro Valley to investigate how physical arrangements might influence inhabitant levels. Edges were all along a 1km walk within the same park area, so to ensure the same source pool of bird species, and be sure any discrepancies are due to edge conditions only.

This study highlighted the importance of variety within the vegetation types, particularly with providing a decent depth of edge plant species. Open grass spaces with specimen trees placed throughout increased diversity, allowing for quick refuge for smaller birds when people approach, as well as a vantage point for hunting birds to observe the open space.

The study reflected the literature findings that the more abrupt the edge condition between vegetation and open space, the lower the bird and insect activity.



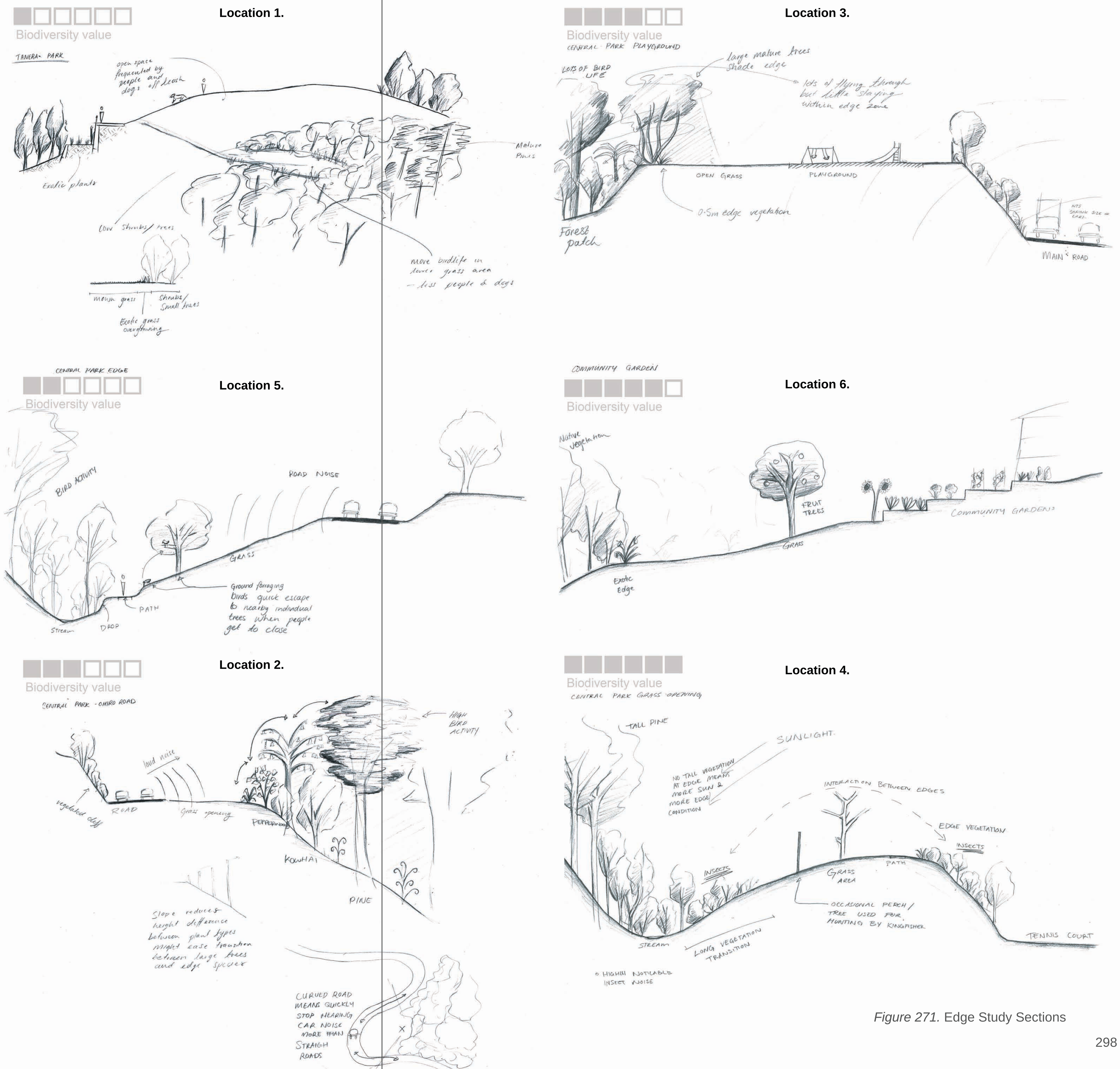


Figure 271. Edge Study Sections

EDGE FORMALITY COLLAGE

While naturalised edges are more beneficial for wildlife, sometimes a more formal edge is needed to designate usage (eg paths) or boundaries (eg public vs private) this collage explores how different edge formalities might influence human interaction.

Figure 272. Edge Formality Collage

THE IMPACT OF FORM

The fragility of an edge comes largely from wind penetration - carrying seeds which are potentially invasive or harmful to the vegetation patch. Form will therefore influence the success of an edge condition.

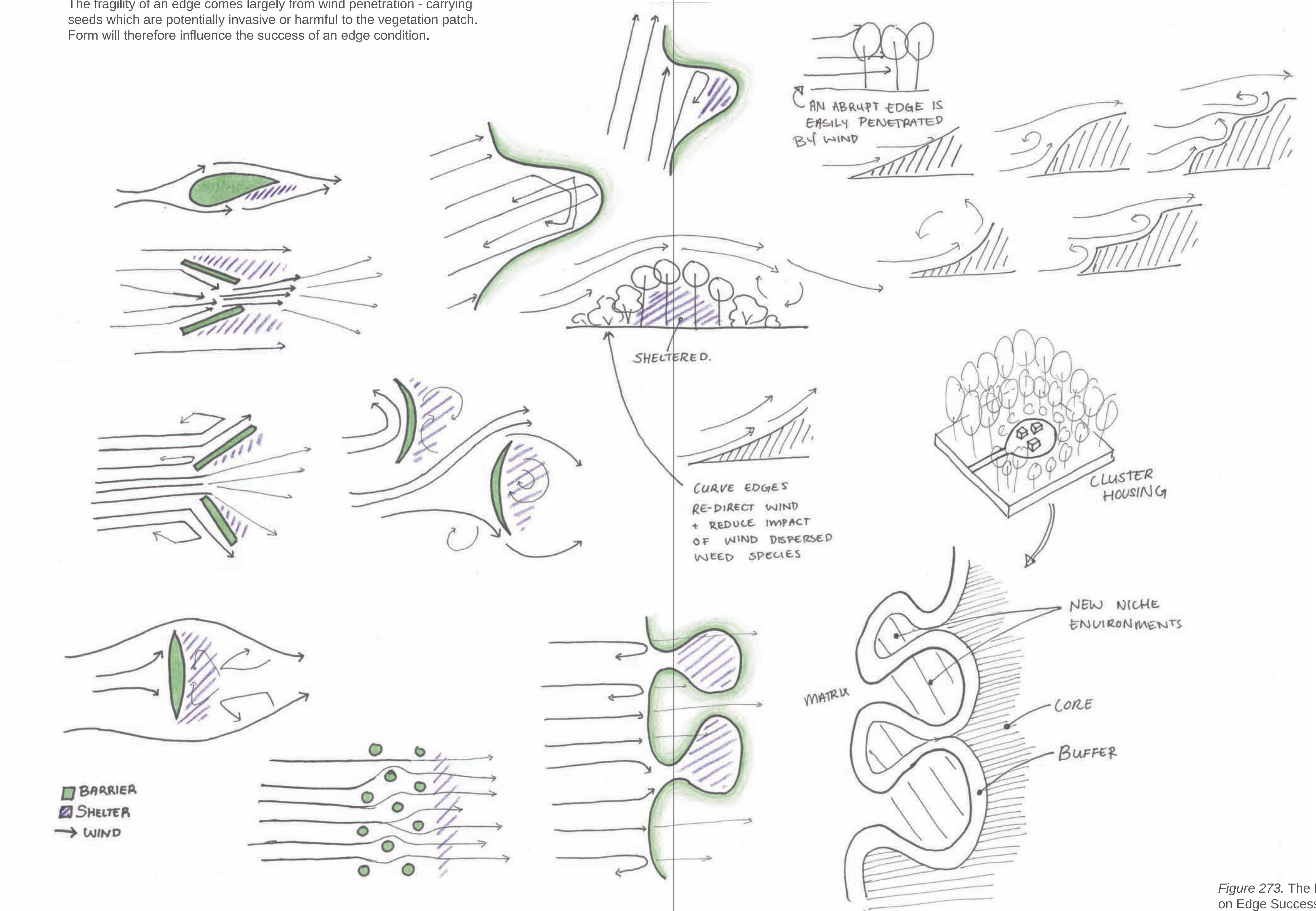


Figure 273. The Impact of Form on Edge Success

ROAD TO FOREST EDGE CONDITIONS

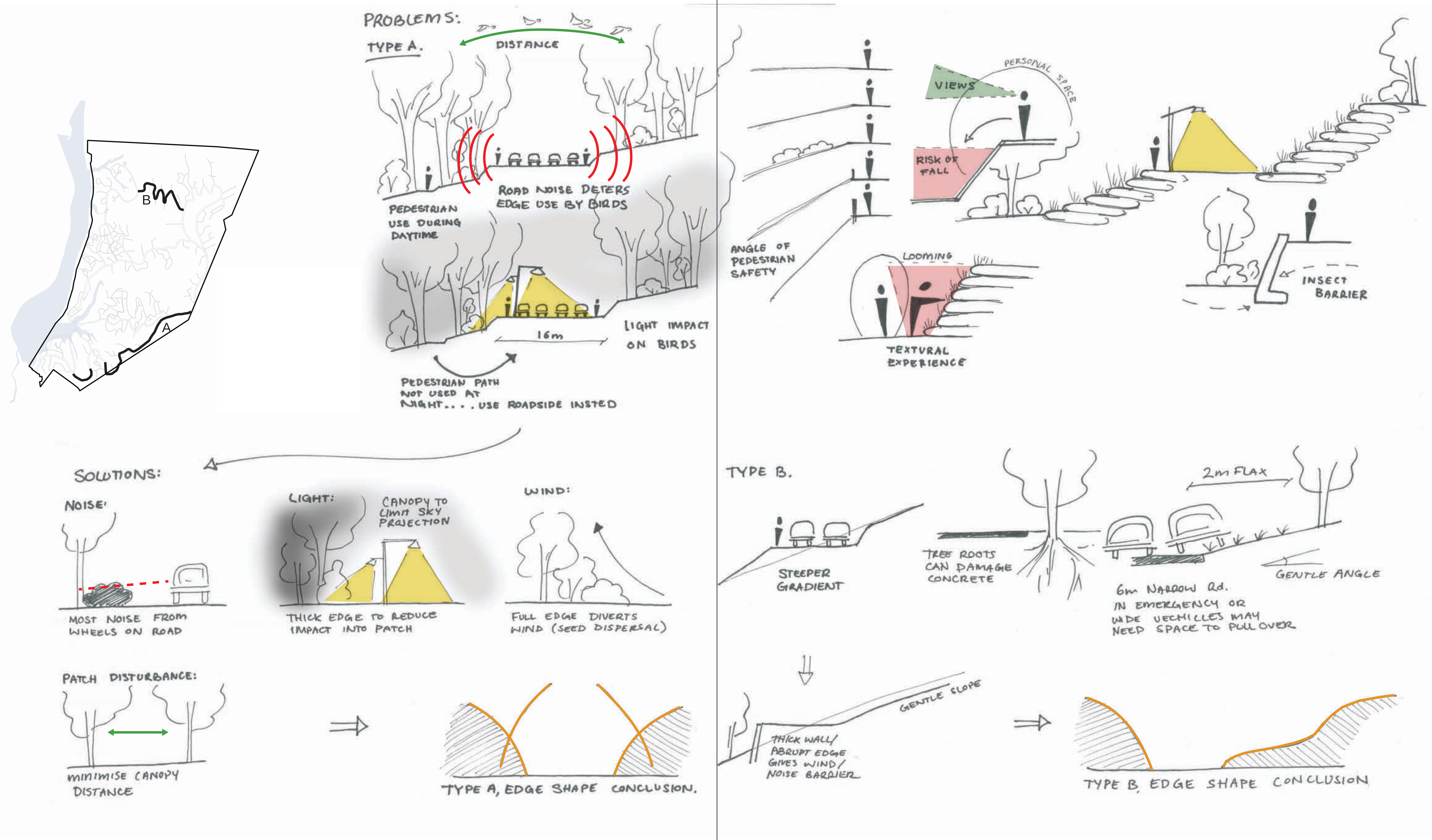


Figure 274. Road to Forest Edge Condition Process

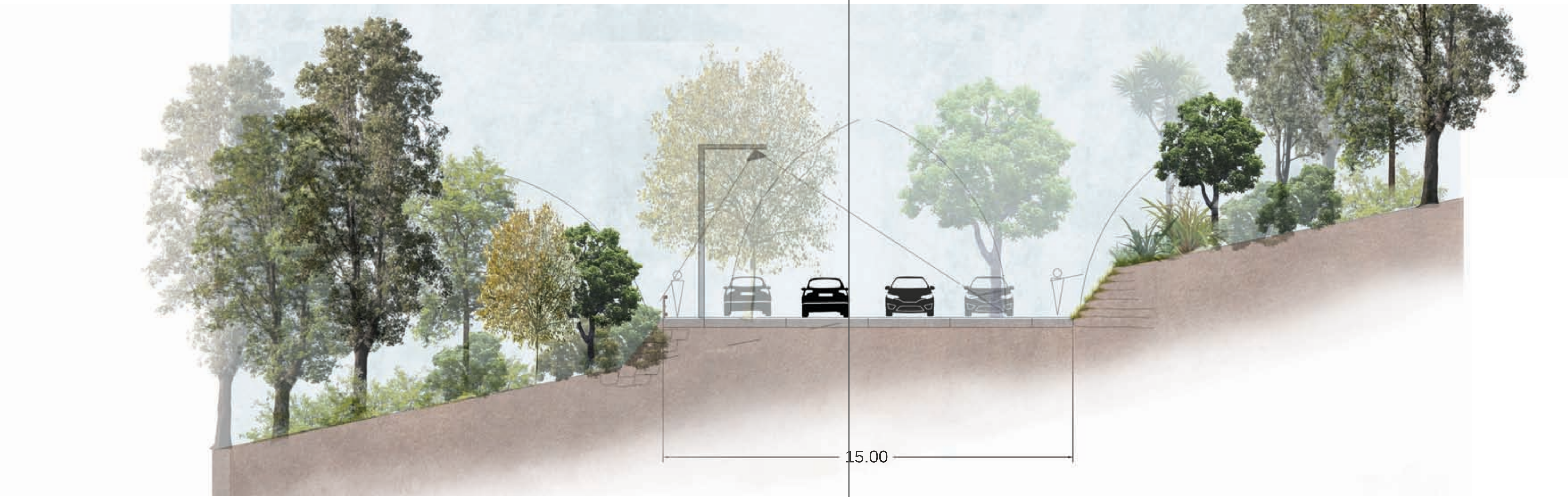


Figure 275. Road Type A Edge Condition

SCALE 1:200

Edge Species plant list:

Tall (10-15m)
Mahoe
Titoki
Karaka
Kohekohe
Kowhai
Puriri

Medium (5-10m)
Kaikomako
Akeake
Rangiora
Wineberry
Karo
Kohuhu

Shrub (2-3m)
Koromiko
Horopito

Flax
Phormium Cookianum
Phormium Tenax
Toetoe
Carex Dipsacea

Accenting Plants
Cabbage Tree
Lancewood

Street trees to be planted off the following list*. Trees should be mixed along the street for ecological variety.
Titoki
Kowhai (WF)
Kahekatea
Putaputaweta
Totara
Karaka (WF)
Puriri (WF)
Kohekohe (WF)
WF = winter foodsource

*Street trees selected are from akana nursery's recomended list but also provide winter food source for birds or are reflective of existing forest species so to offer continuity of the patch.

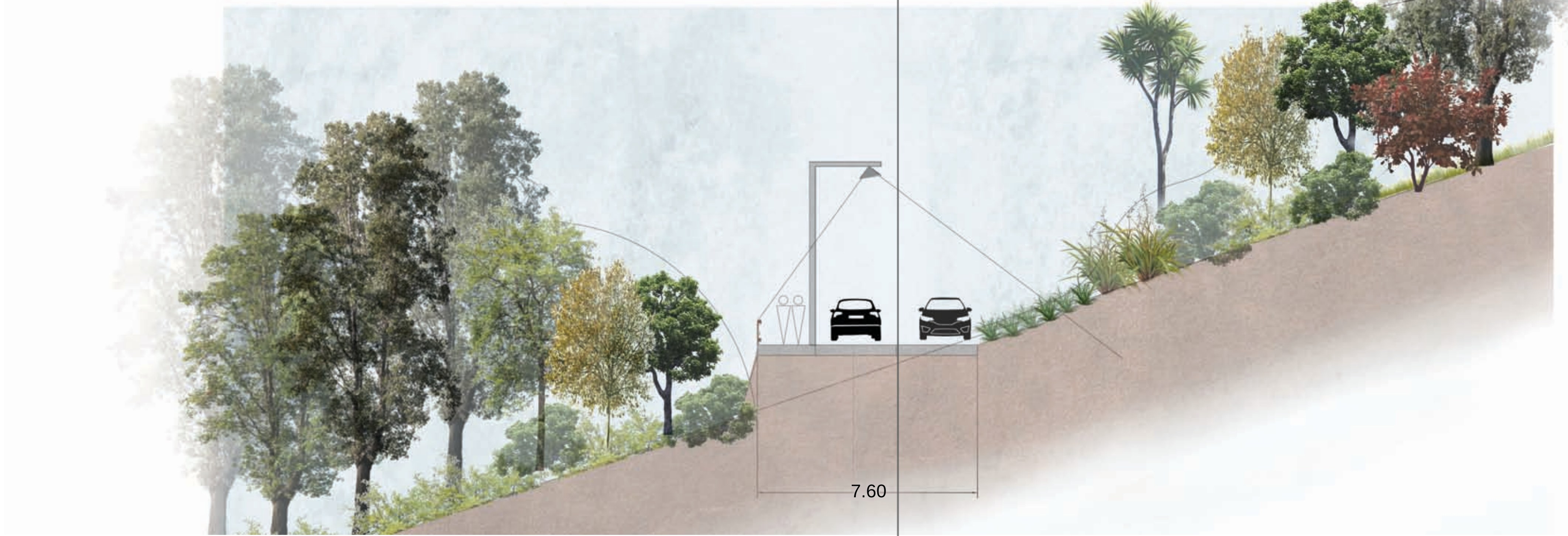
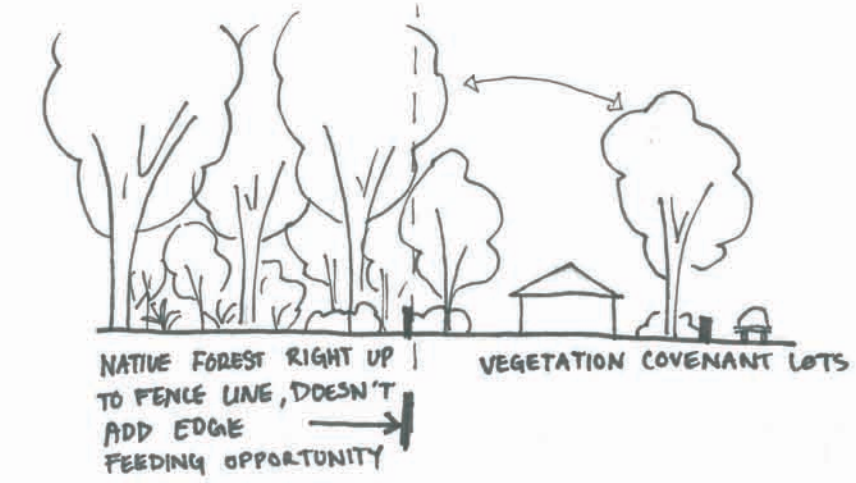
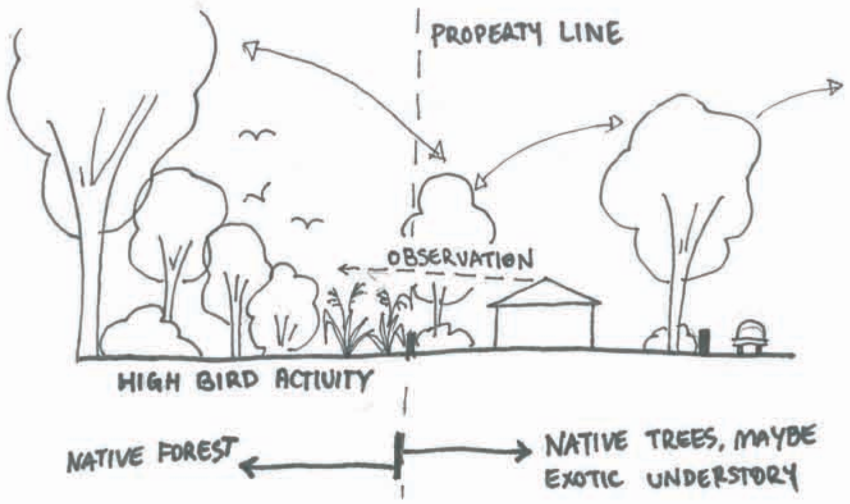


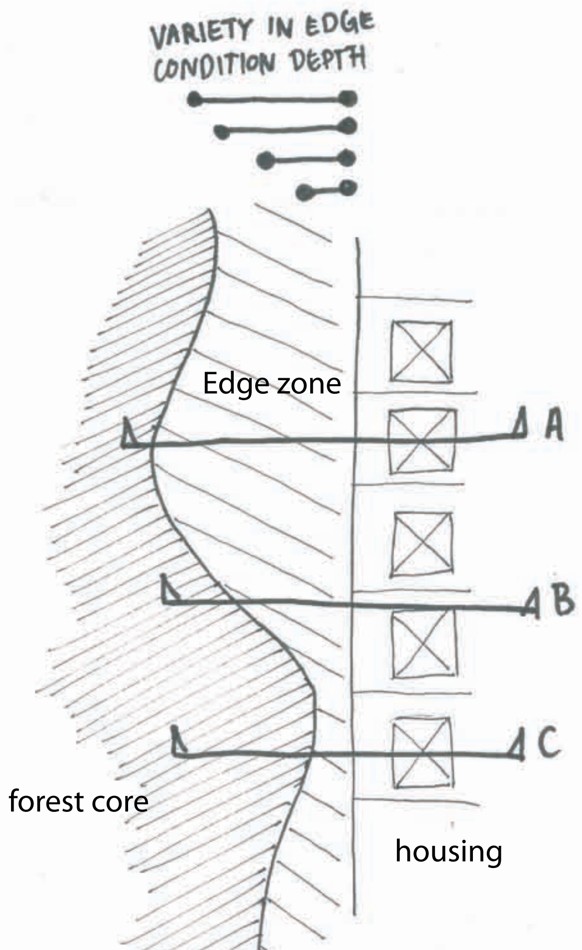
Figure 276. Road Type B Edge Condition

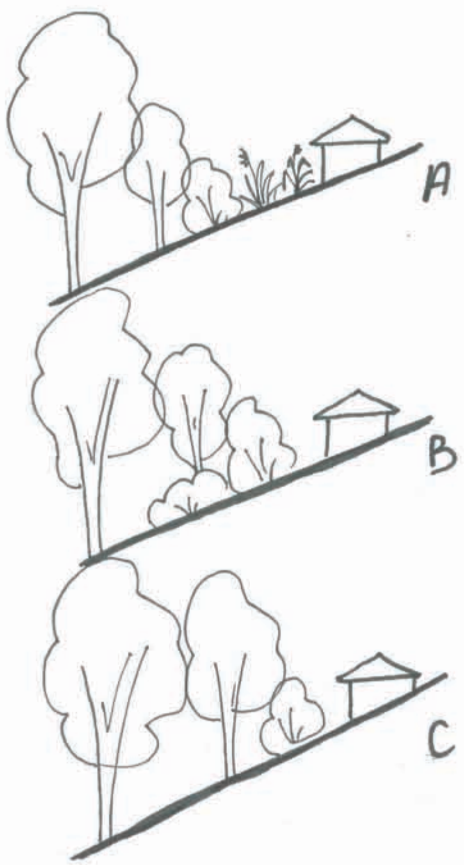
SCALE 1:200

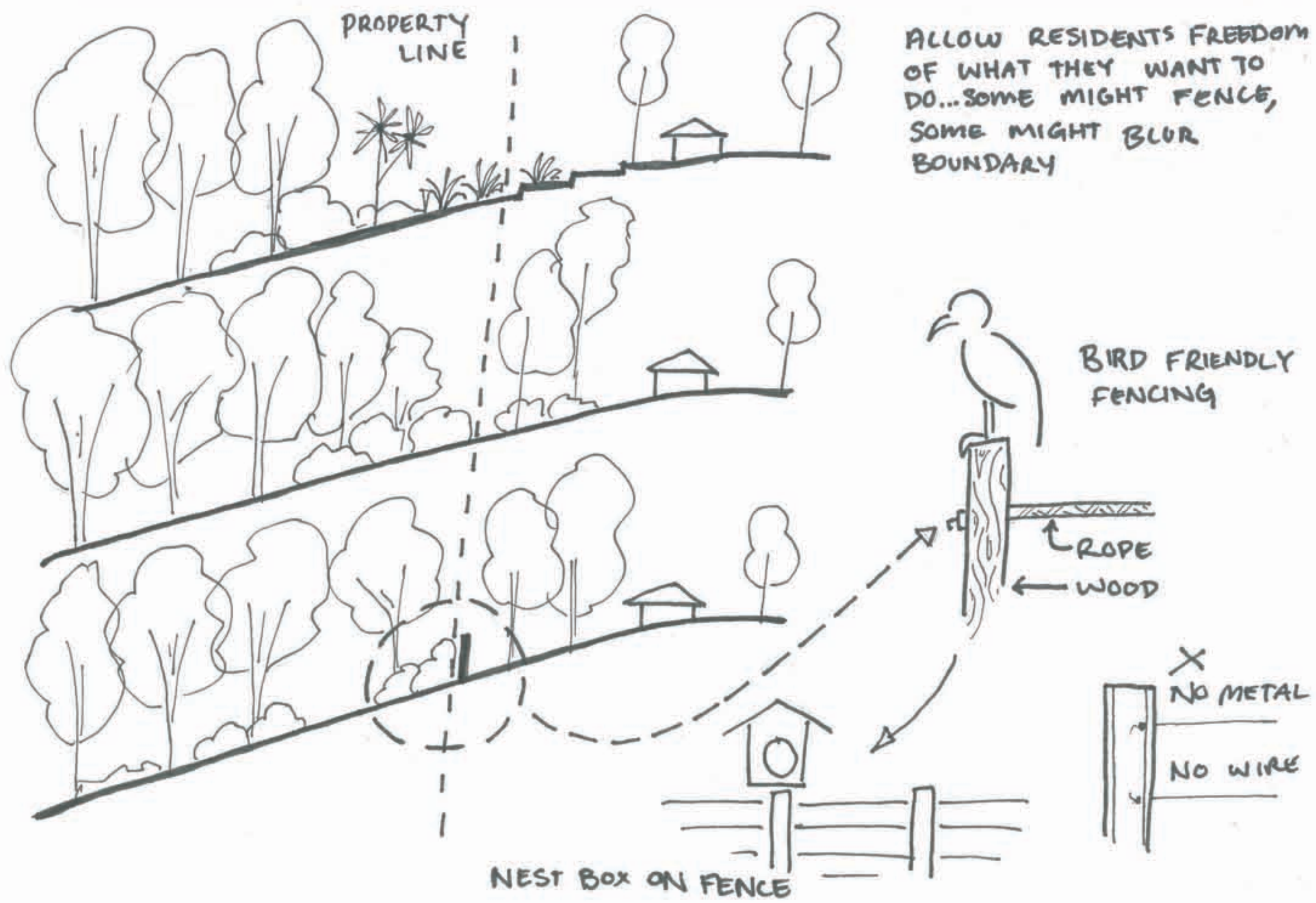
LOW DENSITY HOUSING TO VEGETATION











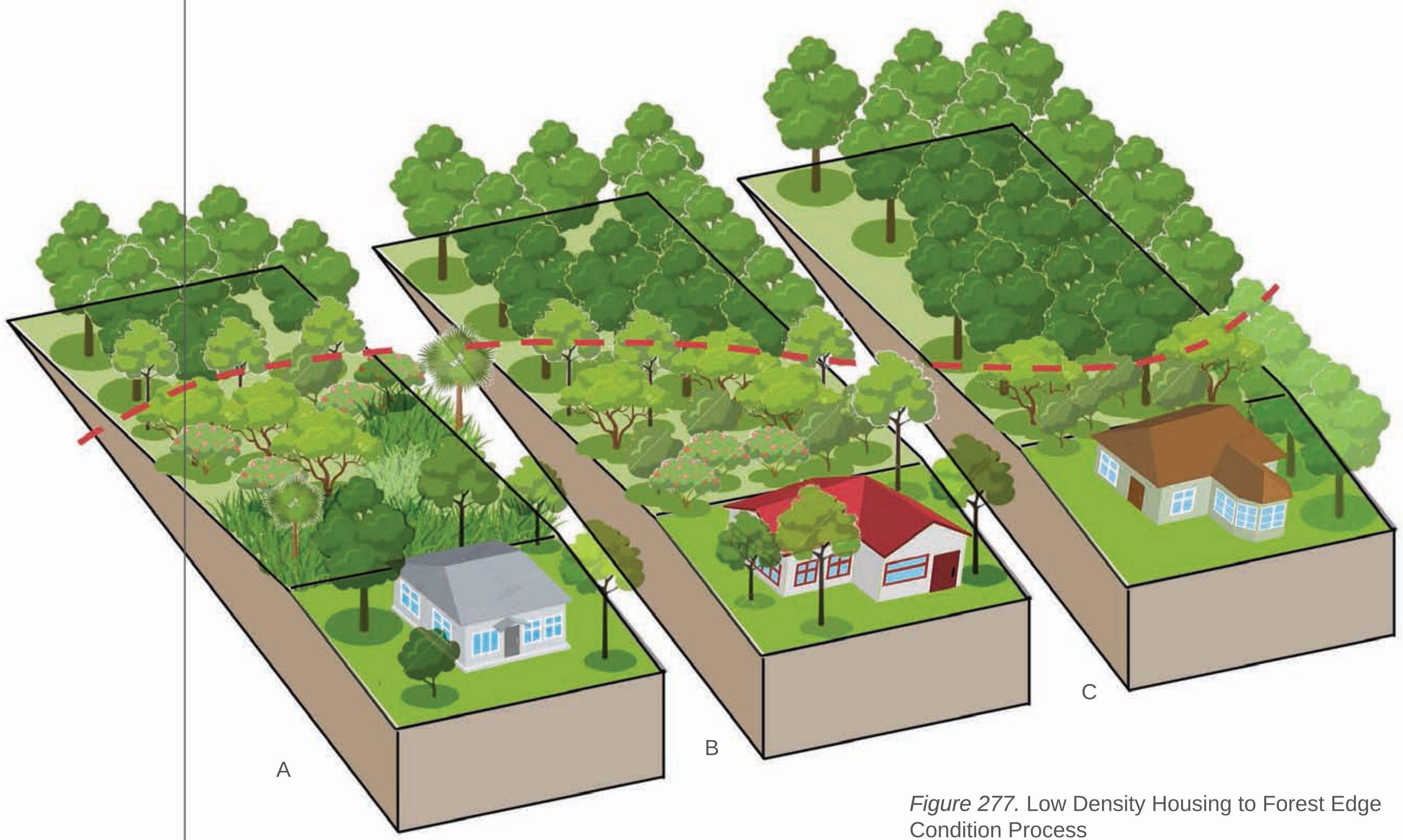


Figure 277. Low Density Housing to Forest Edge Condition Process

CLUSTER HOUSING - THE SITUATION

This edge condition explores an example strategy of how the development can grow over time. This adresses the transition of lifestyle blocks to cluster housing, exploring how these housing types which are deep within forested areas can minimise their impact on surrounding habitat.

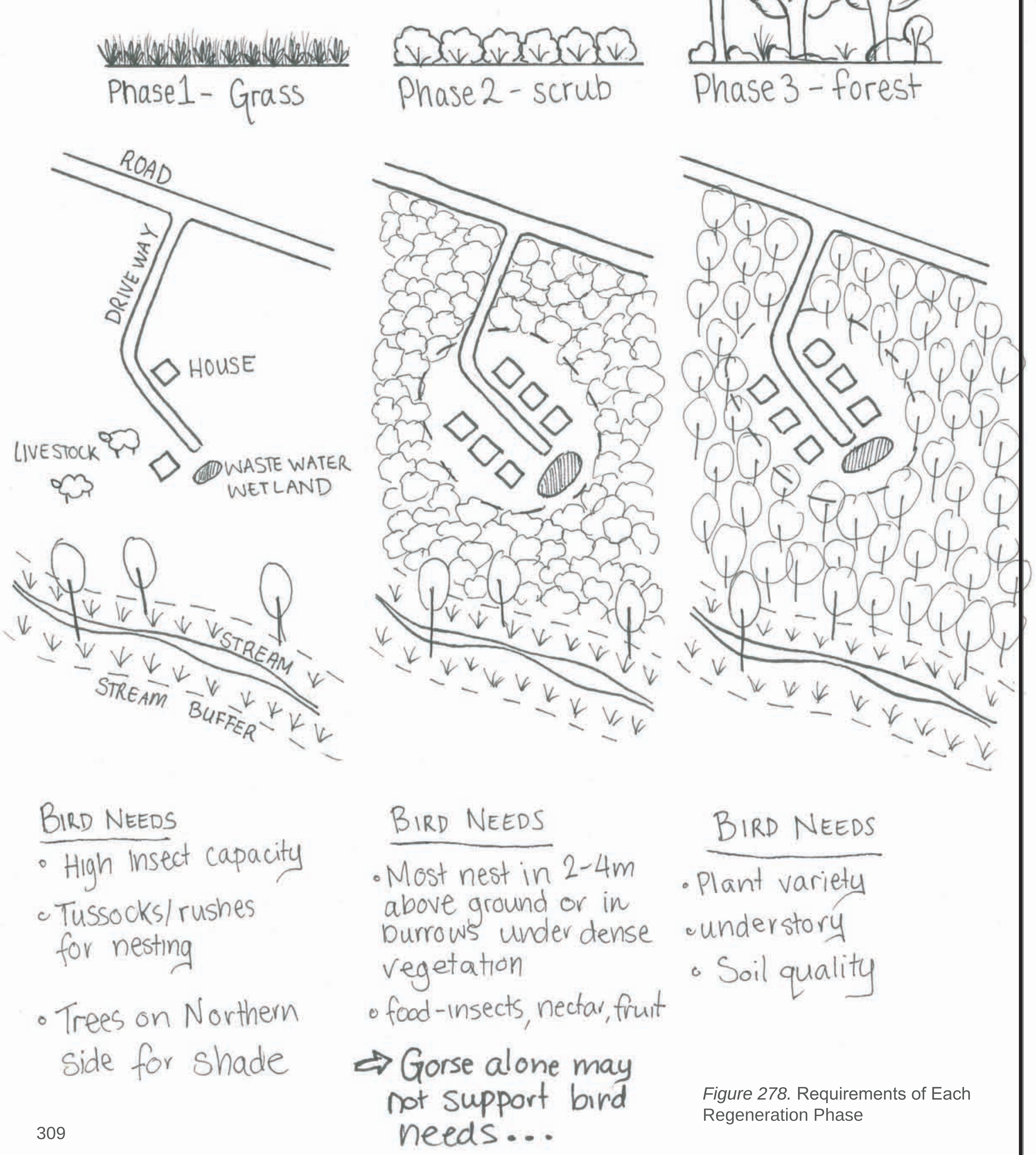


Figure 278. Requirements of Each Regeneration Phase

THE PROBLEM

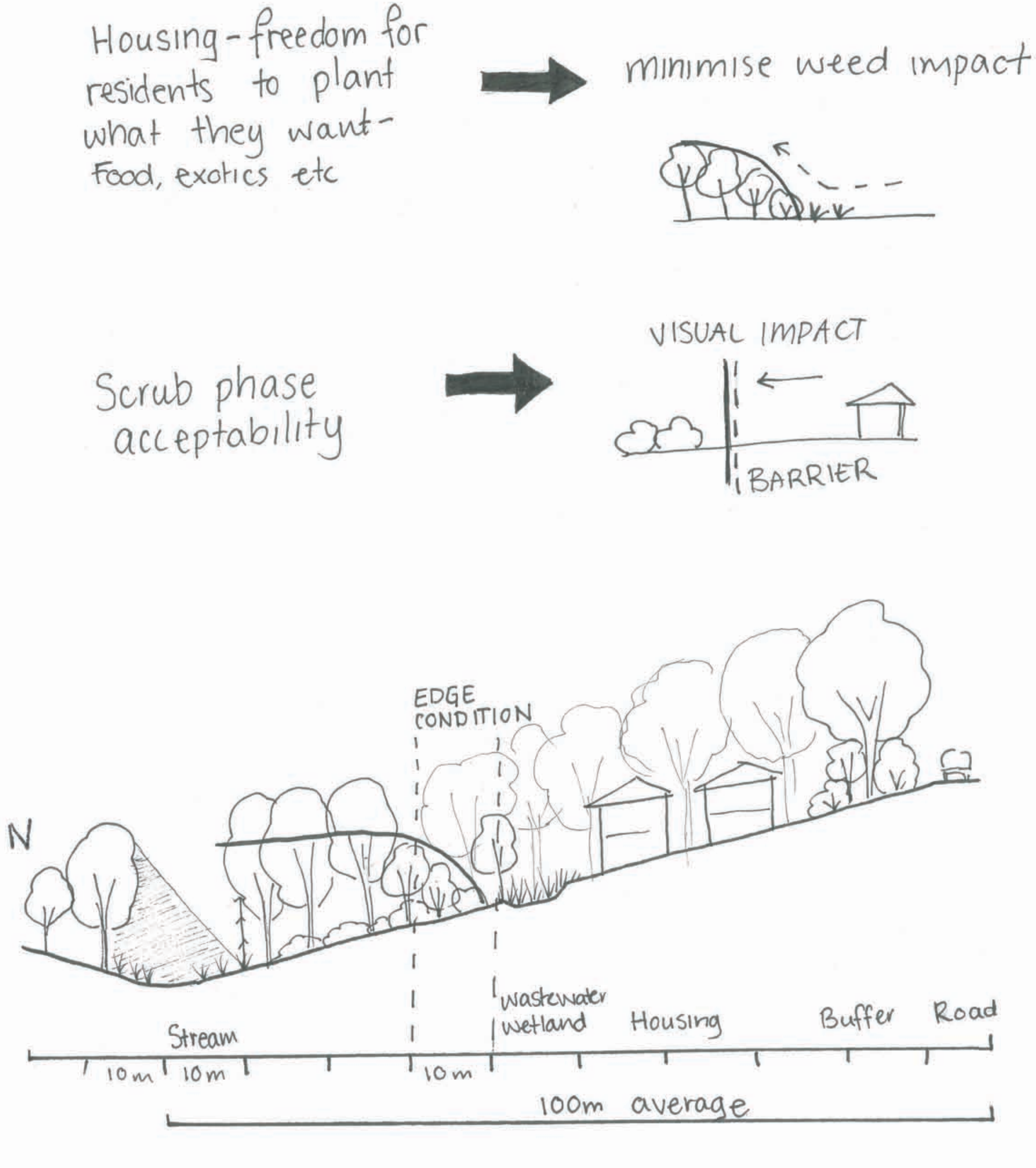


Figure 279. Section of Cluster Housing final Regeneration

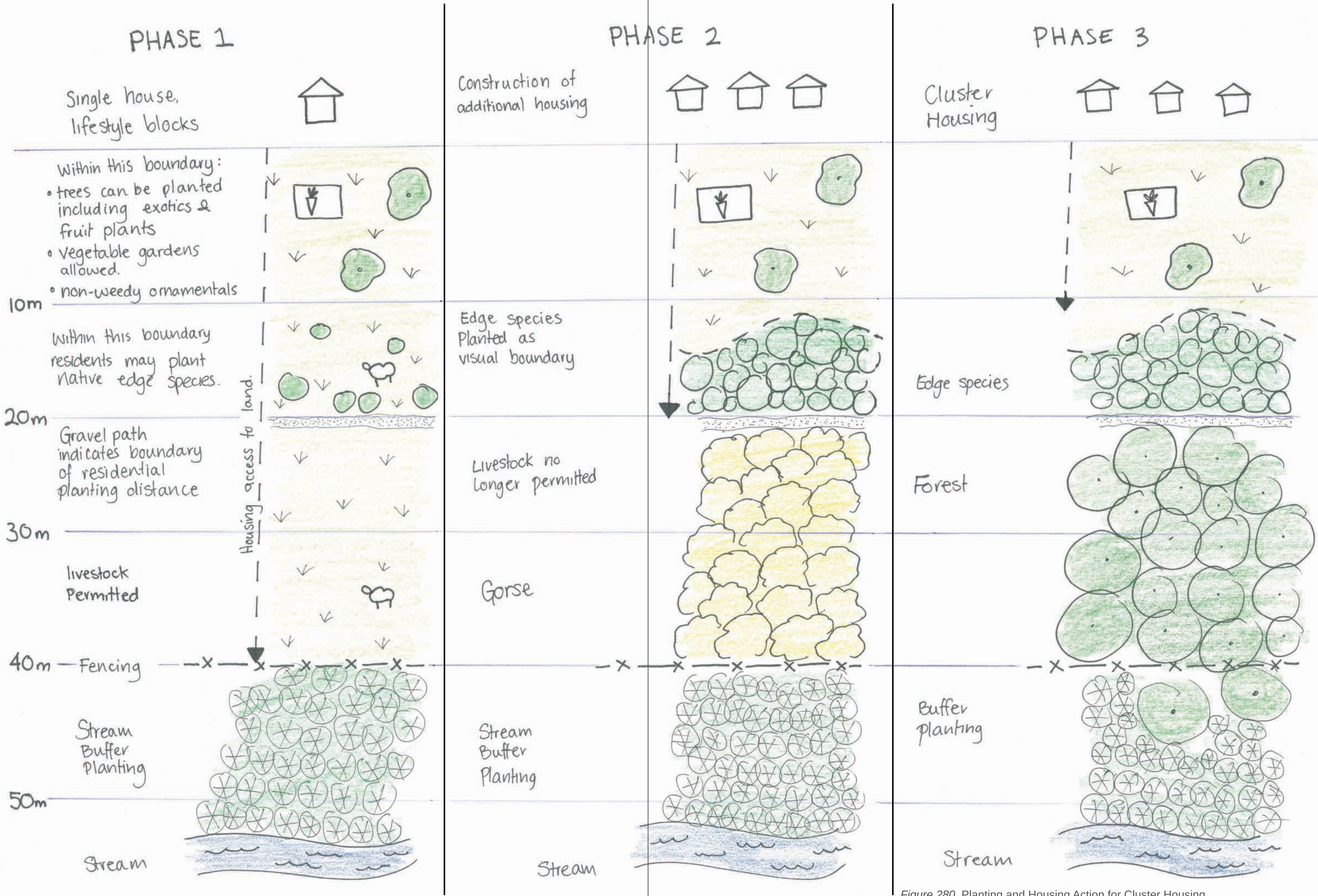


Figure 280. Planting and Housing Action for Cluster Housing Edge Condition

REVIEWING THE APLICABILITY OF DESIGN IMPLICATIONS

Implication groupings		Literature Review	Precedent Review	Design phase 1	Design phase 2	Design phase 3 - aproach 1	Design phase 3 - aproach 2	Design phase 3 - aproach 3	Design phase 4	Design phase 5 - edge conditions	summary
Transportation	Design Implication 1	minimise car use within the development	Example of how to action - Design to accommodate public transport routes. Make parking difficult.	Considered	Example of how to action - maximise walkability	Considered	Considered	Considered	Considered		kept
	Design implication 2	limit car speeds within development	Example of how to action - narrow roads			Considered	Considered	Considered	Considered		kept
Vegetation	Design implication 6	Provide human-free areas within recreation patches to allow birds to nest undisturbed.	Example of how to action - Zealandia						Considered		kept
	Design Implication 3	Restrict human movement to designated paths within natural areas to help habituate birds to human activity.	Example of how to action - Zealandia						Considered		kept
	Design Implication 23		**Transitional levels of human interaction with patches to reflect species sensitivity**		Example of how to action - Transitional park zones inbetween housing and reserves	**Example of how to action - Create car-free housing communities near vegetation patches to minimise disturbance.**	Considered	Considered - transition into car-free roads as vegetation patches mature and bird abundance increases	Considered		most important / significan design tool once basic zoning established
	Design Implication 7	locate patches to utilise natural succession including seed source and spread.		Considered	Considered		Considered - utilising shaded sides first as no nurse crop needed		Considered + phasing		kept
	Design implication 8	provide several medium sized patches within the development.		Considered	Considered						kept - this implication would need to be tailored to individual projects depending on size…
note no DI 17	Design implication 9	where possible, provide continuous vegetated corridors between vegetation patches. If Steppingstone connections are being implemented, minimise distance travelled between resting spaces.		Considered	Considered - streams used as vegetated conenctions	Example of how to action - Pinch points of suburban density			Considered		kept
	Design implication 10	Patches should be shaped with non-linear edges to increase edge sizes while maintaining a large and healthy core.		Considered	Considered					Example of how to action - housing edge	kept
	Design implication 11	Edges should reflect a natural gradient of species that would typically occur in each habitat type, including a varied and complex understory planting.								Example of how to action - cluster housing,	kept
	Design objective 4	Develop of a re-vegetation outline that compliments residential development.							Considered		not needed as its own point
	Design objective 5	minimise negative impacts of edge conditions				Incorporated within DI 27 - transitional zones limit forest patch edge to harsh environments				Example of how to action - includes notes on integrating planting strategy to reflect neibouring habitat for birds. Or provide additional resources.	kept
Housing	**Design objective 1**	implementation of medium density in suburban context	observations: public private conflict.	Considered		Turns into design implimentation 28					Turns into design implimentation 28
	Design Implication 24					**Balance MD lack of outdoor space through locating close to natural spaces**	Considered - cluster housing idea. Medium desnity focused around creating viewshafts and relectionship with Taupo Swamp	Considered - cohousing located next toTerraced and detached Medium density to lower the visual density of these areas.	Considered		kept and shown examples of implimentation
	Design objective 3	reduce the impact of housing and urban parks on birdlife to allow co-habitation in these areas.				Incorporated within design implication 27			Considered - vegetation covenants, site coverage restrictions, road design, water systems	Edge design to minimise impact of housing and roads	Incorporated within design implication 27
	Design objective 2	encourage residents' engagement with local wildlife and natural habitats.	Design objective 3 turns into design implications 25 & 26								Design objective 3 turns into design implications 25 & 26
	Design implication 21		Use nodes of open space to encourage walking and engagement with forested areas						Considered		kept
	Design implication 22		Open spaces to include understory plantings with thinning trees to create view shafts encourages biodiversity and allows sunlight into space.						Considered		too specific and limiting as a design principle
	Design implication 20		Use housing orientation to create small communities		Considered loosely through overall housing location	action through a mix of street frontage and internally facing housing groups	action through facing of housing over communal parks		Considered		kept
Lighting	Design implication 12	Only light up trees where birds will not be nesting (eg street trees and key residential trees only). Limit lighting in forested areas.								Considered - road design adresses impact of lighting on forest patches	lighting remains important but was not really considered in this design due to scale and scope of project. Keep for more detailed designs
	Design implication 13	design public lighting to limit skyward projection and select hues that interfere the least with sleeping patterns (blue and green light).								Considered - road design adresses use of canopy trees to limit skyward projection	
	Design implication 14	Additional mitigation: ask residents to buy UV reflective collars for pets to make them easy to see by native birds.									
Water systems	Design implication 15	50m buffers to main waterways, 20m buffers to headwaters where possible		Considered	Considered						kept
	Design implication 16	Minimise channelling of waterways and maintain a naturalised stream bed where possible.		Considered	Considered	Considered - minimised stream crossings.	Considered - minimised stream crossings.	Considered - minimised stream crossings.			kept
	Design implication 17	Manage water use through rainwater harvesting and grey water recycling.	Example of how to action						Considered - offline water strategy including wastewater system		kept
Earthworks	Design implication 18	minimise earthworks	Example of how to action - stilt housing	Considered	Considered	Considered - ridgelines successful	Considered - contours	Considered - combination of contours and ridgelines	Considered - combination of contours and ridgelines		kept
	Design implication 19	vegetate steep slopes for soil stability		Considered	Considered						kept
	Design implication 4	reduce impermeable surfaces.	Example of how to action			Considered - co-housing and restricted car access lowers road surface	Considered - co-housing and restricted car access lowers road surface	Considered - co-housing and restricted car access lowers road surface	Considered - co-housing and restricted car access lowers road surface		kept
	Design implication 5	Prioritise rejuvenation of soil and access to insect food sources.								Somewhat considered - significant edge depths suggested to provide space for insect habitation	remove - too challenging for this type of work and will naturally be achieved through incorporating other principles
Materials Pallet								Where possible, use sustainable materials	Considered	Considered	kept

Figure 281. Excell spreadsheet used to track how design implications were derived, implemented and changed at each stage of the design process. Used to conclude a set of final design principles.

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FINAL DESIGN PRINCIPLES

This research has led to a refinement of 8 final Design Principles which reflect key considerations for the incorporation of cohabitation into suburban environments. These principles form a guideline for future suburban developments, providing both a base for design decisions and a reflection tool to evaluate against.

DESIGN PRINCIPLE 1 – MINIMISE CAR USE, MAXIMISE WALKABILITY

Minimise car use within the development.

Limit car speeds within development.

Use nodes of open space to encourage walking and engagement with forested areas.

DESIGN PRINCIPLE 4 - PROVIDE WELL CONNECTED NATIVE VEGETATED PATCHES

Locate patches to utilise natural succession including seed source and spread.

Provide several medium sized patches within the development.

Where possible, provide continuous vegetated corridors between vegetation patches. If Steppingstone connections are being implemented, minimise distance travelled between resting spaces.

Patches should be shaped with non-linear edges to increase edge sizes while maintaining a large and healthy core.

Edges should reflect a natural gradient of species that would typically occur in each habitat type, including a varied and complex understory planting.

DESIGN PRINCIPLE 3 - TRANSITION LEVELS OF HUMAN INTERACTION RELATING TO BIRD ACTIVITY

Provide human-free areas within recreation patches to allow birds to nest undisturbed.

Restrict human movement to designated paths within natural areas to help habituate birds to human activity.

Transitional levels of human impact on bird life and habitats to reflect a scale of sensitivity that provides a range of conditions and levels of cohabitation.

Create car-free housing communities near vegetation patches to minimise disturbance.

DESIGN PRINCIPLE 2 - CREATE SMALL HOUSING COMUNITIES WITH A STRONG VISUAL AND PHYSICAL CONNECTION TO NATURAL SPACES

Balance MD lack of outdoor space through locating close to natural spaces.

Use housing orientation to create small communities.

DESIGN PRINCIPLE 7 – MINIMISE LIGHTING IMPACT

Only light up trees where birds will not be nesting (eg street trees and key residential trees only). Limit lighting in forested areas.

Design public lighting to limit skyward projection and select hues that interfere the least with sleeping patterns (blue and green light).

Additional mitigation: ask residents to buy UV reflective collars for pets to make them easy to see by native birds.

DESIGN PRINCIPLE 8 – IMPROVE WATER QUALITY

50m buffers to main waterways, 20m buffers to headwaters where possible.

Minimise channelling of waterways and maintain a naturalised stream bed where possible.

Manage water use through rainwater harvesting and grey water recycling.

DESIGN PRINCIPLE 9 –MINIMISE EARTHWORKS AND INCREASE SLOPE STABILITY

Minimise earthworks.

Vegetate steep slopes for soil stability.

Reduce impermeable surfaces.

DESIGN PRINCIPLE 8 - WHERE POSSIBLE USE SUSTAINABLE MATERIALS

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CONCLUSIONS

PERSONAL REFLECTIONS

A CHANGING MIND-SET

This thesis has challenged my understanding on the role of nature and biodiversity within urban environments. Many of the personal beliefs I was bought up with along with aspects of my landscape education, have altered through the course of this research.

First, this research challenged the prevailing mentality that separates humans from nature. This thinking has been ingrained in New Zealand's society from the beginning of urban settlements, as investigated in Chapter 2. Growing up in New Zealand, my experience of urban landscapes has been limited to this archetype.

The historic separation of humans and nature has led to a disciplinary reliance on reserve land for its biodiversity provision. As such, designers of the built environment within New Zealand have largely disregarded the importance of nature and wildlife within human dominated spaces - such as the suburb.

While my landscape architectural education engages with methods to include ecological services within urban spaces, the emphasis on precedent studies as a teaching tool has limited exposure of non-main-stream thinking. To this end, despite the research goal of cohabitation, in the first stages of the design process I found myself designing from within this binary, and effectively going against the research ambitions. This mentality slowly shifted throughout further design phases, although constant reflection was needed to achieve this. The final design does include large forested spaces, but the intent of such spaces is to integrate urban environments into natural habitats rather than separate the two.

The second change in mind-set required me to challenge my human-centric design techniques. All the ecological literature reviewed for this project described the challenges of ecological design as birds being sensitive to human environments. This positioning, though subtle, limits the landscape architecture discipline to fitting bird species into urban habitats. Design solutions therefore tend to focus on adding more native plants to urban parks and other small initiatives, but shy away from challenging the wider urban fabric. Throughout the design process this human-centric mentality was confronted and ultimately my design orientation was shifted towards adapting human landscapes to suit bird habitat needs.

This shifting perspective allowed the ecological processes and wildlife needs to lead the project and guide alternative design solutions to our built environments. It allowed me to be more open to alternative modes of human living, such as a reduced reliance on cars and co-housing land ownerships.

REFLECTING ON THE GOAL OF COHABITATION

The overall ambition of the investigation was to experiment with the landscape design of a green-field suburb that affords cohabitation between humans and bird life. Such an experiment was attempted so as to re imagine the suburb counter to prevailing models.

The definition of cohabitation was to have birds and humans living together within the same habitat. Whilst this research has resulted in a number of positive findings to wards cohabitation, a single habitat solution was not achieved. This was due to the complexity and contradictions of human lifestyles with living ecologically.

However, throughout the research process, the concept of designing within a 'scale of sensitivity' emerged. This concept progressed my definition of cohabitation from a single urban environment inhabited by both humans and wildlife, to a gradient of habitat typologies that blended the boundaries between human and wildlife while still allowing each to have spaces un-occupied by the other.

The 'scale of sensitivity' concept eventually became the main design tool, giving agency to the placement and design of housing, roads, water systems and pedestrian open space networks. 'Scale of sensitivity' in the context of suburban land development was thus a key discovery in the research and the governing principle within the complex spatiality of cohabitation.

The initial concept of cohabitation may not have been achieved, but this investigation proves potential to move towards a less impactful suburban model that prioritises biodiversity.

REFLECTING ON RESEARCH OUTCOMES

Successes:

The final design explores several key design approaches that could improve the suburban environment towards cohabitation.

1.The value of designing largescale masterplans within a 'Scale of Sensitivity' to limithuman impact on wildlife.

2.The utilization of life-style blocks as a tool for forest regeneration.

3.Alternative approaches to medium density cater to edge city developments; includinga focus on noise reduction and connection with nature.

4.To design road layouts with the potential to change over time to reduce car use.

Design limitations:

Edge conditions were identified as a vulnerable and important aspect of vegetation patch design. Consideration of edge conditions were reflected within the zoning of spaces, and somewhat explored in the design process, but a deeper exploration of edges would have strengthened the overall design solution.

REFLECTING ON THE DESIGN PRINCIPLE METHOD

METHODThe overall project structure began with the objective to discover, test and refine design implications into a final set of principles.

This method ensured that findings from the literature and precedents were incorporated into the design phases, showing examples of actionable responses to the theoretical knowledge. Had design implications not been clearly stated, many of the learnings might not have been tested to determine their impact on master planning.

The creative process of designing inherently allows a freedom to explore original ideas. Having the implications open to change allowed this research to discover solutions that a more ordered process would not have, such as discovering the key idea of ‘scale of sensitivity’. While this concept was hinted at in the literature review, through the categorisation of wildlife to their sensitivity to human habitats; it was only through the process of designing that this concept was developed and refined. The same can be said for medium density design. The literature highlighted the need for medium density to be implemented in edge-city developments, but it was the design process that found potential ways to achieve this.

At the same time, a solely creative process has the potential to divert and lose sight of project objectives. Having the principles as a framework to work within was essential to holding to design accountable to the cohabitation objective.

FUTURE EXPANSION

The continued reflection and evaluation has resulted in 8 design principles that guide suburban projects to achieve cohabitation and increased biodiversity. The principles are written as a set of guidelines, and how to action the principles remain flexible to the designer and to the site.

This project shows that human development can be a catalyst to support the regeneration of ecosystems. The final schematic design proves a suburb that implements these design principles will be able to achieve a similar amount of housing yield to current suburban trends, whilst also improving biodiversity.

The next step in developing this research objective would be to use the final design principles to design other green field suburban developments to test the success and validity of the design principles in other settings.

SIGNIFICANCE TO THE DICIPLINE

This research highlights the opportunity of suburban environments to improve biodiversity in New Zealand. The project challenges the idea that suburban sprawl conflicts with biodiversity goals, and encourages landscape architects embrace the potential of suburban environments. The design principles developed create a checklist from which landscape architects and urban planners involved in suburban master planning can improve the ecological value of an area.

This research could also be used by City Councils to achieve biodiversity goals. The design principles could be used to assess development proposals and resource consents to evaluate the impact on biodiversity. Future developments should be required to show how their construction will provide opportunity of increased wildlife habitat.

LIMITATIONS

This project was limited by my personal knowledge and technical skills as a landscape architecture student.

In reality, a project of this scale would be undertaken by an interdisciplinary team. As such, many of the systems included were based on generalisations and “rule of thumb” due to my limited technical knowledge.

The reality of restoring ecosystems is a complex and unpredictable process. Local weed species would impact the development. Frequent monitoring would need to be included to guide the process.

The context of the research means real-life testing of design moves is obviously impossible. As such conclusions of the success of this design and the design principles are just the author’s theoretical opinion.

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