Peri-Fusion

An integrated agriculture and densified housing model for New Zealand's peri-urban zones.

By Sarah Morris

Peri-Fusion

An integrated agriculture and densified housing model for New Zealand's peri-urban zones.

By Sarah Morris

A thesis submitted in partial fulfilment of
the requirements for the degree of Masters of
Architecture (Professional).

Victoria University of Wellington
2019

Abstract

Peri-Fusion housing is an integrated densified housing and agricultural model, that this thesis proposes as an alternative to the current problematic suburban model prevalent in New Zealand's peri-urban zones. Suburban sprawl driven by the single storey housing model, New Zealander's desire towards standalone housing, and the loss of fertile agricultural land are all driving issues behind this proposed Peri-Fusion housing. This research defines the peri-urban zones as areas of unknown development surrounding New Zealand's towns and cities, addressing the increasing rigid, concrete-clad, urban perimeter invading further into agricultural fertile land. Peri-Fusion design strategies are established to test and develop a new integrated housing model, aiming to achieve attractive densified living, that is integrated with preserved agricultural land. This proposed housing development model could achieve a resilient flexible system of land use, where housing is integrated into a natural agricultural and horticultural resource cycle.

This thesis includes typological research and a design-led research methodology. Literature and case studies were reviewed initially to define common traits of successful low-rise high-density housing, spatial agricultural landscaping typologies, agricultural integration and agricultural ownership. From these reviews, Peri-Fusion design tactics

were derived to form a basis for testing in the design-led research methodological step. These tactics included the adaptive iterations and application of the ha-ha wall as an agricultural boundary, layered pathways between humans, vehicles and animals, and level change within landscapes. Alongside these main strategies, the integrated operational model was addressed, which included extensive grazing, intensive horticulture dedicated to housing and the inclusion of agricultural education. Also, a basic circular natural resource model was developed to address the operation of water, waste and food production management.

In order to measure the success of Peri-Fusion tactics, Blenheim was established as a case study site for the design-led research. Conceptual and developed design was undertaken, which was reviewed against the Peri-Fusion framework, resulting in a final proposed integrated and densified housing model for the Blenheim case study site. Findings were then tested against the adjacent plot to the site with the same site coverage. This successfully revealed an increase of 131 housing units, decreased average gross floor area from 175m² to 80.5m², and an increase of unsealed preserved fertile land by 20%. This resulted in 38% of final model dedicated to agricultural and horticultural food production.

Acknowledgements

To my friends and family, thank you for your consistent encouragement over the course of my study.

To my supervisor, Hans-Christian Wilhelm, thank you for your advice and support throughout this year.

Table of Contents

V	Abstract
VII	Acknowledgements

Chapter One

03.	1.1 Problem Statement and Background
09.	1.2 Proposition, Aims and Objectives
11.	1.3 Methodology and Scope

Chapter Two

13.	Literature Review
15.	2.1 Low-Rise High-Density Housing.
17.	2.2 Agricultural Integration & Ownership
19.	2.3 Agricultural Typological Research

Chapter Three

23.	Design Strategies
25.	3.1 Literature + Typological Findings Summary
27.	3.2 Peri-Fusion Design Strategies
29.	3.3 Key Peri-Fusion Strategy: The Ha-ha Wall

Chapter Four

31.	Case Study
33.	4.1 Site Selection
35.	4.2 Site Analysis
43.	4.3 Programme

Chapter Five

47. **Case Study Preliminary Design**

- 49. 5.1 Masterplan Scale 1:2000
- 61. 5.2 Street Scale 1:1000
- 73. 5.3 Home Scale 1:100

Chapter Six

85. **Developed Design**

- 87. 6.1 Masterplan Scale 1:2000
- 97. 6.2 Street Scale 1:1000
- 109. 6.3 Home Scale 1:100

Chapter Seven

125. **Final Design**

- 127. 7.1 Masterplan
- 131. 7.2 Street
- 137. 7.3 Row House
- 143. 7.4 Semi-Detached House
- 149. 7.5 Detached House

Chapter Eight

155. **Conclusion**

- 157. 8.1 Research Findings
- 161. 8.2 Conclusions

Chapter Nine

- 165. 9.1 Reference List
- 167. 9.2 Figure List

This content is unavailable.

01.

Chapter One

1.1 Problem Statement and Background

1.1.1 *Sprawl*

1.1.2 *New Zealand Attitudes*

1.1.3 *Impact on the Landscape*

1.1.4 *New Zealand Context*

1.1.5 *Defining the Peri-Urban Zone*

1.2 Proposition, Aims and Objectives

1.3 Methodology and Scope

Figure. 1.1: (Opposite) In 2001, the suburb of Flat Bush in Auckland's south-east was farmland; by 2025 it's expected to be home to as many as 45,000 people.

1.1 Problem Statement and Background

1.1.1 Problem: Sprawl

Urban sprawl driven by the one storey housing model is becoming an increasingly unsustainable societal issue. While many cities around the world follow a ‘compact city’ development model, New Zealand is defined by ‘urban sprawl’ (Abrahamse, Stuart, & Witten, 2011, p. 9). Developer driven subdivisions consisting of sizeable plots of land, accommodated by large one storey homes, are sprawling around fringes of towns and cities, often invading highly fertile greenfield land. Urban sprawl has many negative attributes to the environment, including increase vehicle miles travelled, decrease in physical activity, increase of carbon emissions and the invading of highly productive land that supports the New Zealand economy ((Abrahamse, Stuart, & Witten, 2011). These sprawling developments are considered ‘low-density,’ where density is defined as “spatial compactness of urban development in a given area” (The Department of Internal Affairs, 2019). Quantitative indicators of density include dwelling per hectare, inhabitants per hectare and floor area ratio. From 1974 to 2016, average floor area of households in New Zealand has increased from 110 square meters to 182 square meters (Statistics New Zealand, 2016). Figure 1.2 shows a basic 182 square meter house occupying a quarter acre section, then multiplied to visualise New Zealand’s current urban sprawl.

1.1.2 Problem: New Zealand Attitudes

Along with the physical problems of sprawling subdivisions, there is also an issue with New Zealanders desired attitude towards the detached owned dwelling. Research identifies that New Zealanders still have a strong preference to the standalone home with a private backyard (Bryson, 2017). In 2017, BRANZ conducted a housing preference survey in New Zealand, that concluded with a large percent of participants stating they would primarily consider living in the standalone home, believing this type of home provided an enjoyable lifestyle and were more visually appealing (Bryson, 2017, p. 24). This becomes even more prevalent when relocating from cities to smaller New Zealand towns, where the private detached home becomes an expectation.

Figure. 1.2: New Zealand’s urban sprawl diagram.

The suburban detached home is the main housing typology for New Zealand, where these low-density detached suburbs often relies on the use of the private vehicle. After the Second World War, the car became more affordable to working-class families, where the sprawling one storey housing model became achievable (Derby, 2011). The detached home also takes on the connotation of freedom due to influential advertising in the 1900's and economical state housing models over time (Figure 1.3). The 'quarter-acre pavlova paradise' is also a well-known influential description of owning a home in New Zealand, coined by Austin Mitchell in his 1972 novel "The Half-Gallon, Quarter-Acre Pavlova Paradise" (Mitchell, 2002). The 'quarter acre section' was determined

plot size for the privately-owned detached home, whereby the 1960's it took on the connotation of freedom (Coxhead, 2017).

The problematic urban sprawl we are currently experiencing, could be a result of New Zealander's preference to this dated way of living, when space was abundant and sustainable impact was not a consideration. This desire towards the 'quarter acre dream' has been compromised in these new sprawling subdivisions, where sections have been cut in half and home footprints have increased. But this phenomenon is not just relevant to New Zealand but is present in many developing countries around the world, resulting as a larger societal issue.

Figure. 1.3: Railway poster promoting the suburbs in the 1930s.

1.1.3 Problem: Impact on the Landscape

Sprawling subdivisions often result in loss of productive landscape and create strong separation between rural and urban contexts (Figure 1.4). Since the days where humans started developing skills to provide shelter and farming for food, architecture and agriculture have coincided. As the human population grows and cities begin to form, architecture and agriculture are more commonly experienced as separate entities. The United Nations Department of Economic and Social Affairs (UN DESA, 2016) estimated that 54.4 percent of the world's population living in cities or urban area, and by 2060 urban areas are projected to house 60 percent. This figure is even higher in New Zealand with 86% of people living in urban areas, based on a New Zealand-specific definition (New Zealand Productivity Commission, 2017). This definition includes main urban areas as a minimum 30,000 people, secondary urban areas as 10,000 to 29,999 people, and minor urban areas as 1,000 people or more (New Zealand Productivity Commission, 2017). This figure has remained constant since 1991, where there is often a stark transition from urban dwellers to rural living (Environment Aotearoa, 2019). The separation between urban and rural living creates a bubble of ease for people living in urbanised

Figure. 1.4: Aerial image of Blenheim, New Zealand, showing the separation between urban sprawl and farmland.

areas, where lack of consideration for rural food production results in an unsustainable detached mindset. This is due to the ease of purchasing all food and animal products at supermarkets and reliance on the private vehicle.

The concern with this growing urban fringe, is that it is encouraging an urban development trend of occupying fertile greenfield land. It is evident that New Zealand prioritises housing and

individuals' preferences, over the value of fertile land. When the land becomes expendable to humans, the economic decision for single story home subdivision developments becomes an easy one. Within the Environment Aotearoa 2019 report produced by the Ministry for the Environment and Statistics New Zealand, it highlights the irreversible impacts of reducing versatile land and native biodiversity. It states that our urban areas have increased by 10 percent over 16 years, where 29 percent of these new urban areas were developed in highly productive versatile land (p. 41).

Another negative trend contributing to the loss of versatile land in New Zealand is the 'lifestyle block'. The lifestyle block is where fertile land is often divided up into smaller parcels of land and sold off (Figure 1.5). A 2013 study revealed that in 2011, 873,000 hectares of land were used for 175,000 lifestyle blocks, where there are an estimated 5,800 lifestyle blocks are being established each year (Environment Aotearoa, 2019, p. 41). This New Zealand trend links back to the 'quarter-acre section' dream mentality, where the lifestyle block alongside sprawling subdivisions are decreasing the productive use of versatile land. These generally irreversible actions can limit the options for future generation,

Figure. 1.5: Lifestyle blocks on the fringe of Auckland's north shore.

by decreasing job opportunities in the horticulture and agriculture industry and reducing readily accessible food sources. Even though lifestyle block land is legally reversible, it isn't economically practical for owners as there is an "increase value of the property per hectare," due to the construction of large houses (Andrew & Dymond, 2013, p. 9). The irreversible actions of this sprawling development due to an undervalued attitude towards versatile land, could be detrimental for future generations if change isn't made.

Figure. 1.6: Definition of New Zealand's urban centres and where the peri-urban zone lies.

1.1.4 Background: New Zealand Context

Before proposing potential solutions to urban sprawl, rural and urban contexts must be defined and analysed to identify where problematic sprawl is taking place. New Zealand's context can generally be categorised into an urban context (cities, towns) and a rural context (rural towns, agricultural land). As mentioned earlier, Main Urban Areas are identified to have a minimum population of 30,000 people, Secondary Urban Areas with a population between 10,000 and 29,999, and Minor Urban Areas with a population of 1,000 or more that aren't already identified in the secondary category (New Zealand Productivity Commission, 2017, p. 70). These contexts are shown in figure 1.6, where large sprawling subdivisions are commonly being developed on the fringes of these urban area. These urban fringes can be defined as 'peri-urban zones' (Iaquinta & Drescher, 2000).

1.1.5 Defining the Peri-Urban Zone

Peri-urban does not have one clear definition, as it has been used inconsistently by theorists and practitioners over the last half century (Iaquinta & Drescher, 2000). This area can be viewed as a transition zone where rural and urban clash and mix, or alternatively it can be categorised as an individual land type and/or zone. The OECD provided a fair observation of the use of the word in 1979, where they stated:

“The term ‘peri-urban area’, cannot be easily defined or delimited through unambiguous criteria. It is a name given to the grey area which is neither entirely urban nor purely rural in the traditional sense; it is at most the partly urbanised rural area. Whatever definition may be given to it, it cannot eliminate some degree of arbitrariness.”

Since this word is defining a ‘grey area,’ this thesis will interpret the word and the area it addresses for the purpose of this study.

Breaking down the word in simple terms, ‘peri’ is the Greek word for ‘about,’ and urban is defined as ‘characteristic of a town or city.’ Therefore, the peri-urban zone is defined as an area of potential development that exists around the fringes of cities and towns in New Zealand. This zone will extend beyond the current urban fringe and into the farmland beyond (Figure 1.6 & 1.7), as this is where potential future sprawling subdivisions or lifestyle blocks may occur.

Figure. 1.7: Blenheim's peri-urban zone highlighted.

1.2 Proposition, Aim and Objectives

Proposition

To summarise the problem statements for this thesis; urban sprawl driven by the large single storey housing model, New Zealander's desire towards standalone housing, and the loss of fertile agricultural land, all need to be addressed in this research. Therefore, this thesis will propose the following research statement, aim and objectives:

Research Statement

Peri-Fusion: Integrating agriculture and densified housing as an alternative model within New Zealand's peri-urban zones.

Project Aim

The proposed Peri-Fusion housing model aims to achieve integration between densified housing and agriculture, creating a resilient flexible use of land for future generations by preserving versatile land within the housing model and a circular natural resource cycle.

Objectives

1. Develop a densified housing solution, with the aim of increasing the number of

housing units per hectare and decreasing the average floor area.

2. Create an integrated housing and landscape solution, that injects agricultural/rural architectural motifs into the architecture, while retaining the qualities of the desired standalone home.

3. Increase the amount of preserved greenfield or agricultural land (soft surfaces) while decreasing sealed land coverage (hard surfaces).

4. Increasing sustainability and housing resilience by actively embedding housing into a natural resource cycle.

The qualities of these objectives compared to the current suburban model have been visualised in figure 1.9, whereby achieving these objectives, a successful Peri-Fusion housing model will emerge. The term 'Peri-Fusion' has also been visually explained in figure 1.8, where the role of architecture in addressing this thesis' aim, will be realised through design led research.

Figure. 1.8: Diagram explaining 'Peri-Fusion.'

Figure. 1.9: Diagram showing the proposed Peri-Fusion housing qualities and aims contrasting the existing suburban model.

1.3 Methodology & Scope

Methodology

The research includes typological research and a design-led research methodology. Literature and case studies were reviewed initially to define common traits of successful low-rise high-density housing, spatial agricultural landscaping typologies, agricultural integration and agricultural ownership. From these reviews, Peri-Fusion design tactics were derived to form a design strategy for testing in the design-led research. In order to measure the success of Peri-Fusion design strategy, Blenheim was established as a case study site for the research. Conceptual and developed design was undertaken at three different scales, being phenomenologically critiqued against the Peri-Fusion framework, case studies and literature, resulting in a final proposed Peri-Fusion housing model for the Blenheim case study site. Findings were then tested against the adjacent plot to the site with the same site coverage, to identify whether the research objectives had been achieved. Figure 1.10 shows a visual representation of this process.

Scope

This study will aim to provide a precedent for future developments in peri-urban zones, and ultimately contribute to the ongoing housing and urban development research in New Zealand. The outcome of this thesis will be a conceptual alternative housing solution, where the conceptual framework and strategies will be discovered and tested.

The site chosen in Blenheim will act as a vehicle for design testing. The site-specific issues addressed in this selection will be relevant to Blenheim, but also provide broader lessons in rural urban fringes, density, agricultural integration and mix use amenities.

The study is explored at a theoretical level, while all the design decisions and considerations will be tested at a plausible level for the testing of strategies. The study will not focus on meeting New Zealand resource consent, neither will it define exact costing or exact construction detailing. Therefore, it will be assumed due to the demand in housing in peri-urban zones through developer-led construction, that economic feasibility will be achieved.

Figure. 1.10: Methodology diagram.

02.

Chapter Two

Literature Review

- 2.1 Low-Rise High-Density Housing.
 - 2.1.1 *Why Low-Rise High-Density?*
 - 2.1.2 *Literature Review*
 - 2.1.3 *Literature Summary*
- 2.2 Agricultural Integration & Ownership
 - 2.2.1 *Agricultural Importance to New Zealand*
 - 2.2.2 *Literature Review*
 - 2.2.3 *Literature Summary*
- 2.3 Agricultural Typological Research
 - 2.3.1 *Agricultural Definitions and Features*
 - 2.3.2 *Literature Review*
 - 2.3.3 *Literature Summary*

Figure. 2.1: (Opposite) New development in Auckland, showing invasion of fertile land with a new subdivision and lifestyle blocks.

2.1 Low-Rise High-Density Housing

2.1.1 Why Low-Rise High-Density?

Within New Zealand's Peri-Urban Zones, the current preferred housing typology is the large detached dwelling, including the large private back yard and garage. Examining housing size in New Zealand, in August 1974 the average new dwelling footprint was recorded at 110 square metres, compared to August 2016 where it had increased to 182 square metres (Statistics New Zealand, 2016). This is a large luxury way of living compared to other countries around the world. Figure 2.2 shows a study completed in 2016 of the average footprints of new dwellings across the globe, where we can see New Zealand one of the largest in size (CommSec, 2017, p. 3).

But this way of living cannot continue with a rising population and the depletion of versatile land due to new housing developments and lifestyle blocks. Therefore, low-rise high-density tactics must be implemented into the densified integrated housing for peri-urban zones. Since the peri-urban zones are on the fringes of New Zealand towns, high-rise living is not a plausible solution. It would not be well received, due to the desire and preference for the standalone home compared to apartment living, just

as the BRANZ 2017 report concludes. Hence, why a low-rise high-density typology will be researched and tested for the New Zealand's peri-urban zones.

2.1.2 Literature Review

Compactness and density techniques within the built environment has been widely discussed throughout literature. For this topic, three publications have been reviewed that are relevant to a New Zealand peri-urban context.

The first text, *Unravelling Sustainability and Resilience in the Built Environment*, published by Brenda Vale and Emilio Garcia, highlights the fact that rural environments aren't necessarily less sustainable than high density ones. They go on to argue that, "if there are too many buildings on an area of land then the system can be too rigid," which is something that many new subdivisions are demonstrating in New Zealand (Garcia & Vale, 2017, p. 137). Therefore, openness and compactness/density are an important balance to have when designing resilient and sustainable housing developments. This discussion is relevant to this research, as there must be a balance of densified housing and open preserved landscape in the case study.

Figure. 2.2: Diagram of average footprint of new dwellings across the globe. Adapted from CommSec report data 2017.

Paul Kuitenbrouwer and Raf De Saeger wrote the paper, *High-density, Low-rise – a challenge for Dwelling Landscapes in the Netherlands*, as part of the Housing and Welfare Conference, Copenhagen 2015. The paper expresses the need for low-rise high-density housing solutions in the Netherlands, where the authors pose a relevant research question, “can architects, landscape architects and urban designers secure the landscape to become a main ingredient in their urban densification plans, thus respecting the existing city boundaries?” (Kuitenbrouwer & De Daeger, 2015, p. 145). From analysing a range of successful projects, the paper discusses five design strategies that effectively allow the landscape to integrate with the residential. These five features were repetition, layered landscapes, sustainable living, smart floor plans and textile materialisation (Kuitenbrouwer & De Daeger, 2015). The literature confirms the plausibility for low-rise high-density housing and provides these design considerations for achieving a successful solution.

Finally, Bernard Leupen and Harald Mooij

published the book, *Housing Design: A Manual* in 2011, where the authors analyse and provide information on basic design typologies and spatial organizations at a variety of scales (Leupen, 2011). These typologies and arrangement strategies (Figure 2.3), are relevant design tactics that can be utilized at the three defined methodology scales of this design led research.

2.1.3 Literature Summary

As stated, all these texts are relevant for low-rise high-density design, where the conference paper and the design manual give clear strategies that can be tested in this research. Vale and Garcia’s text gives broad theories on why openness and compactness are important in development and that rural environments are often more sustainable than dense ones. But what the research is missing is proposed strategies on how to achieve this flexible and ‘non-rigid’ built environments. Also, these key publications only define a relationship towards open space or generalised landscape but lacks the specifics on an integration and relationship between agriculture.

Figure. 2.3: Diagram redrawn from text by author, highlighting the linking + stacking and urban ensemble categories.

2.2 Agricultural Integration and Ownership

2.2.1 Agricultural Importance to New Zealand

As mentioned previously, there is a gap in research on specific design strategies for integrated low-rise high-density architecture and agriculture. This is important research for New Zealand specifically, as the economy relies on rural agriculture production and has done for many years. The OEC identified that 45 percent of New Zealand exports are animal products, 12 percent foodstuffs and 7.3 percent vegetable products (OEC, 2017). In a perfect sustainable minded world, the exportation of meat and animal products would be reduced or non-existent. But due to animal agricultural export demand, the industry will be consistently trading for many years to come. Even disregarding animal agriculture, feeding the population through horticulture practice will always be a vital necessity. Hence the importance of integrating the current separate urban and rural entities. But when considering the integration of these entities, the discussion ownership arises. Within New Zealand, the current agricultural ownership consists of private or leased land for agricultural practices. The number of farms in New Zealand have also been consistently decreasing, due to the amalgamation of individual farms as a result of economic pressure, making larger farms a cost-effective solution (McAloo, 2008). Therefore, alternative ownership models for integrating smaller agricultural land and practices have been discussed in the following literature.

2.2.2 Literature Review

Two key texts have been chosen to review, as they highlight the importance

of bridging the gap between urban areas and rural agricultural areas and outline agricultural ownership models within urban areas. The key idea that Dewey Thorbeck advocates for in his book, *Architecture and Agriculture: A Rural Design Guide*, is the importance of design thinking and problem-solving, when bridging the gap between rural and urban environments. He believes that “rural design is a new design discipline that tries to transcend the dichotomy between urban and rural to integrate and make connections at both the macro and micro levels” (Thorbeck, 2017, p. 179). The text discusses the linking of urban and rural issues and how careful design can create resilient futures, without limiting future generations.

Ingrid Jahrl and Otto Schmid discuss solutions to farmland ownership pressures within the chapter, “The Governance of Urban Agriculture and Multifunctional Land Use in the City of Zurich,” from the text, *Toward Sustainable Relations Between Agriculture and the City*, published in 2017. The authors highlight Zurich’s multifunctional approaches to the large area of farmland in the city. Zurich is a growing city, where unlike many New Zealand urban areas, residential living consists of high-density housing. However, 810 ha of land in the city is still dedicated to agricultural practices (Jahrl & Schmid, 2017). Figure 2.4 shows the multifunctional approaches to ownership in Zurich city, and the areas they occupy. These include private farmland, city owned agricultural land, city owned and rented to private owners, city owned gardens organised by associations and

the city, and native woodlands. These different ownership models have worked successfully for the city of Zurich and are models that will be explored when applying to a low-rise high-density context in New Zealand.

2.2.3 Literature Summary

Again, this literature expresses the

importance of architecture and agriculture integrated thinking and provides design methods on how a 'rural design' process might look like. These methods are defined for a masterplan scale, but the research is lacking on specified agricultural design techniques to achieve this. These specific design interventions need to be researched to develop a Peri-Fusion design strategy guide.

This content is unavailable.

Figure. 2.4: Farming and gardening land use within the Zurich city

2.3 Agricultural Typological Research

2.3.1 Agricultural Definitions + Features

In order to achieve an alternative Peri-Fusion housing model for New Zealand's peri-urban zones, a set of Peri-Fusion design strategies must be established. From already discussed literature, we have a strong set of design strategies for designing for high-density low-rise housing. But where the literature is lacking, are in the strategies for how to achieve this agricultural integration with housing. Therefore, further research on agricultural boundaries, access ways, and motifs will be explored. The agricultural boundaries and landscape interventions will not only apply for the landscape, but for architectural boundaries between densified housing. Agricultural design features will be defined by Oxford University's "A Dictionary of Agriculture and Land Management," the University of Mexico's "Dictionary of Landscape Architecture" and "The New Zealand Heritage of Farm Buildings." (Manley, Foot, & Davis, 2019) (Morrow, 1987)(Thornton, 1986).

2.3.2 Literature Review

Agricultural Boundaries: Agricultural field boundaries for livestock control were identified to be banks, fences, dry stone walls, hedgerows, ditches, dykes and ha-has (Manley et al., 2019, p. 238). From these identified boundaries, the Ha-ha wall (Figure 2.5) shows the most potential for achieving agricultural integration. This is due to the uninterrupted line of sight between dwellers on the wall side, to the livestock on the ditch side. This ha-ha wall also has potential for adaptability and iteration to test in the Peri-Fusion housing

model. Banks and planting hedgerows also show potential and practicality as they are more versatile agricultural boundary compared to fences, stone walls or ditches.

Agricultural Access Ways: It is common knowledge that accessways around farms must cater for people, animals and vehicles alike. Features such as cattle stops, catering for people and vehicles and preventing animals' access, is an example of a multi access feature on a farm. Where there is common public accessway through country or farmland, this is called a bridleway (Figure 2.14), which are unsealed tracks for public, animal, and sometimes vehicle use (Manley et al., 2019). Green lanes are also unsurfaced tracks between walls, hedges, fences and ditches, with infrequent use that allows vegetation to grow as shown in figure 2.17 (Manley et al., 2019). Field margins are a buffer strip of grass or vegetation between agricultural land and pathways, to allow habitats for wildlife (Manley et al., 2019). All these features of agricultural accessways can all be used under the strategy 'layered accessways' as the layering of their different uses will be appropriate to different aspects of circulation around the Peri-Fusion model.

Agricultural Level Change: Level change on farmland is a common occurrence due to New Zealand's undulating terrain. This creates a dynamic agricultural setting and has the practical function of controlling site runoff and providing viewpoints. This natural and sometimes man-made level change (Figure 2.18), and previously mentioned features such as the ha-ha

Figure. 2.5. Ha-ha Wall

Figure. 2.6. Banks

Figure. 2.7. Ha-ha Wall + Sunken Fence

Figure. 2.8. Fences

Figure. 2.9. Dry Stone Wall

Figure. 2.10. Hedgerow

Figure. 2.11. Hedge

Figure. 2.12. Ditches

Figure. 2.13. People + Animals + Vehicles

Figure. 2.14. Bridleway

wall and banks, can be useful techniques in Peri-Fusion housing. Level change can be a powerful technique for altering views for privacy, indicating space, and creating viewpoints for dwellers.

Agricultural Motifs and Materiality: Throughout the 19th century, agriculture was the backbone of New Zealand economy and the architecture remaining today has become a “memorial to the early colonial economy” (Thornton, 1986, p. 10). Within the text *The New Zealand Heritage of Farm Buildings*, heritage farm architecture has been extensively documented (Figures 2.19 – 2.24). From these images we can start to observe some simple rural architectural languages and typologies, (Figure 2.25). Most of these rural architectural features have a very practical purpose, as Thornton stated many of these buildings “exemplify the pragmatism and primacy of purpose” (1986, p. 11). Regarding this design led research, instead of these rural forms driving housing design, the idea of practicality as a design driver to meet the needs of occupants. Thornton also identifies a variety of building materials used in New Zealand heritage farm architecture. Timber, earth, stone, brick, concrete, thatch, shingles, corrugated iron, slate and tiles were all mentioned. From observation, simplified materiality categories of timber, corrugated iron and masonry could be successful in Peri-Fusion housing.

2.3.3 Literature Summary

From this evaluation of agricultural typological research, the specified agricultural design techniques have been realised, where these techniques can be applied to densified housing. By applying agricultural landscape interventions and boundaries to housing, and by using these techniques architecturally, this will achieve a full integration between housing and agricultural landscape. Defined agricultural boundaries, access ways and level changes will form the basis of peri-fusion design strategies for designing agricultural landscape, animal control, architectural boundaries and densified housing solutions.

Figure. 2.25. Diagram New Zealand's architectural language of agricultural heritage buildings.

Figure. 2.15. Rolling Landscape + Level Change.

Figure. 2.16. Field Margin.

Figure. 2.17. Green Lane.

Figure. 2.18. Level Change.

Figure. 2.19. Extended Gable.

Figure. 2.20. Pop-Up Gable + Veranda.

Figure. 2.21. Twin Gable.

Figure. 2.22. Arch.

Figure. 2.23. Dormer Window.

Figure. 2.24. Asymmetrical Gable.

This content is unavailable.

03.

Chapter Three

Design Strategies

3.1 Literature + Typological Findings Summary

3.2 Peri-Fusion Design Strategies

3.3 Key Peri-Fusion Strategy: The Ha-ha Wall

Figure. 3.1. (Opposite) Ha-ha wall at the 18th century Berrington Hall in Herefordshire, UK.

3.1 Literature + Typological Findings Summary

Findings from the literature and typological research have been summarised and visualised in figure 3.2. These findings start to provide a set of design strategies or design toolkit, that can be applied and tested on a case study in order to meet the research aim. Going through the five research objectives, key findings have been identified from this list that relate to the respective objectives, where a final Peri-Fusion design strategy framework has been formed.

Final Peri-Fusion design strategies have been summarised on page 27, and how these strategies will be placed within the research methodology.

Objective One: Develop a densified housing solution, with the aim of increasing the number of housing units per hectare and decreasing the average floor area.

- Low-rise high-density techniques.
- Agricultural motifs

Objective Two: Create an integrated housing and landscape solution, that injects agricultural/rural architectural motifs into the architecture, while retaining the qualities of the desired standalone home.

- Agricultural motifs
- Agricultural boundaries
- Level change between dwellings

Objective Three: Increase the amount of preserved greenfield or agricultural land (soft surfaces) while decreasing sealed land coverage (hard surfaces).

- Agricultural boundaries
- Agricultural accessways

Objective Four: Increasing sustainability and housing resilience by actively embedding housing into a natural resource cycle.

- Agricultural boundaries
- Agricultural accessways

Figure. 3.2. Literature and typological visual summary. Low-density high-rise section adapted and redrawn from literature.

3.2 Peri-Fusion Design Strategies

Peri-Fusion Design Strategies

Primary Strategy: The Ha-ha Wall	
Agricultural Boundaries	
Layered Agricultural Access	
Rolling Landscape + Level Change	
Rural Motifs + Materiality	

Figure. 3.3: Final Peri-Fusion Design Strategies

Peri-Fusion Operational Strategies

Figure. 3.4: Final Peri-Fusion Operational Strategies.

Figure. 3.5: Peri-Fusion strategies and methodology summarised.

3.3 Key Peri-Fusion Strategy: The Ha-ha Wall

The ha-ha wall is a sunken wall in the landscape, accompanied by a ditch that levels back out to ground level. The traditional ha-ha section can be seen in iteration 1 of figure 3.7. The ha-ha wall emerged in the 18th century in Britain as a physical barrier for livestock, where it “preserves an uninterrupted view across the landscape” (Manley et al., 2019, p. 268). As a partially visible barrier, this agricultural landscape feature can be used to generate privacy, control access, indicate boundaries, and as well as in its original role, as a barrier to extensive livestock. Hence why it will be used as the primary peri-fusion tactic, because of the multiple design outcomes it can create through its multiple iterations. It also has the strongest uninterrupted visual integration between people and animals, which is the strongest overall strategy for integration between housing and agriculture. A ha-ha wall iteration study was conducted to reveal the potential solutions of this adaptable element (Figure 3.7). Heights, level changes and sloping iterations were iteratively applied to the ha-ha wall to test view lines, if the ha-ha wall is to be used to generate privacy and indicate property boundaries. Also, the inverted ha-ha wall and the spaces it created was explored. Sight lines between human and animals were not tested as we know this was the

successful feature with its original use. When ha-ha wall heights exceeded the 1m regulated height without a barrier (Figure 3.6), additional iterations had to be made. The iteration study concluded in multiple adaptations of the ha-ha wall, which can be tested and applied into the Peri-Fusion housing model where it is qualitatively deemed most suitable.

Figure. 3.6. Acceptable Solution F4/AS1. Safety from falling.

Figure. 3.7. Iteration study on the ha-ha wall.

04.

Chapter Four

Case Study

4.1 Site Selection

4.1.1 Blenheim Case Study

4.1.2 Demographics

4.2 Site Analysis

4.2.1 Urban Analysis

4.2.2 Climate Conditions

4.2.3 Existing Structures

4.2.4 Surrounding Context

4.3 Programme

4.3.1 Blenheim Statistics

4.3.2 Agricultural Industry + Education

4.3.3 Proposed Programme

Figure. 4.1: (Opposite) Aerial image of a section of Waterlea Racecourse

4.1 Site Selection

4.1.1 Blenheim Case Study

Blenheim was chosen as the urban area to test Peri-Fusion housing, as it currently demonstrates unsustainable developer-led urban sprawl, driven by the one storey housing model. Figure 4.3 shows where these developments are taking place in the peri-urban zone, where they are invading highly productive fertile land. The site selected for this case study is Waterlea Racecourse (Figure 4.3) due to its size, distance from the CBD, and currently has a mixed use of agricultural land and racecourse facilities (greenfield and grey field land). The methodological steps taken in this chapter will be analysing the site and surrounding context, to determine a programme for the site that will address research objectives for Peri-Fusion housing.

4.1.2 Demographics

Blenheim is a sizable urban area at the top of the South Island in the Marlborough region (Figure 4.2). The estimated population in 2018 was 31,600, and the greater Marlborough region is estimated to be 46,600 (Marlborough District Council, 2018, p. 13). By 2043 one third of Marlborough residents will be 65 years or over, where the medium age is 48.6. The average household size is 2.2 people, compared to the national average

Figure. 4.2: Map of New Zealand highlighting significant urban areas

of 2.7 (Statistics New Zealand, 2013). Demand based off building consents issued over the past 10 years and the forecasted population growth, it is estimated that 110 dwellings will be needed per annum in Marlborough, therefore potentially up to 3300 new houses must be constructed in the next 30 years. Hence why, Blenheim has been selected to test Peri-Fusion housing, due to the predicted housing demand. This research also would be applicable on one of the many other urban areas with the population over 10,000 (Figure 4.2).

Figure. 4.3: Blenheim site map.

4.2 Site Analysis

Figure. 4.4: Site plan of Waterlea Racecourse. 1:5,000 @ A4. Grid showing 50m2.

4.2.1 Urban Analysis

Waterlea Racecourse is 31.14Ha section of land (565m x 555m), northwest of the CBD. Walking time to the CBD is an average of 23.5 minutes, where there are many public amenities and schools in walking distance to the site (Figure 4.5). Therefore, this site option is a more sustainable option for a housing,

than the current development in Blenheim's peri-urban zones. However, the site can still be considered being within the peri-urban zone, as it is on the fringe of the urban context and most of the site is used for agricultural practices. There are two main access points to the site, as shown on figure 4.4.

Figure. 4.5: Urban analysis of Waterlea Racecourse. 1:30,000 @ A4

4.2.2 Climate Conditions

Wind: In Blenheim prevailing winds are from the west and little from the east (Figure 4.6). This is due to the sheltering of southern hill country and the mountain range to the north. All strong winds recorded at Blenheim airport, 36% occurred in summer, 17% in autumn, 10% in winter and 37% in spring, where the average annual wind speed is 14.6km/hr (Chappel, 2016, p. 14). Since the test is a flat site with little immediate shelter, prevailing winds from the west must be taken into considerations when designing.

Water: Due to the east coast positioning, Blenheim receives less than 800mm of rain each year with the summer months generally records the lowest proportion of annual rainfall (Chappel, 2016, p. 16). These dry, warm conditions make the perfect climate for specific horticultural practices. Viticulture and orchard cropping are very common around

Blenheim's urban centre, plays a large part in the Marlborough economy and brings many seasonal workers to the area. These horticultural practices will be considered in the integration with Peri-Fusion housing.

Sunshine Hours and Temperature: Blenheim generally has a very sunny climate, where in 2018 it had the third highest annual sunshine total of 2503 (NIWA, 2019, p. 5). Winter and summer solstices sun paths are shown in figure 4.7, where midday sun at the winter is 14° and in summer at 56°. Marlborough's average annual maximum temperature is 23-24 °C, minimum 2-3 °C and the mean air temperature is 11-12 °C (Chappel, 2016, p. 23). Since the site is large and flat with little shading apart from mature trees on the south-west edge of the site, this location is perfect for Peri-Fusion housing and horticultural practices.

Figure. 4.8: Blenheim panorama with Waterlea Racecourse in the foreground.

Prevailing Wind Diagram

- 1-20 km/hr
- 21-30 km/hr
- 31-40 km/hr

Figure. 4.6

Sun Path Diagram

- December Solstice
- June Solstice

Figure. 4.7

4.2.3 Existing Structures

It is feasible that Waterlea Racecourse will be turned into housing in the near future, making this thesis research relevant for a potential solution. The site is currently occupied by 24 buildings on a gravel area, a dirt racetrack and greenfield land that is used to graze the horses (Figure 4.9). As of 2016, sixty horses lived at the track permanently, where the facilities have the capacity for 150 horses to house during the two major races the club holds annually (McPhee, 2016). In 2018 it was announced that 20 racecourses around the country were to be closed, but this didn't include Waterlea (McPhee, 2016). But there is an uncertain future for the land, as it is highly sort after by the council and the Ministry of Education for a new high school. Marlborough Mayor, John Leggett, states in a Marlborough Express article that he, "expected most the land to become residential," and at the council they have, "plans to develop the residential area out towards the northwest" (Eder, 2019).

Observing the current conditions of the

buildings, they range from many tired and falling apart stalls, to functioning sheds, grandstand, stables, and the club rooms. Since the research focus for this thesis is an alternative model for new integrated densified housing and agriculture, it will be assumed that these structures will be sustainably and adaptively reused to take advantage of constructing on grey field land. These assumptions will be made in the masterplan for the site, but not taken into any further detail. For the purpose of sustainability, reprogramming of these buildings will only be mentioned, as this is not a heritage reuse study.

Even so, these buildings demonstrate strong agricultural motifs and materiality. Horizontal and vertical timber cladding, block work and functional steel gates and fixtures are used throughout the site. From these existing structures, we can clearly observe the agriculture architectural language being derived from functionality, where the design of Peri-Fusion housing will be driven by these features.

Figure. 4.9: Aerial images showing many of the existing buildings at Waterlea Racecourse.

01.

Site Access

02.

Site Access

03.

Site Access

04.

Property Cottage

05.

Stables

06.

Stables

07.

Stables

08.

New Stables

09.

New Grandstand

10.

Tot Building

11.

Old Grand Stand

12.

Club Rooms

Figure. 4.10: Images 1 - 12 showing different existing structures on site.

4.2.4 Surrounding Context

The immediate surrounding context to Waterlea Racecourse is primarily residential to the east and west, a public park and golf course to the south and rural horticultural land to the north (Figure 4.13). The site is also in very close proximity to schools, a rugby club, backpackers and a rest home (Figure 4.13). If there is going to be a large amount of new housing for this case study research potentially occupying this site, more public amenities may be necessary. Convenience stores, marketplaces, healthcare facilities, sport facilities, local café, playgrounds and community hall could all be beneficial community attribute to this case study housing development. The potential new amenities for the masterplan will be explored in the conceptual design phase.

An initial residential property density study was conducted to get an understanding of the current urban density that the new housing development will coexisting with. 45 houses around the perimeter of the site were examined in this density study, where council property records identified total floor area for

dwelling and the property area (PropertyNZ Ltd.). The average floor area for the dwellings in the immediate context was 157m2 and the average property area was 847m2 (Figure 4.11). These are generous areas, that gives an indication of the nature of the detached dwelling urban sprawl in the area. This case study design will aim to be denser than this existing context, and instead of having continuous large privately-owned property, there will be an integration of open agricultural land to strive for a resilient model. The increase of soft surfaces (unsealed) and the decrease of hard surfaces (sealed roads, driveways, houses etc) in the Peri-Fusion model, will be measured for success against the adjacent 31.4Ha of land (Figure 4.12).

	Floor Area	Property Area
Minimum	80m2	328m2
Maximum	307m2	1547m2
Average	157m2	847m2

Figure. 4.11: Density study.

Figure. 4.12: Adjacent plot of land that will be used to measure the success of Peri-Fusion housing.

Figure. 4.13: Site plan with surrounding context highlighted.

1. Marlborough Technology Centre	6. Mayfield School
2. Waterlea Lifecare Rest Home	7. Blenheim Golf Course
3. ABC Learning Centre	8. Pollard Park
4. Central Rugby Football Club	9. Horse Grazing Paddocks
5. Leeways Backpackers	10. Viticultural/Rural Land

Residential Property Density Study
Education
Other Ammenties
Site Buildings
⋈ Bus Stops

4.3 Programme

4.3.1 Blenheim Statistics

To define a programme and housing typologies, some further demographic studies on household composition, professions and travel in Blenheim were undertaken. The 2013 census identified as shown in figure 4.14 that 58.1% of houses in Blenheim were made up of one family households, 34.6% were one person households and 7.3% were multiple people or families (Statistics New Zealand, 2013, p. 10). In Blenheim's Housing and Business Development Capacity Assessment (Marlborough District Council, 2018), the report identifies that in a study of average annual dwelling sales by number of beds, 54% were three bedrooms, 21% was four bedrooms, 20% was two bedrooms, 4% was five bedroom and 1% one bedroom (Figure 4.15). But the council has forecasted that smaller homes will have more demand in the years to come, stating that "feedback from stakeholders is that there is a shortage of 1- and 2-bedroom homes in Blenheim" (Marlborough District Council, 2018, p. 32). The 2013 census also concluded that 71.5% of people get to work by vehicle and only 14.2% by foot (Statistics New Zealand, 2013, p. 12). This is an unsustainably large amount of people driving, due to Marlborough's minimal public transport options. From these Blenheim statistics, 2-4-bedroom housing is the most in demand size, where the increase of smaller housing will be included in the case study housing program. It is also clear that there is a reliance on the private vehicle, where the Peri-Fusion case study is in

close proximity to Blenheim's CBD, which will promote other forms of travel.

4.3.2 Agricultural Industry + Education

Blenheim has a unique industry due to Marlborough's dry climate, where 77% of New Zealand's wine grape production comes from Marlborough (Marlborough District Council, 2018, p. 18). At the Nelson Marlborough Institute of Technology, there are several tertiary level qualifications for horticulture and viticulture based in Blenheim. Institutes like these need land for the students to gain practical physical experience, which is something that could be integrated into the case study. Education in agriculture incorporated into urban dwelling is an important notion when developing sustainable cities, just as Dewey Thorbeck states, "urban agriculture may be a key component of future urban land use and a strategic resource that cities, townships, counties and states can utilise in planning that recognises the values of agriculture in economic, social and environmental terms" (Thorbeck, 2017, p. 167). Therefore, agricultural education not only for tertiary education, but for all schools and the general public, will help the public realise the importance of urban agriculture and transition their thinking. Hence why, an agricultural education will be an important part of the Peri-Fusion housing programme, for this large site in Blenheim's peri-urban zones.

Figure. 4.14: Blenheim Households (Statistics NZ)

Figure. 4.15: Average Annual Dwelling Sales by Number of Beds 2014-2018 (Statistics NZ)

4.3.2 Proposed Case Study

Programme

From surrounding context, demographic and industry analysis of Blenheim, the following proposed programme includes:

Built Public Amenities:

- Convenience store and market area.
- Community hall.
- Sports courts.
- Medical facility.
- Local café.
- Day care facility and playgrounds.

Agricultural:

- Extensive agricultural grazing for sheep/goats/chickens.
- Intensive horticulture dedicated to housing (community/private gardens).
- Horticulture dedicated to education centre.
- Combined agriculture and horticulture education centre.
- Amenities (wool sheds, hay sheds, coups).

Housing:

- Low-rise high-density with three typologies which are row housing, semidetached, and detached housing.
- Proposed percentage of 1-5-bedroom housing as shown in figure 4.16.
- Housing will have a semi-public entrance integrated with agriculture and a private 'backyard' area.

Figure. 4.16: Proposed housing programme.

Built Public Amenities

Community Hall

Convenience Store/Markets

Sport Courts

Medical Facility

Day Care Facility

Local Cafe

Agricultural

Agricultural Amenities

Agricultural Education

Extensive Grazing

Intensive Horticulture

Proposed Housing Typologies

Detached Housing

Semi-Detached Housing

Row Housing

Figure. 4.17: Proposed peri-fusion programme.

05.

Chapter Five

Case Study Preliminary Design

5.1 Masterplan Scale 1:2000

- 5.1.1 Precedent Study*
- 5.1.2 Precedent Findings*
- 5.1.3 Concept Design Testing*
- 5.1.4 Findings + Critical Reflection*

5.2 Street Scale 1:1000

- 5.2.1 Precedent Study*
- 5.2.2 Precedents Findings*
- 5.2.3 Concept Design Testing*
- 5.2.4 Findings + Critical Reflection*

5.3 Home Scale 1:100

- 5.3.1 Precedents Study*
- 5.3.2 Precedent Findings*
- 5.3.3 Concept Design Testing*
- 5.3.4 Findings + Critical Reflection*

Figure. 5.1: Typical New Zealand Agricultural Scene

1:2000

5.1 Masterplan Scale Concept Design

Introduction

Before concept design at the 1:2000 scale commenced, residential masterplan precedents of a relevant scale were analysed. From these evaluations a series of successful design features were identified and considered alongside Peri-Fusion strategies (Figure 5.2), when producing conceptual designs for Peri-Fusion housing. After reviewing a range of case studies, the following were selected as they had the most similar characteristics and aims that the potential case study housing model will possess.

The masterplan for Peri-Fusion housing was conceptually tested at the 1:2000 scale in plan. Zoning of areas according to the proposed programme for the site was explored through a trial and error process, evaluating the successes of the design according to the site. The peri-fusion tactics that were tested and space was dedicated to these were layered access ways, agricultural boundaries, extensive grazing, intensive horticulture, agricultural education space, public amenities and infrastructure. Ownership models of land use were also considered at this stage of the design.

1:2000 Peri-Fusion Strategies

Figure. 5.2: Masterplan Peri-Fusion Tactics.

5.1.1 Precedent Study

Village Homes - Mike Corbett.

Construction 1975-1982

Total area: 24.3ha

No. of lots: 244

Average lot size: 370m²

Even though developed and constructed in the 1970's, Village Homes in Davis, California is still considered to be a leading model of sustainable planning (Wack, 2005, p. 36). A main design feature in this development is the preservation of open space, where central green, vineyards, orchards, common areas (Figure 5.4), playgrounds, drainage swales, community gardens, private courtyards and bicycle and pedestrian paths (Figure 5.5). Overall there is 4.9Ha of open green space and 4.9Ha of common agricultural land. From the masterplan (Figure 5.6), we can see that open green space in the middle of the residential housing, and intensive horticulture on the edges. The paths and roads show pedestrian and bicycle paths receive higher hierarchy than the narrow, curving cul-de-sac streets. The curvaceous and integrated masterplan demonstrates Garden City Movement features, and shows the importance of careful urban planning.

This content is unavailable.

Figure. 5.3: Home and planting

This content is unavailable.

Figure. 5.4: Common area

This content is unavailable.

Figure. 5.5: Bicycle & pedestrian paths

This content is unavailable.

Figure. 5.6: Village Homes masterplan (not to scale)

Nanhu New Country Village Master Plan - SOM

Location: Jiaxing, China
Design Completion: 2011
Site Area: 1,140 Ha
Project Area: 223 Ha

This masterplan located in Jiaxing, China, is a proposed masterplan in reaction to China's accelerating urbanisation that is rapidly depleting agricultural landscapes (SOM, n.d.). Although this project is significantly larger than the site for Peri-Fusion housing at 223 Ha, it holds similar values in agricultural preservation and integration. Figure 5.10 highlights these values, where out of the total 1,100 Ha, 500 Ha will be organic farms, 100Ha will be eco-tourist farms. This masterplan uses the compact technique and Garden City Movement features successfully. What is unique about this project is the water canals and wetlands that integrate and support modern agricultural production, quality and value.

Figure. 5.7: Nanhu community based agriculture

Figure. 5.8: Nanhu street

Figure. 5.9: Nanhu Master Plan Visualized

Figure. 5.10: Nanhu New Country Village Master Plan.

Andrew Peterson Farmstead - Dewey Thorbeck

Location: Carver County, Minnesota.
Grant for restoration assessment: 2010
Site Area: 4.8 Ha

Thorbeck Architects Ltd designed a master scheme for the restoration of the historic Andrew Peterson Farmstead in 2010, where the aim of the project was to “become a public forum for discussion about urban agriculture and community aspects and impacts of urban sprawl”(Thorbeck, 2017, p. 163). This project is important for agricultural education aspect of Peri-Fusion housing. The project plan included an apple orchard, vegetable gardens and crop plots that would be leased to urban farmers to sell at the Twin Cities farmers market (Figure 5.11). The educational building provides, “public information, ticketing, management offices, an orientation theatre, interpretive exhibits, public toilets, grounds maintenance and a caretakers apartment”(Thorbeck, 2017, p. 166). Thorbeck has identified that this project is in the peri-urban zone (Figure 5.12), where the project aims to act as a catalyst for discussion of the people of Carvery County and the responsibility, they have in maintain the rural land that they depend on. This is the values that Peri-Fusion housing should encourage through its education component, and general example to the public of a different way of living integrated with agricultural environments.

Figure. 5.11: Andrew Peterson Farmstead Masterplan.

Figure. 5.12: Diagram showing Twin Cities peri-

Figure. 5.13: Concept for the Andrew Peterson Farmstead education building.

Figure. 5.14: Initial parti diagrams exploring urban plan zoning.

5.1.2 Precedent Findings

From these precedents, it was clear that the zoning and consideration of where green spaces, walkways and the built environment is situated is important to the outcome of the project. Village Homes' central green space and fringe of agriculture showed successful yet restrained integration, along with the Nanhu masterplan with the surrounding agriculture integrating built environment through corridors. Prioritising non-linear pathways was also a common theme in all precedents, and the roads and carparking as a secondary system in the urban plan. The involvement of the eco-tourist farming in Nanhu and the Andrew Peterson Farmstead education building gave examples of how an agricultural educational component could look like in Peri-Fusion housing, where a New Zealand adaptation of these solutions will be explored.

Parti Diagrams

Initial abstract parti diagrams were produced to start to develop the potential zoning for agricultural land, public green space, community and educational areas, walking access ways and road access ways (Figure 5.14). From these initial studies, the discussion of the use of the original racetrack was explored,

whether to turn it into a road system, walking/cycling system, or to remove the shape from the site completely. Also green corridors and green central areas were explored and how they could drive the urban plan, before considering the built residential areas.

Following the parti diagram study, these basic concepts were explored further in plan at 1:2,000 through hand-drawing. Main spatial planning for open green space, extensive agriculture, intensive horticulture, roads, walkways and community/education areas were explored. Remaining white space is where low-rise high-density residential development will take place.

5.1.3. Concept Design Testing

Concept One:

Concept one looks at fragmented integration of smaller green pockets throughout the centre of the existing racecourse, where the racecourse is converted into a road. Another road intersects the crossroad, with branching col-de-sacs leading directly to housings and green space. This concept has too many road/hard surfaces and col-de-sacs mimicking suburbia and unnecessarily increasing hard surfaces.

Figure. 5.15

Figure. 5.16

Concept Two:

Concept two focusses on drawing a line of access from the rural land of the north, down to the green park below the site, through a green corridor/walkway. The roads intersecting this green space isn't as successful, and again the dead-end road mimics suburbia. A continuous roading system will be more effective. A community and educational centre have been shown on the southern section of the site.

Figure. 5.17

Concept Three:

This concept has a focus on a central green area with a curvaceous road system and a pinwheel array of walkway networks. Less roading has been used which is successful as is the central green area, but consideration of agricultural animal and vehicles need consideration in this plan.

Figure. 5.18

Concept Four:

With this concept, the northern fringe of the site is highlighted and continues through to a central green corridor. The roads are expressed as continuous which is more successful than previous concepts, but hard surfaces could be decreased even more. Agricultural education has been shown on the south fringe and community buildings shown integrated into the central green corridor.

Figure. 5.19

Concept Five:

Concept five focuses on large green corridors, driving into a central community area with the educational centre at the south end of the site. This plan has resulted in excessive roading to get to the central community public area of the site. Therefore, having both the community areas and educational buildings in proximity will decrease roading (hard surfaces).

Figure. 5.20

Concept Six:

Again, utilising all accessways, this concept tries to reduce the hard surface areas of the roads, by creating two continuous 'loops.' This loop idea is strong as it challenges the current linear grid and col-de-sac of suburbia. A ribbon of green agricultural land moves through the site where it provides a walkway from southern public community areas to northern rural side of the site. The disconnect between two road systems might be less successful.

Figure. 5.21

Figure. 5.22

Concept Seven:

This concept tests the idea of letting the unsealed dirt track be rejuvenated to green field space over time, which is a successful concept. The parallel roading at the northern and southern ends of the site conflict with the organic green spaces around the site. But the intensive horticulture leading from the education buildings to the middle of the site is an interesting feature, along with a public walkway, will draw people into the middle of this Peri-Fusion model.

Concept Eight:

This concept carries through this idea of continuity in access, utilising half of the existing racetrack. This is the most successful concept so far due to the roading working as one system integrated with the flow of green spaces. But the multiple accessways seem unnecessary, especially on the east side of the site

Figure 5.23: Final masterplan concept design.

5.1.4 Findings + Critical Reflections

This final concept for the masterplan was derived from findings of the initial eight concept testing, where this final concept design (Figure 5.23) used the following peri-fusion design strategies:

- Infrastructure: It was determined that access by car, limited to two main points on the west and east of the site, was the solution that limited hard surfaces the most. The one narrow continuous ring road following the shape of the existing racetrack as the main access for residents, again limiting sealed surfaces on site.

- Layered access ways: The existing racetrack will become a walkway, cycleway and access to move livestock around the site. This is successful as it will be allowed to grow out overtime, so eventually this will become a green walkway, increasing unsealed surfaces.

- Agricultural boundaries and extensive grazing: The northern fringe of the site will be agricultural land, highlighting the northern context beyond the site. There will also be a main agricultural green strip that will draw down the side from north to south, creating a green agricultural walkway front the park to the south to the northern rural country. These areas will control people and animal movement with the ha-ha wall.

- Intensive horticulture and education: Community amenities and agricultural education buildings will be adaptive reuse of existing site buildings on the southern end of the site, where the intensive horticulture and a walkway will people into the middle of the site.

- Horticulture and ownership: Main horticulture areas dedicated to housing, (or community gardens) will run along the inner edge of the racetrack walkway, where the ha-ha wall will create an agricultural boundary between the public and residents.

These strategies will be tested through sectional studies to determine the successful spatial. The dotted area shown in figure 5.23, shows the area that will be explored at the 1:1000 level in the following continued concept design phase.

1:1000

5.2 Street Scale Concept Design

Introduction

Before concept design at the 1:1000 scale commenced, residential development precedents at the street scale were analysed. From these evaluations a series of successful design features were identified and considered alongside Peri-Fusion strategies, when producing conceptual designs for Peri-Fusion housing. After reviewing a range of case studies, the following were selected as they had the most similar characteristics and aims that the potential Peri-Fusion housing model will possess.

The 'street level' for Peri-Fusion housing was conceptually tested at the 1:1000 scale in plan and section. Zoning the areas according to the proposed programme for the site was explored through a trial and error process, evaluating the successes of the design according to the site and Peri-Fusion characteristics. Layered accessways, agricultural boundaries, extensive grazing, intensive horticulture and rolling level change were all primary peri-fusion tactics that were tested (Figure 5.24). The detached, semi-detached and row house from the proposed programme was used to start testing options for urban ensemble layout (Figure 5.25).

1:2000 Peri-Fusion Strategies

Figure. 5.24: Peri-Fusion tactics.

Figure. 5.25: Urban ensemble tactics.

5.2.1 Precedent Study

Looren Housing Complex – Metron AG.

This concept was chosen because, even though it is not in the peri-urban zone, it has interesting features that would be successful in a Peri-Fusion housing model. This includes the half-sunken and half covered communal car parking running along the row of housing (Figure 5.26), which creates a level change within the site and gives hierarchy to the housing and greens space, instead of the vehicle. Another successful feature of this complex is the semi-detached houses (Figure 5.27, 5.28) and how the main separating walls between units is extended into a fence line, where it then stops to allow common green space beyond. This creates the sense of a private backyard and successfully combines into common green space. This level of openness might not be as desired in a New Zealand compared to European living, as backyards have high levels of privacy, but this technique could be tested to function in a New Zealand housing.

This content is unavailable.

Figure. 5.26: Half-sunken car parking.

This content is unavailable.

Figure. 5.27: Semi-detached housing.

This content is unavailable.

Figure. 5.28: Looren housing complex site plan (not to scale).

**Earthsong Ecovillage - West Auckland.
Robin Allison & Community.**

This cohousing development was built in 1995, which is a New Zealand model of social and environmental sustainability. The based on the principals of permaculture, where the development has a variety of productive and edible landscaping, native bush and orchard areas. Half of the site (6000 m2) is common open green space, where 20% of that space is private gardens around the housing (“Earthsong Eco-Neighbourhood | Cohousing NZ,” n.d.). This balance between private and community run space is very successful for this housing model. The ownership and maintenance of these productive green spaces are very community orientated, where this sort of system might not work for a large scale Per-Fusion housing model, therefore other alternatives must be explored.

The dwelling types are a variety of semi-detached houses, which use passive solar design and PV panels to reduce energy use of dwellings. The dwellings are densified to reduce the physical footprint on site, where housing floor areas range from to 56m2

to 122 m2. The units are arranged in an organic free-form layout around a central curvaceous path at different orientations, giving visual variety to the standard linear grid of suburbia. Common carparking for the site is on the edge of the site to encourage physical exercise and social connections. The materiality of the scheme is based on natural and functional materials.

Figure. 5.29: Earthsong housing

Figure. 5.30: Earthsong housing

Figure. 5.31: Earthsong housing development.

The Gardens (Haverne).

Schmidt Hammer Lassen Architects.

In 2008 Schmidt Hammer Lassen won the Vejle Prize with 'The Gardens' located in Jelling, Denmark (Baun, 2017). But only ten of the proposed eighty houses ended up being constructed due to the market collapsing (Figure 5.34). This proposed development showed potential with its central green space and aesthetically interesting and diverse architectural forms, challenging suburban models. The architects described the clustering of "six dwellings enclosed by each of their projected garden walls," which is a good example of compacting and releasing in plan (Baun, 2017). But there are unsuccessful attributes, for instance the covered parking directly in front of housing gives priority and hierarchy to the private vehicle in this housing model (Figure 5.32). Also, since the houses are compacted closely together and at the same level, there is issues with privacy between dwellings (Figure 5.33). Since the central green space is surrounded by access road, there isn't clear and pedestrian friendly pathways to and throughout the central green space. Therefore, level change and a pedestrian priorities scheme will be successful for Peri-Housing.

This content is unavailable.

Figure. 5.32: Carparking in front of housing.

This content is unavailable.

Figure. 5.33: View into neighbour's house.

This content is unavailable.

Figure. 5.34: Current development.

This content is unavailable.

Figure. 5.35: Proposed development.

Figure 5.36: Initial sketch design exploration

Precedents Findings + Initial Diagrams

5.2.2 Precedent Findings

The 1:1000 precedent studies showed some important features that should be taken into consideration alongside the already established Peri-Fusion design strategies. The sunken carpark and semi-private to public zones created in the Looren housing complex showed strong hierarchy towards open green space and housing over the private vehicle. Earthsong Ecovillage demonstrated the free-form layout, public and private gardens, and the clustering of communal carparking on the edges of developments were successful attributes. And finally, from The Gardens it was clear that level change between dwellings will improve privacy, and direct integration to green space through pathways is beneficial to developments.

Initial Diagrams

Initial sketch diagrams explored different layouts and densities throughout the masterplan conceptual design stage. Housing orientation, clustered dwellings, and carparking and vehicle access started to be tested loosely to get an understanding. Hierarchy of primary and secondary road and pathway networks started to form, along with common green open spaces (Figure 5.36).

Figure. 5.37: Street level concept plan (1:2000 @ A4)

Figure. 5.38: Street level concept section (1:1000 @ A4)

5.2.3. Concept Design Testing

Concept One

Concepts were explored at 1:1000 in plan (Figure 5.37) and section (Figure 5.38), where the plan has been scaled down to 1:2000 for reading purposes. Urban ensemble techniques of the Free Composition and Ribbon Development were tested in this concept. Denser row housing was placed on the south-west site of the site, and when crossing over the public walking track, the housing becomes less dense semi-detached and detached housing. This area in the free composition randomised free-form layout, where access from communal carparking is via curved random parking. There is a central green area within ribbon row housing, which could be suitable for further extensive grazing. But due to the randomised nature of the lower density freeform layout, integrating extensive grazing into this plan would be difficult. A more ordered solution will be explored. Layered access ways, agricultural boundaries (focusing on the ha-ha wall), extensive grazing, intensive horticulture and level change was explored through section (Figure 5.38). The sunken carpark was also looked at as a technique, which is successful in terms of challenging suburban motifs and giving hierarchy to landscape over the private vehicle.

Figure. 5.39: Urban ensemble & Peri-Fusion tactics

Figure. 5.40: Street level concept plan (1:2000 @ A4)

Figure. 5.41: Street level concept section (1:1000 @ A4)

Concept Two

This concept tested a more ordered layout of dwellings, using the urban ensemble techniques of a fragmented semi-open block, or a villa park layout for the less dense area, and sun orientated rows for the denser row housing (Figure 5.40). These layouts give more defined areas for potential extensive grazing between dwellings, that could be monitored more easily from the public walkway/ access way, where livestock will be moved. Again, half-sunken communal carparking was explored, trying to place these spaces under dwellings to reduce hard surfaces on site. Private garden areas have started to be explored, where they are potentially too large on the semi-detached and detached dwelling area. The straight path from communal carparking towards public walkway and the straight characteristics of the row housing are less successful as they don't demonstrate the organic nature of successful Garden City Movement, and don't follow the curvaceous nature of the ha-ha wall.

Figure. 5.42: Urban ensemble & Peri-Fusion tactics

Figure. 5.43: Street level concept plan (1:2000 @ A4)

Figure. 5.44: Street level concept section (1:1000 @ A4)

5.1.4 Findings + Critical Reflections

This final street level concept that was tested at 1:1000, where the villa park and ribbon development urban ensemble techniques were used. The staggered row housing gives interesting opportunity of additional light into row houses and follows the inverted curving ha-ha wall between the rows (Figure 5.43). This ha-ha wall acts as a property boundary between private backyards and semi-public gardens or extensive grazing with walkways to the public accessway. The semi-detached and detached housing are in the villa park layout, where the orientation is parallel to the public accessway and again follows the curve of the ha-ha wall and pathway. These curved pathways and ha-ha walls define areas of potential extensive grazing between dwellings, where the layered pathways for people and animals all lead to the main public accessway of the existing racetrack.

Critical Reflection

Further densification, level change and agricultural boundaries will need to be developed in the plan and section to achieve maximum green space and decrease sealed surfaces for the case study. Access points and movement around the site needs to be resolved.

Figure 5.45: Urban ensemble & Peri-Fusion tactics

1:100

5.3 Home Scale Concept Design

Introduction

Before concept design at the 1:100 scale commenced, minimum best average floor areas for dwelling were established to aim for when starting the concept design phase. These were derived from average minimum best practice floor areas from different countries around the world. Then residential dwelling precedents at the home scale were analysed. From these evaluations a series of successful design features were identified and considered alongside Peri-Fusion strategies, when producing conceptual designs for the case study. After reviewing a range of case studies, the following were selected as they had the most similar characteristics and aims that the potential Peri-Fusion housing model will possess.

The 'home level' for Peri-Fusion housing was conceptually tested at the 1:1000 scale through hand drawing in plan and section. The three housing typologies that were tested for Peri-Fusion housing are detached, semi-detached and row housing. Rural form, rural materiality, agricultural boundaries and rolling level change will be the primary peri-fusion tactics when testing at 1:100. But also, low-rise high-density strategies realised from literature, such as repetition, layered landscapes, sustainability, smart floor plans, textile materialisation and detached home perceived qualities were implemented into design research.

1:2000 Peri-Fusion Strategies

Figure. 5.46: Peri-Fusion tactics.

Figure. 5.47: Low-rise high-density tactics.

Minimum Internal Gross Floor Area

For the range of housing sizes (Figure 5.48), the minimum internal dwelling area (MIDA) were examined for housing in the Auckland Design manual (NZ), London Housing Design Guide (UK) and the suggested MIDA per person in the Housing Space Standards (UK). An average was derived from these values of best practice to establish the minimum best practice internal dwelling area ranging from one bedroom to five bedrooms (Figure 5.48). These minimal densified floor areas will be the goal when trying to achieve densified Peri-Fusion housing. MIDA can be measured against the final designs floor area to measure the success of these densified units.

Design research for detached, semi-detached and row housing as the main tested housing typologies will be allocated different housing scopes according to bedroom numbers, to cover a range of potential sizes. These sizes are shown in figure 5.49, where each typology will aim to meet the specified MIDA.

	NZ MIDA	UK MIDA	MIDA Per Person	Average MIDA
1B 2P	50m ²	50m ²	44m ²	48m ²
2B 4P	70m ²	70m ²	67m ²	69m ²
3B 5P	90m ²	86m ²	81m ²	86m ²
4 B 6P		99m ²	92m ²	96m ²
5B 7P		112m ²	105m ²	109m ²

Figure. 5.48: MIDA study

4B 6P	1B 2P + 2B 4P	3B 5P
96m ²	48m ² 69m ²	86m ²

Figure. 5.49: MIDA and typologies summary

5.3.1. Precedent Study

Newhall Be - Harlow, UK. Alison Brooks Architects.

This case study was chosen for its success in density yet providing privacy, connection to rural form and materiality, and showing qualities of the standalone home. The design intended to half standard garden sizes of the area and replacing them with garden terraces, “equalling the land lost” (Alison Brooks Architects, n.d.). The roof forms and materiality were inspired by Essex’s rural buildings, which is successfully portrayed in aesthetics and spatial qualities (Figure 5.51). The inspired roof form provided an extra finished room for an office space, spare bedroom or storage (Figure 5.53). Areas that could be improved in terms of Peri-Fusion housing, is the connection and integration with green spaces and agricultural.

Figure. 5.50: Essex’s rural heritage

Figure. 5.51: Newhall Be row housing

Figure. 5.52: Newhall be showing the row housing integrated into masterplan

Figure. 5.53: Newhall Be ground floor, first floor and second floor (not to scale)

Quartier Garmisch - Beer Bembé Dellinger

This housing development of 20 units in Garmisch was chosen as a precedent because of its simple and functional forms, materiality, shading, and its connection to a semi-public green space between the row of units. The row housing is open at two ends of the unit, where one end faces a central green corridor (Figure 5.54). The private outdoor area immediately in front of units steps down to semi-public unsealed green space and pathway, informally defining space without walls or fences. Shading louvers are used not only to prevent solar gain in the summer, but the buildings setback from the shading also provides a level of privacy (Figure 5.56). Floor plan areas are quite generous (Figure 5.55), where Peri-Fusion will aim for a denser housing solution.

Figure. 5.54: Garmisch Lodging semi-public path

Figure. 5.55: Plans (not to scale)

Figure. 5.56: Garmisch Lodging

K Valley House - Herbst Architects

This detached dwelling situated in rural New Zealand by the Kauaeranga river, takes inspiration from agricultural motifs and functionality. The building has a small narrow land coverage on the greenfield site, but stands tall and holds its own against the vast landscape (Herbst Architects, n.d.). Corrugated rusted iron rainscreens act as a “rural camouflage,” where timber and blockwork also pay tribute to a New Zealand agricultural material language.

The client wanted the home to focus on sustainability, recycling and provenance of materials, that matched their self-sufficient lifestyle, including “growing, animal husbandry and butchery” (Herbst Architects, n.d.). This marriage of architecture and agriculture through functionality and materiality will be main drivers in Peri-Fusion housing.

Figure. 5.57: K-Valley House

Figure. 5.58: K-Valley House interior

Figure. 5.59: K-Valley House integrating into the agricultural landscape

5.3.2. Precedent Findings

Findings

From this precedent study, Newhall Be (row housing), Garmisch Lodging (semi-detached) and K Valley House (detached) all demonstrated a range of successful housings solutions, some with strong agricultural integration. Newhall Be was successful due to its unique densified floor plans, but also possessing standalone qualities and rural inspired forms and materiality. Although this standalone quality above the ground floor is an appealing notion, it is more costly and uses more materials. The lodging in Garmisch showed how level change between private and public can be a successful indicator of space and stepped back facades from shading screens can not only provide appropriate shading but also a quality of privacy. And finally, K Valley House shows a New Zealand example of architecture acting as a rural entity through materiality and functionality. The common materiality used throughout all three projects were timber, masonry (block work), glass and corrugated iron.

Modern Agricultural Language

New Zealand heritage agricultural architecture has been examined, as well as precedents with agricultural integration, now modern agricultural motifs and materiality will be explored. Figures 5.60 to 5.64 are all modern agricultural buildings from New Zealand and around the world, that demonstrate these previously mentioned primary materials and how they can be used in a variety of ways. Different thin roof lines and opening sizes are determined by the buildings differing functions.

This content is unavailable.

Figure. 5.60: Farm building from Barn Builders

This content is unavailable.

Figure. 5.61: Farm building from Four Square

This content is unavailable.

Figure. 5.62: Farm building from Four Square

This content is unavailable.

Figure. 5.63: Farm building from Goldpine

This content is unavailable.

Figure. 5.64: Farm shed from Goldpine

Figure. 5.65: Row housing concepts in plan and section

5.3.3. Concept Design Testing

Row House Concepts

Row housing concepts were explored at 1:100 in plan and elevation (Figure 5.65) (drawings have been scaled down for reading purposes). The row house concepts have been established as 3-bedroom home, aiming for a total internal floor area of 86m². Rural forms and materiality are explored in basic forms as shown in figure 5.65. This includes the extended gable and the pop-up gable, along with timber, glazing, blockwork and corrugated iron as the material form.

Critical Reflection

Smart floor plans have started to be explored, where zoning divides the spaces within the rectangular row housing. The issues with these concepts are that the forms have become over complex and doesn't show the simplistic functional nature of rural design. The layering of materiality on the façades also overcomplicates the aesthetics. Moving forward, stripping back to simple forms and materials through simple techniques design techniques will benefit the row housing design.

Figure. 5.66: Peri-Fusion tactics

Figure. 5.67: Peri-Fusion tactics

Figure. 5.68: Low-rise high-density

Figure. 5.69: Semi-detached concepts in plan, elevation and section

Semi-Detached Concepts

Semi-detached housing concepts were explored at 1:100 in plan, section and elevation (Figure 5.69), where the drawings have been scaled down for reading purposes. The semi-detached house concepts have been established as 1-bedroom and 2-bedroom joint homes, aiming for a total internal floor area of 48m² and 69m². Again, rural forms and materiality are explored as shown in figure 5.69, where three concept designs were tested. The smaller 1-bedroom unit is one storey and the 2-bedroom unit is two storeys, creating a level change and giving the impression of two different units.

Critical Reflection

The differing roof levels and layering of materials again is giving too much complexity to the forms of the housing. This needs to be stripped back to show the pure functional elements of the housing and materiality. The most successful smart floor plans of these concepts are the second, where the two simple masses are staggered beside each other, but entrances and further research on this layout needs to be developed.

Figure. 5.70: Peri-Fusion tactics

Figure. 5.71: Peri-Fusion tactics

Figure. 5.72: Low-rise high-density

01.

02.

Figure. 5.73: Detached concepts in plan, elevation and perspective

Detached Concepts

Detached housing concepts were explored at 1:100 in plan, elevation and perspective (Figure 5.73), where the drawings are not to scale. The semi-detached house concepts have been established as 4-bedroom homes, aiming for a total internal floor area of 96m². This detached home has been tested as a two-storey building, with double height spaces added for improved quality of densified living.

Critical Reflection

The twin gable and asymmetrical gable have been explored, where the asymmetrical gable is the more successful rural form due to its simplicity and functionality. Block work and timber work well together but need to work more functionally to define spaces and firewalls. Plans now need to be explored on site to be developed to respond to site conditions, where different orientations around the site must be explored.

Figure. 5.74: Peri-Fusion tactics

Figure. 5.75: Peri-Fusion tactics

Figure. 5.76: Low-rise high-density

06.

Chapter Six

Developed Design

- 6.1 Masterplan Scale 1:200
 - 6.1.1 Access + Boundaries
 - 6.1.2 Populating the Masterplan
 - 6.1.3 Ownership Model
- 6.2 Street Scale 1:1000
 - 6.2.1 Property Boundaries + Extensive Grazing
 - 6.2.2 Level Change Sectional Study
 - 6.2.3 Public, Semi-Public and Private Access
 - 6.2.4 Ha-ha Wall Construction + Drainage
- 6.3 Home Scale 1:100
 - 6.3.1 Basic Form Study
 - 6.3.2 Orientation Sun Studies

Figure. 6.1: Typical shared walkway through farmland in Blenheim

1:2000

6.1 Masterplan Scale Developed Design

Figure. 6.2: Masterplan zoning diagram

Introduction

From the conceptual design at 1:2000, a final masterplan has emerged with primary zoning. This zoning includes agricultural land, horticultural land, main road access, main layered public accesses and areas dedicated to public amenities and the agricultural education buildings (Figure 6.1). To develop this masterplan further, the following was addressed to achieve a successful masterplan:

1. Developing of the shared access ways around the site, and the agricultural boundaries included around these areas
2. Populate the plan with housing, identifying where are the denser row houses going and where is the less dense detached and semi-detach houses situated
3. Assigning an overall ownership model for Peri-Fusion housing. Identify who will own and maintain larger agricultural and horticultural spaces, and who owns what between housing.

Figure. 6.3: Masterplan scheme

6.1.1 Access + Boundaries

Working through the different zones of the masterplan, a more in-depth scheme has been explored (Figure 6.3). The first two steps of this scheme included positioning of the primary ha-ha walls, and the direction of the view lines over agriculture or horticulture areas where the boundary is needed. The primary boundaries will surround the multi-use access around the racetrack so people, bicycles and animals can use this public track. Also, main agricultural ha-ha walls will separate livestock and the public walkway from residential housing throughout the middle of the site. Pedestrian walkways are prioritised in this Peri-Fusion model, where there is only one main ring road, and all other accessways are walking friendly (Figure 6.3). Similarly, animal access is very important to this model, which is shown in section three of figure 6.3, highlighting the main animal access around the site is via the wide racetrack and the main agricultural corridor. In section four the buildings have been addressed, where the denser row housing and less dense detached and semi-detached housing have been assigned to zones around the site. The denser row housing is on the current urban fringes of the site, and the less dense looser housing is in the middle of the racetrack, integrated into the green space and agriculture.

The journey around this main public accessway around the existing racetrack was tested through section studies. Eight sections were taken to get an understanding of the journey that would be experienced by someone on foot, visiting the site and walking around the main public walkway. Where these eight sections are taken are shown in figure 6.4, where the journey starts from entering the site from the western road access point. The sectional study is on the following page.

Figure. 6.4: Masterplan diagram showing sections

Figure. 6.5: Sectional study 1:500 @ A4

Figure. 6.6: Sectional study 1:500 @ A4

Figure. 6.7: Populated masterplan 1:5000 @ A4

6.1.2 Populating the Plan

Row housing, semi-detached and detached housing with established areas (Figure 6.7) have been populated in the masterplan. Denser row housing populates the eastern edge and western edge of the site, emphasizing the current urban fringe. Moving into the centre of the site, semi-detached and detached houses are arrayed around the centre of the racetrack. By doing this, further spatial interventions between dwellings and pathways are established in the masterplan (Figure 6.7).

The dwellings are staggered and arranged around curvaceous pathways, to encourage variation of views between dwellings and challenge the current grid of suburbia. The three main orientations identified around the site are demonstrated in figure 6.9, which are north-south (N-S), west-east (W-E) and north west-south east (NW-SE). These orientations will be addressed when developing housing typologies at the 1:100 scale. Plans will be flexible so housing solutions can be placed anywhere on site. Areas indicated in the dotted circles on figure 6.7 are areas where orientation of the dwellings do not follow these main orientations exactly, therefore these areas need further development.

The curving pathways also mimic the curve of typical ha-ha walls, where ha-ha walls will act as property boundaries and space indicators between private and public space. These spaces will be developed further at 1:1000 street

level scale. Other boundaries and space indicators will also be tested to realise the most appropriate solution. The green areas highlighting semi-public pathways between housing developments (Figure 6.7), can be used as extensive grazing areas dedicated to residents. All these curving green paths between dwellings all lead to either the main public walkway, or to the agricultural green corridor, both of which can be used to move livestock around the site. All these areas will be further developed at the 1:1000 street level development stage.

4B 6P	1B 2P + 2B 4P	3B 5P
96m ²	48m ² 69m ²	86m ²

Figure. 6.8: Established housing typologies and areas

Figure. 6.9: Housing orientation

Figure. 6.10: Ownership model diagram 1:5000 @ A4

6.1.3. Operational Model

<i>Public: Open green space</i>
<i>Public: Horticulture and/or agriculture dedicated to education</i>
<i>Public: Amenities where commercial spaces are leased to residents and/or the public</i>
<i>Public: Agricultural land leased to residents or the public</i>
<i>Semi-public: Local residential leased land</i>
<i>Private: Residential dwellings and private land</i>

The ownership model for the Peri-Fusion housing is shown in figure 6.10, where public, semi-public and private areas of ownership have been identified. Public areas include

open green space, horticulture owned by educational organisation, public amenities leased to residents and/or the public, and agricultural land leased to residents or a member of the public. These areas have already been defined in the masterplan zoning, where the general public have access to walk through the land. The semi-public areas between dwellings, as shown in figure 6.10, is a flexible space that surrounding residents can choose to lease the land and use it for agricultural purposes. Just like the farming and gardening land use within Zurich city, this agricultural land can be owned by the council or another authority and rented to the private farmers in the Peri-Fusion housing. Farmers can own multiple plots around the development and move the livestock via the public walkway to different plots throughout the year. Further attention as to who is maintaining public green space must be considered.

1:1000

6.2 Masterplan Scale Developed Design

Figure. 6.11: Zoning diagram of street level

Introduction

From the conceptual design at 1:1000, a final street level plan has emerged with primary zoning. This zoning included identifying basic layout for housing typologies, public, semi-public and private areas, carparking areas, horticulture dedicated to housing and access pathways between dwellings (Figure 6.11). To develop this further, the following was addressed to achieve a successful street level plan:

1. Identifying property boundaries using agricultural boundaries, and potential extensive grazing sites between dwellings.
2. Level changes (including carparking level changes) throughout the site, through a sectional study.
3. Identifying public, semi-public and private space and their access ways.
4. Maintenance of greenery and agricultural land at street level, including drainage systems of the ha-ha wall.
5. Identifying house peri-fusion housing could be embedded into a natural resource cycle.

Figure. 6.12: Developed design street level plan 1:1000 @ A4

6.2.1. Property Boundaries + Extensive Grazing

The developed street level plan uses ha-ha walls as the primary boundary defining walkways, property and animal boundaries. The primary ha-ha walls, secondary ha-ha walls and alternative agriculture boundaries are shown in figure 6.14, where areas of potential extensive grazing become realised. Due to these extensive grazing areas being small pockets of land, only minimal numbers of small livestock would be able to inhabit areas, like sheep or goats. In the Marlborough region, one hectare carries between two and seven stock units (Beef + Lamb New Zealand, n.d.). For sheep, the livestock unit equivalent is 0.85-1.25, therefore a range between two and seven sheep per hectare (Farmlands Co-operative Society, 2016, p. 89). For the nine plots of land shown on this section of the master plan, the total area is 5,450m² (0.55 Ha), therefore three to four sheep could be rotated around the grazing plots. Typical fence heights for sheep and goats are 1.02-1.2m (Gregory, n.d.). The following two pages display the sectional study at 1:1000 for this section of the masterplan. Three sections were taken from this plan (Figure 6.12), where level change between houses was tested. The secondary

ha-ha walls create level change in the y-axis (or moving from west to east), but in the x-axis (north to south) a gradual rolling level change was implemented (Figure 6.12). The sunken communal carpark technique was tested and then applied to areas of the site. The carparking was sunken 1m below ground level and positioned as much as possible underneath dwellings to reduce hard surfaces and increase green space on site.

Critical Discussion:

Further development is needed with addressing entry and exiting points (Figure 6.12) to these agricultural areas for people, animals and agricultural vehicles. The access points that cross over ha-ha walls will need to be resolved to contain animals but allow easy access for people to move from the residential semi-public walkways, to the public walkway. Wooden or steel gates, cattle stops and stiles will be explored. Alternative agricultural boundaries that are indicated on Figure 6.12 could comprise of masonry walls and hedgerows as defined on page 27. Banks and ditches wouldn't contain livestock effectively, therefore walls and hedgerows will be developed, alongside the entry and exit points, in these sections highlighted. Also, the property dividers between semi-detached and detached dwellings needs to be further developed, as currently it is resembling a suburban model. To possess Peri-Fusion housing qualities, property dividers need to be extensions of the dwellings, acting as agricultural boundaries themselves. Again, these property dividers running in the y-axis will be tested as masonry walls and/or hedgerows.

Level Change Sectional Study

Figure. 6.13: Street level sectional study 1:500 @ A4

Figure. 6.14: 3D diagram showing public, semi-public and private spaces.

Figure. 6.15: Showing the ha-ha wall acting as a property boundary between backyards

6.2.2. Public, Semi-Public + Private

Access around the site is identified in figure 6.14, where private and semi-public areas can be accessed from the public walkway or from the inner ring road. Private vehicles can access communal car parks from this inner road and from secondary road south of the row housing. The public walkway that was the existing racetrack, which is approximately 20m wide, will be left unsealed to allow for potential greenery to be reinstated. This public area will allow animals and animal moving vehicles to move livestock around the site to different grazing plots.

Critical discussion

Ha-ha walls have been used to define property boundaries in the x-axis direction effectively, as shown in figure 6.15 and 6.16. But the property dividers between semi-detached and detached dwellings needs to be further developed, as currently it is mimicking a suburban model. To possess Peri-Fusion housing qualities, property dividers need to be extensions of the dwellings, acting as agricultural boundaries themselves. Again, these property dividers running in the y-axis will be tested as masonry walls and/or hedgerows.

Figure. 6.16: Inverted ha-ha wall between semi-public area and private backyards

Figure. 6.17: Dry ha-ha wall section 1:50 @ A4.

Figure. 6.18: Water collection and purification ha-ha wall section 1:50 @ A4.

6.2.3. Ha-ha Wall Construction + Drainage

The ha-ha wall was first popularised by Charles Bridgeman (d. 1738), where traditionally it was constructed as a dry stone wall (Morrow, 1987b, p. 145). Ha-ha walls can be constructed out of a masonry unit, stone or poured concrete, where figure 6.19 shows a modern masonry ha-ha wall. Ha-ha walls (or retaining walls) often fail because of water build up due to lack of drainage. Water in the soil expands and contracts over the winter months, pushing against the wall. Figure 6.17 and 6.18 shows the gravel backfill behind the ha-ha wall preventing this movement, where excess water is drained out through the perforated drain piping.

Another issue that is created by the ha-ha wall is that it creates a ditch or swale on site, where after heavy rain it will flood with storm water. Especially in agricultural areas, this storm water needs to be sustainably filtered when being drained from the site. Figure 6.17 shows a dry swale with layers of permeable soil and gravel, where figure 6.18 shows a ha-ha that collects water runoff, where planting and gravel acts as a biofilter before entering the perforated drain piping to be reused on other parts of the site.

This content is unavailable.

Figure. 6.19: New masonry ha-ha wall

Figure. 6.20: Conceptual circular model

6.2.4. Natural Resource Circular Model

Following on from examining how the ha-ha wall has the potential to act as a storm water collector and purifier, this natural collection is developed to a masterplan scale, and integrated into the natural resource circular model. Figure 6.21 demonstrated how the ha-ha walls between housing can be collected by a central water system running along the inner ring road, where recycled water can be

distributed back out. The basic workings for this conceptual circular resource scheme are detailed in figure 6.20, where water and waste collection and recycling back into the system is outlined. This is only at a conceptual level, where specific detailing of whether this system could work for the Blenheim case study needs further technical research.

Figure. 6.21: Water collection diagram 1:5000 @ A4

1:100

6.3 Home Scale Developed Design

Figure. 6.22: Developed design orientation study

Introduction

From the initial conceptual design phase at 1:100, it was determined that the overcomplex conceptual drawings were not reading as an integrated agricultural Peri-Fusion housing form. Simple forms will be explored in plan (Figure 6.22), perspective sketches, physical modelling and sun orientation study. To develop row housing, semi-detached and detached typologies, the following was addressed to achieve successful Peri-Fusion housing:

1. Basic form study: Driven by the agricultural boundary wall in a single orientation, where the plan and perspective form design are driven by these walls. This will be tested through plans, perspective drawings and physical modelling.
2. How these agricultural boundary wall extends and integrates with the site. This will be researched through plan design and physical modelling.
3. Orientation study: The three prominent orientation as identified in figure 6.23, where the semi-detached and detached housing will be tested at the NW-SE, N-S and W-E orientations, and row housing at the NW-SE and W-E. This allows the solution to be places anywhere around site with minor alterations

Figure. 6.23: Orientation diagram

Figure. 6.24

Figure. 6.25

Figure. 6.26

Figure. 6.27

Figure. 6.28

Figure. 6.29

Figure. 6.30

Figure. 6.31

6.3.1. Basic Form Study

Row Housing

Simple row housing two storey floor plans were tested at NW-SE and W-E, and then a basic form study was conducted through physical modelling and perspective sketching. The green walls indicated in figures 6.24 – 6.31, are the main partitioning wall between units, and the main agricultural boundary walls driving the form. These walls were then tested through extending the wall to create private yard boundaries, integrating with the inverted ha-ha wall on site. Mono pitched and stepped roof lines were tested (Figure 6.26 and 6.27), where the flat roof was chosen as it did not subtract from the vertical agricultural boundary elements. A secondary vertical wall was successfully inserted to indicated functional spatial arrangements inside. A step back in the entrance façade (Figure 6.31) gives the appearance of the standalone entity and indicates where the main entrance is. Further development is needed on extending entrance walkways and boundaries.

Figure. 6.32 Orientation study

Figure. 6.33 Material palette

Figure. 6.34

Figure. 6.35

Figure. 6.36

Figure. 6.37

Figure. 6.38

Figure. 6.39

Semi-Detached Housing

Semi-detached floor plan designs for one-bedroom and two-bedroom units were driven by three agricultural walled boundaries at three different orientations (Figure 6.40). These driving walls are shown again in green in figures 6.34 – 6.39, where a further agricultural wall was tested. These two central boundaries create a threshold between units, giving the desired sense of detachment and individual ownership. Again, the staggered floor plans give opportunity for additional sun to the southern unit and gives variety to entranceways. One of the agricultural walls has been extended to indicate a potential backyard boundary, but these extensions and integration into the site needs to be developed further. An extended agricultural wall indicating an entranceway would be a successful attribute. Gable and mono pitched roofs were explored, where the mono pitched was the most successful choice due to the simple functionality of the form, as seen in agricultural structures.

Figure. 6.40 Orientation study

This content is unavailable.

Figure. 6.41 Material palette

Figure. 6.42

Figure. 6.43

Figure. 6.44

Figure. 6.45

Figure. 6.46

Figure. 6.47

Detached Housing

This four-bedroom detached home was tested with three to four agricultural boundaries walls, to divide space within the unit. Again, the main boundary walls run in one direction, allowing two façades to have prominent openings. Twin gable roof forms were tested as it appeared within New Zealand's agricultural heritage buildings, but the asymmetrical gable was the most successful roof form as it indicated one entity and encased the form in the most practical way. The staggering shifting of the agricultural boundary walls within the floorplans was used again to create variation and spatial opportunities within the primary walls.

This content is unavailable.

Figure. 6.49 Material palette

Figure. 6.48 Orientation study

6.3.1. Orientation Sun Studies

Row Housing NW-SE

Winter	Altitude	Azimuth
9.00am	9°	47°
12.00pm	25°	7°
3.00pm	16°	324°
Summer	Altitude	Azimuth
9.00am	33°	94°
12.00pm	65°	51°
3.00pm	63°	304°
6.00pm	31°	265°

Figure. 6.50

Row Housing W-E

Winter	Altitude	Azimuth
9.00am	9°	47°
12.00pm	25°	7°
3.00pm	16°	324°
Summer	Altitude	Azimuth
9.00am	33°	94°
12.00pm	65°	51°
3.00pm	63°	304°
6.00pm	31°	265°

Figure. 6.51

Semi-Detached NW-SE

Winter	Altitude	Azimuth
9.00am	9°	47°
12.00pm	25°	7°
3.00pm	16°	324°
Summer	Altitude	Azimuth
9.00am	33°	94°
12.00pm	65°	51°
3.00pm	63°	304°
6.00pm	31°	265°

Figure. 6.52

Semi-Detached W-E

Winter	Altitude	Azimuth
9.00am	9°	47°
12.00pm	25°	7°
3.00pm	16°	324°
Summer	Altitude	Azimuth
9.00am	33°	94°
12.00pm	65°	51°
3.00pm	63°	304°
6.00pm	31°	265°

Figure. 6.53

Semi-Detached N-S

Winter	Altitude	Azimuth
9.00am	9°	47°
12.00pm	25°	7°
3.00pm	16°	324°
Summer	Altitude	Azimuth
9.00am	33°	94°
12.00pm	65°	51°
3.00pm	63°	304°
6.00pm	31°	265°

Figure. 6.54

Detached NW-SE

Winter	Altitude	Azimuth
9.00am	9°	47°
12.00pm	25°	7°
3.00pm	16°	324°
Summer	Altitude	Azimuth
9.00am	33°	94°
12.00pm	65°	51°
3.00pm	63°	304°
6.00pm	31°	265°

Figure. 6.55

Detached W-E

Winter	Altitude	Azimuth
9.00am	9°	47°
12.00pm	25°	7°
3.00pm	16°	324°
Summer	Altitude	Azimuth
9.00am	33°	94°
12.00pm	65°	51°
3.00pm	63°	304°
6.00pm	31°	265°

Figure. 6.56

Detached N-S

Winter	Altitude	Azimuth
9.00am	9°	47°
12.00pm	25°	7°
3.00pm	16°	324°
Summer	Altitude	Azimuth
9.00am	33°	94°
12.00pm	65°	51°
3.00pm	63°	304°
6.00pm	31°	265°

Figure. 6.57

07.

Chapter Seven

Final Design

7.1 Masterplan

7.2 Street Level

7.3 Row House

7.4 Semi-Detached House

7.5 Detached House

Figure. 7.1 Waterlea Racecourse

Figure. 7.2 Final Masterplan 1:2500 @ A4

7.1 Masterplan

The final case study design for Waterlea Racecourse in Blenheim, explores the opportunity to develop an integrated densified housing and agricultural model of New Zealand's peri-urban zones. The final masterplan consists of 468 dwellings, made up of row, semi-detached and detached housing typologies (Figure 7.3). Public and agricultural amenities are integrated into the model to create a circular sustainable model, where food, waste and water are all utilised. The dotted area on Figure 7.2 shows a potential 'stage one' of this housing development, that has been examined in further detail in pages 137 to 144.

No. Bedrooms	No. Houses	IDA
1B 2P	47	48m ²
2B 4P	117	69m ²
3B 5P	211	86m ²
4 B 6P	70	96m ²
5B 7P	23	109m ²
Total	468	37,702m ²

Figure. 7.3 Housing Summary

Built Public Amenities:	Agricultural:
① - Convenience store/market	⑨ - Agricultural grazing
② - Community Hall	⑩ - Intensive horticulture dedicated to housing
③ - Sports Courts	⑪ - Horticulture dedicated to education centre
④ - Medical Facility	⑫ - Agriculture/horticulture education centre
⑤ - Local Café	⑬ - Amenities (wool sheds, stock pens, hay sheds, coups).
⑥ - Day care/playgrounds	
⑦ - Open green space	
⑧ - Public Walkway	

Figure. 7.4 Masterplan Key

Figure. 7.5 Peri-Fusion Housing at Waterlea Racecourse

Figure 7.6 Street Level Plan 1:1000 @ A4

7.2 Street Level

This development shows an integration of the housing typologies with agriculture. Ha-ha walls, hedgerows, short masonry walls and farm gates controls the spaces where animals and private property resides separately but doesn't interrupt visual integration between agriculture and housing. Level change, walls and hedgerows act as privacy barriers between houses, as well as architectural timber screens. Pages 141 and 142 shows, where these agricultural landscape interventions take place.

Key	
①	- Half Sunken Communal Carparking
②	- Unsealed Public Walkway
③	- Semi-Public Green/Grazing Space
④	- Sealed Road
⑤	- Horticulture Dedicated to Housing (Community Gardens + Private Plots)
⑥	- Horticulture Dedicated to Education
⑦	- Open green space
①①	- Row House Typology. See pages 145 to 150.
①②	- Semi-Detached House Typology. See pages 151 to 156.
①③	- Detached House Typology. See pages 157 to 162.

Figure. 7.7 Section A 1:500 @ A4

Figure. 7.8 Section B 1:500 @ A4

Figure. 7.9 Section C 1:500 @ A4

Figure. 7.10 Perspective Section

Figure. 7.11 Row House Perspective Visualization.

7.3 Row House

The NW-SE row house typology has emerged from design led research, as a case study for dwelling in an integrated agricultural housing model. The architectural form follows agricultural construction's values of functionality and simplicity, where boundary walls and horizontal planes extruded to indicate primary space inside (Figure 11). The main boundaries separating dwellings are constructed of concrete masonry blockwork, derived from the traditional agricultural blockwork wall boundaries. The primary walls provide privacy from neighbouring units, where the exposed timber and glass facades face the semi-public green area and private backyard. Timber screens were also applied to provide another level of privacy and to act as a shading device. A masonry wall leads straight to the front door of the row houses, giving privacy to occupants as they enter and exit the dwelling. Sky lights and voids have been utilised in the centre of the row house to provide natural light to the centre of the narrow floor plan (Figure 13 & 14). Only the NW-SE orientation has been explored in full detail, where its position is highlighted in the Stage One final plan (Figure 7.6).

Figure. 7.12 Row House Orientation Diagram

Figure. 7.13 Ground Floor 1:100 @ A4

Figure. 7.14 First Floor 1:100 @ A4

Figure. 7.15 Section D 1:100 @ A4

Figure. 7.16 Semi-Detached House Perspective Visualization.

7.4 Semi-Detached House

This semi-detached housing typology consists of a one-bedroom one storey unit and two-bedroom two story unit. The height different between units, threshold between rooflines, and separate entrance paths gives the sense of the standalone dwellings and separate ownership (Figure 7.16). Agricultural walls extend beyond the dwellings to meet the agricultural land, creating a physical connection between architecture and agriculture, while also retaining visual integration through the ha-ha wall (Figure 7.20). Similar material languages, forms and privacy screens to the row house have been used to emulate the agricultural integration design strategies throughout the case study.

Figure. 7.17 Semi-Detached Orientation Diagram

Figure. 7.18 Ground Floor Plan 1:100 @ A4

Figure. 7.19 First Floor Plan 1:100 @ A4

Figure. 7.20 Section E 1:100 @ A4

Figure. 7.21 Detached House Perspective Visualization.

7.5 Detached House

The detached housing typology shown for this case study had four bedrooms, and follows the densified principles of smart floor plans, creating a simple and functional design. The asymmetrical roof pitch was inspired by heritage agricultural construction, where the roof space is used efficiently for bedrooms and half height storage. The agricultural boundaries as a driver were less prominent in this solution, compared to the row and semidetached houses, as there were no join units to separate. But the motif of the agricultural boundary still drives the aesthetic of the design, where projected walls from the wooden façade indicate changing space from within the dwelling.

Figure. 7.22 Detached House Orientation Diagram

Figure. 7.23 Ground Floor Plan 1:100 @ A4

Figure. 7.24 First Floor Plan 1:100 @ A4

Figure. 7.25 Section F 1:100 @ A4

08.

Chapter Eight

CONCLUSIONS

8.1 Research Findings

8.1.1 Quantitative Results

8.1.2 Qualitative Results

8.2 Conclusions

8.2.1 Research Implications

8.2.3 Limitations + Further Research

Figure. 8.1 Aerial image of a section of Waterlea Racecourse, showing the exisitng suburban fringe

Figure. 8.2 Comparative plan of existing adjacent plot and new case study research. Each plot is 311,400m2.

	Existing Adjacent Plot	New Case Study
Number of dwellings	337	468
Dwellings Per Hectare	10.8	15
Total Internal Dwelling Area (IDA)	58,275m2 (NZ Property) – only houses	37,669m2
Average Gross Floor Area/(dwelling)	175m2	80.5m2
Average Plot Size (per dwelling)	887m2 (NZ Property)	190m2
Floor Area Ratio (per dwelling)	0.2	0.4
Total Sealed Surface Area	133,469m2 (43%) of 311,400m2	71,965 (23%) of 311,400m2
Total Unsealed Surface Area	177,631m2 (57%) of 311,400m2	239,394 (77%) of 311,400m2

Figure. 8.3 Comparative study summary

8.1 Research Findings

8.1.1 Quantitative Results

Findings from this design led research were gathered on three different scales of the case study, the master plan (1:2000), the street level (1:1000), and the home (1:100). Results from all three scales can be quantitatively evaluated by comparing the masterplan to the existing suburban adjacent plot (Figure 8.2), to measure the success of the design strategies used in the case study. Figure 8.3 is a summary of the comparative study, where it shows the case study successfully increasing the number of dwellings by 131 units but decreasing the sealed built area by 20% (Figure 8.4). The 20% increase of preserved fertile land and the reduction of private green space from the average of 887m² per private property

to 190m² (Figure 8.3), results in 38% of the overall land use dedicated to food production, as shown in figure 8.4 (29% for agriculture and 9% for horticulture). This 38% integration of fertile land was successfully achieved at the masterplan level and street level using Peri-Fusion design strategies such as the ha-ha walls, hedgerows, level change, layered accessways and further alternative agricultural boundaries. The quantitative findings from the home scale, resulted in a decrease of average gross floor area from 175m² to 80.5m² and an increase of floor area ratio from 0.2 to 0.4 (Figure 8.3). Since this research is aimed for low populated areas in New Zealand's peri-urban zones, this low ratio is appropriate.

Figure. 8.4 Visual comparisons and case study break down.

Figure. 8.5. Render of semi-public grazing area and community gardens

8.1.2 Qualitative Results

This research provides an alternative design strategy for developers and designers of large housing developments in peri-urban zones, by creating qualitatively desirable housing. Qualitative evaluation has been made by comparing the case study outcome to the literature and precedent studies and judging whether the results meet the research objectives. Some key qualities that successfully met the research design objectives are:

Qualities of the standalone home and the lifestyle block: This was successfully achieved through using density techniques that have proven to work in design low-rise high-density housing. Also, the integration of agricultural and boundaries on the house's front door (as seen in figure 8.5), create qualities of the lifestyle block.

Agricultural materiality and integrated agricultural views: Again, the proximity of agricultural grazing and successful use of agricultural boundaries like the ha-ha wall, where views are uninterrupted (Figure 8.4). The simple material palette of timber, masonry,

glass and corrugate reflects the success of case studies and modern as well as heritage agricultural architecture.

Smart floorplans with adequate privacy and private green spaces: Floorplans were all specifically designed and adjusted to multiple orientations around the site, where solar gain and privacy were key considerations of these plans and sections at 1:100. Adequate privacy was achieved through basic speculation, but further plan, perspective and detailed sectional studies would improve the qualitative and quantitative results, determining successful viewpoints and privacy between dwellings.

Masterplan layout and dedication of space: This aspect of the design is not only successful through measurement of preserved green area, but also the successful spatial layout. Qualities that have been adopted from successful precedents such as the sunken carparking, narrow continuous road system, curvaceous layered accessways, and green space integrated throughout the site, create a new and desirable housing development for people, challenging the current suburban model.

Figure. 8.6. Natural resource circular model

8.2 Conclusions

8.2.1. Research Implications

With the increase of large-scale housing developments throughout New Zealand and other developing countries, this thesis has produced significant research outcomes, that builds upon existing agricultural and architecture integration research. The initial peri-fusion design strategy framework builds upon Dewey Thorbeck's 'rural design thinking,' by providing very specific strategies when integrating rural and urban contexts into peri-urban zones (2017). This thesis research also produces an alternative model to problematic sprawling housing developments that are invading productive greenfield land. This builds on current housing research being conducted in New Zealand, where the research is currently lacking solutions for low-rise high-density specifically in peri-urban zones. The unique agricultural influenced peri-fusion strategies give an alternative perspective to designing housing developments, with the aim of preserving agricultural land and being embedded in a natural resource cycle (Figure 8.6).

8.2.2 Limitations + Further Research

An apparent limitation for this research was the methodology step of designing at three different scales, as the final design isn't resolved at a high level of detail. This was especially evident in resolving the three housing typologies at three different orientations. If more time was allowed for this research, more detailed design, energy analysis and costing analysis would enrich the depth of research and feasibility for the resulting case study. Another limitation for the research was not going into detail on the proposed integrated natural resource circular model (Figure 8.6), due to time restraints. These limitations open the opportunity for further research in this field. For example, the proposed integrated natural resource circular model that was separately examined to the peri-fusion tactics, could be tested cohesively, for a stronger sustainable peri-fusion housing model. Further research into the public amenities and agricultural education centre proposed in the final case study, would again improve research outcomes for this thesis. Further research into the running and ownership of these facilities is needed to determine the potential success.

09.

Chapter Nine

9.1 Reference List

9.2 Figure List

Figure. 9.1. Typical farmland scene in Blenheim.

9.1 Reference List

Abrahamse, W., Stuart, K., & Witten, K. (2011). Growth misconduct? : Avoiding sprawl & improving urban intensification in New Zealand / edited by Karen Witten, Wokje Abrahamse & Keriata Stuart. Auckland, N.Z.: Auckland, N.Z. : Steele Roberts.

Alison Brooks Architects. (n.d.). Newhall Be. Retrieved October 14, 2019, from Alison Brooks Architects website: <http://www.alisonbrooksarchitects.com/project/newhall/>

Andrew, R., & Dymond, J. (2013). Expansion of lifestyle blocks and urban areas onto high-class land: An update for planning and policy. *Journal of the Royal Society of New Zealand*, 43(3), 128–140. <https://doi.org/10.1080/03036758.2012.736392>

Baun, L. (2017). Prisdyk: Markant Jellingbyggeri sat til salg til halv pris. Retrieved October 13, 2019, from <https://vafo.dk/artikel/prisdyk-markant-jellingbyggeri-sat-til-salg-til-halv-pris>

Beef + Lamb New Zealand. (n.d.). Farm classes. Retrieved October 16, 2019, from Beef + Lamb New Zealand website: <https://beeflambnz.com/data-tools/farm-classes>

Bryson, K. (2017). The New Zealand Housing Preferences Survey: Attitudes towards medium-density housing. Judgeford, New Zealand: BRANZ Ltd., 45.

Chappel, P. R. (2016). The Climate and Weather of Marlborough. NIWA Science and Technology Series 69.

CommSec. (2017). Australian Home Size Hits 20-year Low: CommSec Home Size Trend Report. Economic Insights. Australia.

Coxhead, V. (2017). Density and Desire: Toward's New Zealand's peculiar urban dream. (Master's Thesis). Victoria University of Wellington, Wellington, New Zealand.

Derby, M. (2011). Suburbs—The Role of Transport [Web page]. Retrieved June 23, 2019, from Te Ara—The Encyclopedia of New Zealand website: <https://teara.govt.nz/en/81308>

Earthsong Eco-Neighbour-hood | Cohousing NZ. (n.d.). Retrieved October 13, 2019, from <https://cohousing.org.nz/communities/earthsong-eco-neighbour-hood>

Eder, J. (2019). Marlborough Racing Club rallies against threat to Waterlea Racecourse. Stuff. Retrieved from <https://www.stuff.co.nz/marlborough-express/news/110256041/marlborough-racing-club-rallies-against-threat-to-waterlea-racecourse>

Farmlands Co-operative Society. (2016). Farmlands Lifestyle Guide (No. FAR_04523; p. 110).

Environment Aotearoa 2019. (2019). Wellington: Ministry for the Environment & Stats NZ.

Garcia, E., & Vale, B. (2017). Unravelling sustainability and resilience in the built environment. London: Routledge, Taylor & Francis Group.

Gregory, P. (n.d.). Standard Fencing Measures—LSB. Retrieved October 16, 2019, from LSB website: <https://www.lifestyleblock.co.nz/lifestyle-file/running-the-farm/fencing/item/937-standard-fencing-measures>

Herbst Architects. (n.d.). K Valley House. Retrieved October 14, 2019, from Herbst Architects website: <http://herbstarchitects.co.nz/projects/k-valley-house>

Iaquinta, D., & Drescher, A. W. (2000). Defining the peri-urban: Rural-urban linkages and institutional connections. *Land Reform, Land Settlement and Cooperatives*, 8–27.

Kuitenbrouwer, P., & De Daeger, R. (2015). High-density, Low-rise – a challenge for Dwelling Landscapes in the Netherlands. *Boundaries|Encounters|Connections*, 144–155. Copenhagen: Danish Building Research Institute, Aalborg University.

Leupen, B. (2011). *Housing design: A manual* / Bernard Leupen & Harald Mooij (2nd rev. English language ed.). Rotterdam: Rotterdam : NAI Publishers.

Manley, W., Foot, K., & Davis, A. (2019). *A Dictionary of Agriculture and Land Management*. <https://doi.org/10.1093/acref/9780199654406.001.0001>

Marlborough District Council. (2018). *Housing and Business Development Capacity Assessment. Blenheim Urban Area 2018*. Marlborough District Council.

McAloo, J. (2008). Land ownership – Te Ara Encyclopedia of New Zealand [Web page]. Retrieved September 4, 2019, from <https://teara.govt.nz/en/land-ownership/page-7>

McPhee, E. (2016, December 1). Marlborough's Waterlea Racecourse not for sale. *Stuff*. Retrieved from <https://www.stuff.co.nz/national/education/86996743/marlboroughs-waterlea-racecourse-not-for-sale>

Mitchell, A. V. (2002). *Pavlova paradise revisited: A guide to the strange but endearing land where Kiwis live* / Austin Mitchell. Auckland, N.Z.: Auckland, N.Z. : Penguin Books.

Morrow, B. H. (1987). *A dictionary of landscape architecture* (1st ed.). Albuquerque: University of New Mexico Press.

New Zealand Productivity Commission. (2017). *Better urban planning: February 2017*. Wellington: New Zealand Productivity Commission, Te Kōmihana Whai Hua o Aotearoa.

NIWA. (2019). 2018: New Zealand's Equal-2nd Warmest Year on Record (p. 39). NIWA National Climate Centre.

OECD. (2017). New Zealand (NZL) Exports, Imports, and Trade Partners. Retrieved June 23, 2019, from The Observatory of Economic Complexity website: <https://atlas.media.mit.edu/en/profile/country/nzl/>

OECD. (1979). *Agriculture in the Planning and Management of Peri-urban Areas*. Organisation for Economic Co-Operation and Development, 1.

PropertyNZ Ltd. (n.d.). *homes.co.nz—Free Sales Histories and Estimated Values For NZ Homes*. Retrieved November 13, 2019, from Homes.co.nz website: <https://homes.co.nz/>

SOM. (n.d.). SOM | Nanhu New Country Village Master Plan. Retrieved October 12, 2019, from SOM website: https://www.som.com/projects/nanhu_new_country_village_master_plan

Statistics New Zealand. (2013). QuickStats About Blenheim Central. Retrieved November 13, 2019, from <http://archive.stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-about-a-place.aspx>

Statistics New Zealand. (2016). We're building bigger 40 years on. Retrieved June 19, 2019, from http://archive.stats.govt.nz/browse_for_stats/industry_sectors/Construction/building-bigger-5oct-16.aspx

The Department of Internal Affairs. (2019). Glossary. Retrieved October 7, 2019, from The Department of Internal Affairs website: https://www.dia.govt.nz/diawebsite.nsf/wpg_URL/Resource-material-Building-Sustainable-Urban-Communities-Glossary

Thorbeck, D. (2017). Architecture and agriculture: A rural design guide / Dewey Thorbeck. Milton Park, Abingdon, Oxon: Routledge.

Thornton, G. G. (1986). The New Zealand heritage of farm buildings. Auckland N.Z: Reed Methuen.

UN DESA. (2016). The World's Cities in 2016. Statistical Papers - United Nations (Ser. A), Population and Vital Statistics Report, UN, New York, <https://doi.org/10.18356/8519891f-en>.

Wack, P. (2005). Village Homes, Davis California: A Learning Lab for Future Planners. Focus, 2(1). <https://doi.org/10.15368/focus.2005v2n1.5>

9.2 Figures List

All figures not include in the following list are the authors own drawings or photographs.

Chapter One

Figure. 1.1: Bruce, G. (n.d.). Our new society. Retrieved August 29, 2019, from New Zealand Geographic website: <https://www.nzgeo.com/stories/our-new-society/>

Figure. 1.3: Derby, M. (2011, March 11). Suburbs—The Role of Transport [Web page]. Retrieved June 23, 2019, from <https://teara.govt.nz/en/81308>

Figure. 1.4: Marlborough District Council. (2017). Smart Maps. Retrieved October 7, 2019, from Marlborough District Council website: <https://maps.marlborough.govt.nz/smapi/?map=c6bbc97937834f46a2a3a18d76e79db8>

Figure. 1.5: Hurley, B. (2017). Coatesville, New Zealand, Offers A Country Lifestyle On the Fringe of the City. Retrieved October 7, 2019, from Mansion Global website: <https://www.mansionglobal.com/articles/coatesville-new-zealand-offers-a-country-lifestyle-on-the-fringe-of-the-city-74469>

Figure. 1.7: Author, adapted from Marlborough Smart Maps. Marlborough District Council. (2017). Smart Maps. Retrieved October 7, 2019, from Marlborough District Council website: <https://maps.marlborough.govt.nz/smmaps/?map=c6bbc97937834f46a2a3a18d76e79db8>

Chapter Two

Figure. 2.1: Wilhelm, H.C. (2019).

Figure. 2.2: Author, adapted from CommSec data 2017. CommSec. (2017). Australian Home Size Hits 20-year Low: CommSec Home Size Trend Report. Australia.

Figure. 2.3: Diagram redrawn from text by author. Leupen, B. (2011). Housing design: A manual / Bernard Leupen & Harald Mooij (2nd rev. English language ed.). Rotterdam: Rotterdam : NAI Publishers.

Figure. 2.4: Soulard, et al., (Series Ed.). (2017). Toward Sustainable Relations Between Agriculture and the City (1st ed. 2017.). <https://doi.org/10.1007/978-3-319-71037-2>

Figure. 2.5. Ha-ha Wall. Plaw, J. (1823). Ferme Ornée: Or, Rural Improvements. J. Taylor.

Figure. 2.6, 2.8, 2.9, 2.12, 2.18. Smith, P. (2015). Vernacular: The everyday landscape of New Zealand. Nelson, New Zealand: Potton & Burton.

Figure. 2.7, 2.10, 2.11. Morrow, B. H. (1987). A dictionary of landscape architecture (1st ed.). Albuquerque: University of New Mexico Press.

Figure. 2.16. Field Margin. Figure. 3.16. Field Margin. (Manley et al., 2019, p. 239) Manley, W., Foot, K., & Davis, A. (2019). A Dictionary of Agriculture and Land Management.

Figure. 2.17. Green Lane. (Howard, 2018) Howard, R. (2018, January 24). NZ farm sales fall in December quarter. NZ Herald. Retrieved from https://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=11981270

Figure. 2.19 – 2.24. Thornton, G. G. (1986). The New Zealand heritage of farm buildings. Auckland N.Z: Reed Methuen.

Chapter Three

Figure. 3.1. Porter, G. (n.d.). What is a ha-ha? Retrieved October 8, 2019, from National Trust website: <https://www.nationaltrust.org.uk/features/what-is-a-ha-ha>

Figure. 3.6. Ministry of Business, Innovation and Employment. (2017). Acceptable Solution F4/AS1. Safety from falling. Third Edition, Amendment 2.

Chapter Four

Figure. 4.3, 4.12, 4.13. Author, adapted from Marlborough Smart Maps. Marlborough District Council. (n.d.-b). Smart Maps. Retrieved from Smart Maps website: <https://maps.marlborough.govt.nz/smartmaps>

Figure. 4.6, 4.7. Chappel, P. R. (2016). The Climate and Weather of Marlborough. NIWA Science and Technology Series 69.

Figure. 4.14, 4.15. Author, adapted from Marlborough District Council data. Marlborough District Council. (2018). Housing and Business Development Capacity Assessment. Blenheim Urban Area 2018. Marlborough District Council.

Chapter Five

Figure. 5.3, 5.4, 5.5, 5.6 Wack, P. (2005). Village Homes, Davis California: A Learning Lab for Future Planners. Focus, 2(1). <https://doi.org/10.15368/focus.2005v2n1.5>

Figure. 5.7, 5.8, 5.9, 5.10. SOM. (n.d.). SOM | Nanhu New Country Village Master Plan. Retrieved October 12, 2019, from SOM website: https://www.som.com/projects/nanhu_new_country_village_master_plan

Figure. 5.11, 5.12, 5. 13. Thorbeck, D. (2017). Architecture and agriculture: A rural design guide / Dewey Thorbeck. Milton Park, Abingdon, Oxon: Routledge.

Figure. 5.26, 5.27, 5.28: Gelsomino, L., Marinoni, O., & Bohigas, O. (2009). European housing concepts 1990-2010 . Bologna: Editrice Compositori.

Figure. 5.29, 5.30, 5.31: Earthsong Eco-Neighbour-hood | Cohousing NZ. (n.d.). Retrieved October 13, 2019, from <https://cohousing.org.nz/communities/earthsong-eco-neighbour-hood>

Figure. 5.32, 5.33, 5.34, 5.35. (Baun, 2017). Baun, L. (2017, December 9). Prisdyk: Markant Jellingbyggeri sat til salg til halv pris. Retrieved October 13, 2019, from <https://vafo.dk/artikel/prisdyk-markant-jellingbyggeri-sat-til-salg-til-halv-pris>

Figure. 5.50 – 5.53. Alison Brooks Architects. (n.d.). Newhall Be. Retrieved October 14, 2019, from Alison Brooks Architects website: <http://www.alisonbrooksarchitects.com/project/newhall/>

Figure. 5.54 – 5.56. Beer Bembé Dellinger. (n.d.). Retrieved November 14, 2019, from <https://www.bbdarch.de/>

Figure. 5.57 – 5.59: Herbst Architects. (n.d.). K Valley House. Retrieved October 14, 2019, from Herbst Architects website: <http://herbstarchitects.co.nz/projects/k-valley-house>

Figure. 5.60. Barnbuilders. (n.d.). Farm buildings and sheds. Retrieved October 14, 2019, from Barnbuilders Tim Magill website: <https://www.barnbuilders.co.nz/FARM+BUILDINGSSHEDS.html>

Figure. 5.61 – 5.62: Foursquare. (n.d.). Foursquare Frame Buildings. Retrieved October 14, 2019, from Foursquare Farm Buildings website: <https://farmbuildings.info/masonry.html>

Figure. 5.63 – 5.64. Goldpine. (n.d.). Strongbuilt® Sheds. Retrieved October 14, 2019, from Goldpine website: <https://www.goldpine.co.nz/product-grouping/shed-range/strongbuilt/>

Chapter Six

Figure. 6.29. Boswall, M. (2018). Setting the scene – the garden in the landscape | Marian Boswall Landscape Architects. Retrieved October 16, 2019, from Landscape Architects website: <https://www.marianboswall.com/blog/setting-the-scene-the-garden-in-the-landscape/>

Figure 6.33, 6.41, 6.49. Thornton, G. G. (1986). The New Zealand heritage of farm buildings. Auckland N.Z: Reed Methuen.