Ecology via Architecture

An answer to our future cities.

Master Thesis explanatory document

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Abstract

This thesis project is an architectural response to constructing a more ecologically achievable way of living in our growing urban environments.

Global issues such as climate and economic changes and unsustainable resources usage are becoming more a part in today's society. These issues are only going to intensify over the coming years. Society must act now in response to this. We as architects should become more aware of what is around the corner.
Table of Contents

1.0 Introduction.................................................................................4
   1.1 Research question
   1.2 Project aim
   1.3 Project outline

2.0 Define Project.............................................................................8
   2.1 Brief
      2.1.2 Site
      2.1.3 Achievement of program
   2.2 Precedent survey
   2.3 Literature survey

3.0 Develop Project........................................................................18
   3.1 Design process
   3.2 Design outcome
      3.2.1 Overall concept and strategies
      3.2.2 Apartments
      3.2.3 Grow Towers
      3.2.4 Commercial
      3.2.5 Site Gardens and Market space
   3.3 Presentation Strategy

4.0 Conclusion................................................................................38
   4.1 Summary
   4.2 Appraisal
   4.3 Future directions

5.0 Bibliography..............................................................................40

6.0 List of figures............................................................................42
1.0 Introduction

1.1 Research question

How can a work of architecture provide a more ecological and resilient way of living in our urban environment in the face of a changing future?

1.2 Project aim

This project aims to explore through architectural design a new resilient and sustainable way of living and producing food in the urban environment. It will become an urban and social vision from the architectural realm in response to increasing concern for a sustainable and ecologically balanced way of living in the urban environment of our future cities.

1.3 Project outline

The project suggests producing food in a vertical manner as opposed to the traditional farming methods currently used, as well as living in the same vertical manner. An ecologically balanced lifestyle, amalgamated with food production and living, in the urban environment.

The relevance of this project relates to the need for ongoing research and the realisation that, through architectural design, there is a way to help create a more ecological and sustainable way of living in our urban environments. This project will also act on an environmental level to safe guard the environment by increasing resilience in the face of possible future disruptions.

This project aims to combat problems such as an increasing population and overcrowding in urban areas, food shortages and rising fossil fuel costs. This project will help create a new civic space, as well as strengthening social and cultural infrastructure in the urban environment of Auckland city.

This project, tied with food production, water recycling systems and other sustainable features, will create a centre for sustainable living within the city and will act as a benchmark for future city living.

Through this project, I aim to improve the standard of living in the urban area, as well as making it more sustainable and future proof through quality architectural design. The problem with modern urban dwelling, I believe, is the lack of green space (both public and private), which makes the urban centre lose its sense of community and social awareness. To combat this, I propose creating a sustainable hub within the heart of Auckland on the western fringe of the Central Business District (CBD). This will create a greater sense of community for the urban city users.

Currently in Auckland, as well as all over New Zealand, lower density developments are still being produced in cities, which then push the urban boundaries out even further and create urban sprawl. We simply do not have the luxury for this kind of development in our growing cities. This then blurs the boundaries between town and country. Transportation infrastructure has to be then developed to access the many satellite suburbs and towns, creating the
Additionally, this project aims to respond to the need to reduce the dependence on food that is grown and transported long distances, before being delivered to the urban consumer. This is an intensifying problem because of the decreasing farmland available due to urban sprawl and increasing population within the urban area.

The project will not only provide a template for living and producing food collaboratively in the urban environment but also as an educational tool that can showcase how future ecological developments can improve our cities. It will reshape the generic urban life style and become a manifesto for how urban living can and should be in the future.

Statistics New Zealand population predictions for the Auckland region until 2031, forecast that the nation’s economic hub is ‘to account for 60% of New Zealand’s population growth between 2006 and 2031’ 2, which is estimated to be 1,940,000 people. The 2006 census identified that Auckland had 1.37million residents and it is thought that Auckland has just over 1.4 million residents currently. This means that over the next 21 years Auckland will have an ‘increase of 570,000 from 1.37million to 1.94 million’ 3. This means that approximately 220,000 more houses (assuming a 2.7 people per household ratio) will need to be built.

There will be an increasing demand for renewable energy, clean food and water sources as well as healthy public areas to occupy and interact in.

The rising population is also a global issue, which needs to be addressed, as ‘by the year 2050, nearly 80% of the earth’s population will reside in urban centres.’ 4 This rising population and pressure on urban areas is evident in countries such as China in which ‘400 new cities must be built between now and 2020 to accommodate the more than 300 million people who are moving in from the countryside.’ 5

I believe that with this increase in population, a new way of living and planning needs to be brought to fruition so that we can begin to live more sustainably in our urban environments. Our country and cities will encounter both social and economic issues with this increasing population, climate change and rising energy prices. Traditional, inner city, apartment style living needs to be addressed and a better alternative for housing our ever-increasing population must be brought to realisation. The growing population brings a substantial architectural research problem: how will people live more ecologically aware in the urban environment? I believe that there is an architectural solution and, through this architectural project, I aim to create an urban environment for people to live a more ecologically balanced life by having the opportunity to grow their food, while making respectful decisions for our climate, our ecological system and everyone’s neighbours.

3 Ibid
The Auckland Sustainability Framework has set out eight long-term goals for Auckland in their framework.

They are:
- ‘A fair and connected society
- Pride in who we are
- A unique and outstanding environment
- Prosperity through innovation
- Te Puawaitanga o Te Tangata: Self-sustaining Maori communities
- A quality, compact urban form
- Resilient infrastructure
- Effective, collaborative leadership’

Through these eight goals, the Auckland Sustainability Framework will take a sustainable development approach, which will respond to the forces of change such as, local, and global climate change, global economic change and unsustainable resource use.

The introduction of vertical farming techniques will become one of the main driving forces for this project and will create an ecological way of living once again in our cities. Despommier states that, ‘Vertical farms are immune to weather and other natural elements that can abort food production’ 7. This, I believe, gives an even greater reason for creating an ecological hub for Auckland city to better cope with global

climate change, with ‘the evidence for climate change growing more alarming each year’\textsuperscript{8}, and the main food producing nations of the world ‘imposing food export restrictions’\textsuperscript{9}. These reasons justify the need for a new type of planning and living to be brought to realisation through architectural design. It is also stated in a recent article in The New York Times titled, ‘Global Weirding Is Here’, that ‘global weirding’ will become a replacement for ‘global warming’.

‘Avoid the term “global warming.” I prefer the term “global weirding,” because that is what actually happens as global temperatures rise and the climate changes. The weather gets weird. The hot gets hotter, the wet gets wetter, the dries drier and the most violent storms more numerous.’\textsuperscript{10}

Our cities must adapt to this problem of ‘global weirding’ as well as global warming. This can be done through the use of a more efficient way of planning and building our urban environments, as well as a greater efficiency in the use of energy and resources. I believe that this project can be applied to solve the problems that we as a society face today and through the research and evolution of this project. It can and should be applied to the urban environment of Auckland, and in future it should be applied to other urban centres of New Zealand.

\textsuperscript{9} C J Lim, Ed Liu, Smart Cities and Eco-Warriors (New York, NY: Routledge, 2010), 9.
2.0 Define project

2.1 Brief

Ecology via architecture is an architectural project that will evolve on the western slopes of the Auckland CBD.

This project is about producing food and dwelling collaboratively in the urban environment. The idea it is to create a close to home space where families can produce their own food supply according to their abilities and choices and to create a resilient and self-sufficient area. The design aims to be a leading example of future ecological and sustainable developments in the urban environment of Auckland. In the simplest form it will be a hybrid project, merging inner city apartment living with the production of food.

2.1.2 Site

The site is situated on the western edge of Auckland CBD, in the newly zoned Victoria Quarter block. Currently the site houses the old Auckland City Council's Works Depot as well as a large number of rental car parks. The Works Depot sheds were designed and built by Ewen Wainscott and opened in 1968. Wainscott was ‘famously influenced by the principals of the modern movement and specifically, the American architect Albert Khan (1869-1942), who was known at the time for his benchmark industrial factory, foundry and warehouse architecture.’11 The Nelson St boundary is 190 metres in length and the Cook and Wellesley St boundary are 100 metres long.

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Giving a total site area of 190000m². The site is one of Auckland’s last great undeveloped sites, being situated within a 5 minute walk of Aotea Square, Victoria Park and Viaduct Harbour and a 10 minute walk to Albert Park, Britomart transport centre, Queens Wharf and the newly developed Wynard Quarter and North Wharf. The location and size of the site makes it ideal for my project.

Figure 2.2 Site context.
Figure 2.3 Map showing 5 minute walking area.

Figure 2.4 Map showing 10 minute walking area.

Figure 2.5 Map key.
Figure 2.6 View of site from Victoria St.
Figure 2.7 View of site from Nelson & Cook St corner.
Figure 2.8 View of site along Nelson St.
2.1.3 Achievement of program

Achievement of the program will depend on four aspects: the formal, functional, structural and environmental aspect.

- The formal and aesthetic aspects of this project are heavily focused on green design and ‘biomimicry’ 12. The project will have a strong formal and expressive agenda to educate and demonstrate to the users and public that it is different from the norm in relation to modern inner city developments. It will incorporate a farmer’s market and educational centres. The education centres will educate the general public to the current sustainable issues that New Zealand and the World faces and how we can start to deal with them in an ever-expanding city.

- The functional aspects of the project is to provide a healthy and safe environment where the inhabitants can produce their own food within the same precinct where they reside. The program will support and house offices, administration areas, small scale retail, café and restaurants, early childhood care, education centres, food growing and distribution facilities and, most importantly, residences. The idea is for the whole complex to operate in a closed loop system with food being supplied to the cafés and restaurants, waste products from them and the apartments being turned into energy and fertilizer for the growing of the crops. Minimal to no waste will need to leave the site. There is a large focus on vertical farming aspects and methods and tying that into the form and aesthetics of the building. This project will create a new typology in the form of sustainable living in Auckland City.

- The structural requirements for this project are very important in regard to the added weight of the vertical farming paraphernalia, as well as the added weight of the green roofing systems and resource harvesting and collection systems (solar, water and wind). With the addition of these extra components, it produces more weight and load for the structural systems to support and make the structural aspect of the building significantly more critical.

- The environmental aspect of this project is also highly important, as the project will act as a sustainable hub for the city of Auckland and a benchmark for the rest of the country. Various sustainable technologies are utilized in this project; it will operate as a closed loop system with its main purpose of supplying a healthy, safe and ecologically sound way of living in the urban environment. Closed loop systems are employed to assist in dramatically reducing the amount of waste that other urban buildings and cities produce and deposit. The controlled growing areas in the project use the latest in climate control and hydroponic growing methods. With the systems, organic and healthy food can be produced that is fertilizer and disease free. A 70% reduction in water needed for the grow areas is made possible with the hydroponic growing systems. Drip irrigation is also employed and reduces the amount of water needed for irrigation of the outdoor crops with water being delivered directly to the plants. Water used for irrigation will be mostly made up of recycled rainwater, harvested by the roof top collection systems that is then stored in collection tanks.

With this brief and the four aspects, a full programme is created, which will conclude in the success of the project.

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12 Biomimicry, the design and production of materials, structures, and systems that are modeled on biological entities and processes.
2.2 Precedent survey

The subject of vertical farming is fairly new to the architectural world. Dickson Despommier was one of the first to coin the phrase Vertical Farming. With the subject being relatively new, there are only a small number of completed works that fit into the same category as the current project. Lately there has been an increase in the ‘green’ movement and more projects are being designed, but a lot are still in the unbuilt stages. With the chosen brief still being relatively new in the architectural realm, both built and unbuilt projects have been looked at for the precedent survey.

- 60 Richmond Street - Teeple Architects, Canada (built). This 11 storey-housing complex comprises 85 mixed-use units and integrates ‘urban agriculture and food preparation spaces within the buildings very core.’ 13 The integration of the housing and the urban agriculture functions well, while providing quality spaces which are both functional and aesthetic. From the street view the project looks like any other housing project, but on closer examination the project reveals its green initiatives.

BedZed is a zero energy housing development, which incorporates 82 dwellings and received the 2001 Housing Design Award for sustainability from the Royal Institute of British Architects. The BedZed project ‘reconciles high-density with amenity, providing each dwelling with a sky garden or terrace.’  


Eden Project – Grimshaw Architects, United Kingdom (built).
The Eden Project has become a useful precedent to study with its use of biomimcry. Biomimicry was used to create the form and structure of the green houses. Grimshaw Architects looked at soap bubbles to help create a more resource efficient form that would work with every changing site. They also looked at pollen grains and radiolarian, for the structural systems. The radiolaria are amoeboid protoza, which create cell shaped skeletons. This creates the shapes and patterns used on the structural systems and cladding.

• Ivry-sur Seine- Jean Renaudie, France (built).
The work of Jean Renaudie, although a lot older than the other precedents studied, has been important to look at because of his studies of new town planning systems and the creation of new systems of relations between its inhabitants. To create these systems, Renaudie was 'Informed by research in molecular biology, it was going to be a living organism.' This helps work with the idea of biomimicry and looking at nature to solve architectural problems.  


• Plantagon – Sweco, Sweden (In the process of being built)
Plantagon broke ground in February 2012 for construction and 'construction of the greenhouse will take an estimated 12-16 months.' This project has become an important precedent as it is one of the first 'true' vertical farms to be constructed.

- **Agro-Housing - Knafo Klimor Architects, China.** (unbuilt)
The Agro-Housing project is an award winning design for a housing development in China. It was one of the first projects to incorporate vertical farming and residential units. The design of Agro-Housing offers an ‘urban and social vision that will address problems of chaotic urbanization’ 17. The Agro-Housing project uses prefab design with integrated ‘green building practices, smart growth principles and traditional values to create sustainable urban communities within China’s growing metropolises.’ 18 The Agro-Housing project has been an important precedent as it functions well on with areas for housing and vertical farming areas.

18 Ibid

- **Spire Edge - Ken Yeang, India** (unbuilt)
Ken Yeang is renowned for his work with green design and planning with large projects with a heavy focus on ecological design. His Spire Edge project is a 21 story office tower in India and features his trademark ‘green ecoinfrastructure’ 19. This is made up of vegetated green walls and planter ramps, giving the iconic tower a very distinctive look that is a trademark of Yeang’s work. Like most of Yeang’s work, the client will know they are in a sustainable and more ecological building.

2.3 Literature survey

Literature on the precedents of sustainable building and living as well as urban farming methods and systems has been researched to construct a stronger understanding of the typologies applied in this project. The topic of urban farming is relatively new in the architectural field in regard to publications and built projects. The following literature background represents a selection of significant literature, which provides vital information to aid in the success of this research project.

- Dickson Despommier’s book, The Vertical Farm: Feeding the World in the 21st Century has been an excellent information source for the project. Despommier sets out how to solve America’s food, water and energy crisis through the use of vertical farming. Despommier was the first to coin the phrase ‘The Vertical Farm’ and has now become a leading pioneer in the field. Though the book is heavily based on the American market and scene it touches on the global issues also with regard to the food and energy crisis that we will all face in the future.

- Smartcities and Eco-Warriors is an important book written by C J Lim and Ed Liu. It is a valuable read as it discuss the methods which have led cities to grow out of control and reduce the available agricultural land, which in turn threatens the sustainability of our food system. The authors explore how the reintegration of agriculture in urban environments can cultivate new spatial practices and social cohesion as well as putting food on our tables.

- EcomasterPlanning by Ken Yeang gives examples of master planning for a sustainable future for our planet. Yeang believes that it is vital we find green design solutions for our built environment and that they must start from a wider regional scale. Ken Yeang also uses concepts of ecodesign in all of his architectural projects with the human built environment and the surrounding eco systems.

- Scape: Landscape architecture and urbanism magazine Scape 2 / 2009 (December). This journal discusses the issues of climate change as well as ways to improve the environment we are in with sustainable urban planning and design. They discuss and explore the way in which architects, landscape architects and urban planners can contribute to sustainable design.

- A Deeper Shade of Green: Sustainable Urban Development, Building and Architecture in New Zealand by Johann Bernhardt has been a very resourceful book as it deals with the vernacular issues of the New Zealand climate and sustainable models that are interpreted into architecture through concepts and solutions, as well as the global issue of global warming.

- Carrot City: Creating Places for Urban Agriculture by Mark Gorgolewski, June Komisar, and Joe Nasr looks at architectural design to enable sustainable food production in cities by helping to reintroduce urban agriculture to our cities. The book also examines case studies of built and unbuilt projects.
3.0 Develop Project

3.1 Design process

The early stages of the project began by experimenting with different geometries and researching how they could be applied or adapted to the site. To do this I created and developed early site ethos and force models. These models related to the flow and movement that I felt affected the essence of the site and the surrounding environment, as well as neighboring buildings and landmarks.

Looking at the surrounding site plan at a larger scale, I then started to magnify it in scale. I did this in four steps.

The first step was of the surrounding coastline of Auckland CBD and harbour at a scale of 1:50000, then 1:8000, then 1:5000 and, finally, 1:2500. As the scale in maps reduced, a pattern and layout from each began to form, with each one becoming slightly different. The 1:50000 map, was very loose and had unsystematic geometries with the structure being very organic. The 1:8000 map started to become more fixed and tighten up as city blocks and boundaries became apparent in structure. However, the forms and shapes were still very haphazard. In the 1:5000 map, a more formal arrangement is created, with the rigid make up of the Auckland CBD becoming evident. The final 1:2500 map shows the site for my project in closer detail.

The map has the very formal and strict make up of the Auckland CBD but with my site situated on the western slopes of
the CBD, it breaks away from the perpendicular pattern of the CBD as it, and nearby sites, change in shape in a response to changing contours, features and geometries of the land. This shows that, even though my site is in the strict arrangement of the CBD, it is acting as if it wants to break away from the traditional and formalist planning of the CBD.

From this mapping exercise I created a model of what I felt were the forces and essences playing on the site itself. These took into account the surrounding buildings, topography of the site, prevailing winds, solar paths, connecting open spaces and human migration links.
With this, and the mapping done previously, it was apparent that the form and footprint of the building would be pushed up close to the hard edge of Nelson St. This would not only act as a buffer to the busy one way arterial road but it would be in keeping with the hard edge of the western CBD wall, which is incredibly dominant with its 50 metre high apartment buildings running along the other side.

The form of the site would suggest that the building would shield the site on the two main edges of Nelson St and Cook St.

This would shelter the site from the prevailing westerly winds that can affect the area, as well as noise pollution from the busy streets and arterial road surrounding it. The site has a strong connection visually through the top right corner of Nelson and Cook St down to the Rhubarb Lane and Victoria Park. At this stage it is just a visual link, as current site forms and existing builds block it.

During the stages of the site analysis, I looked at the site and its existing structures and features. This included the council sheds, car parking areas and older building on the corner of Nelson and Cook St. I studied ways of adaptively reusing the existing structures on the site and trying to incorporate the brief’s needs and features. These ideas did not prove successful, so I decided to start fresh on the site. By starting on a cleared site and working around the sites geography, the site becomes more open to potential connections and links as well as stripping back the impervious surfaces of the parking areas.
to create a more ecologically friendly design. Another main link is the connection to and from the CBD, which runs along Wellesley St West. The Wellesley St West connection is used extensively throughout the day and has a high volume of foot traffic, which also flows down into Sale St. Because of this, the site suits having this edge along Wellesley St and Sale St corner remain as open as possible and to have the more public areas and activities situated in this corner of the site. Good levels of sunlight also enter the site from this side. This type of site layout will also work in with the newly developed Rhubarb Lane project.

The Nelson St boundary is 190 metres in length and the Cook and Wellesley St boundary are 100 metres long. This forms a rectangular site with an area of 19000m2 and a maximum total floor area ratio (MTFAR) of 5:1. This is essentially the same size as the traditional central Auckland city blocks, which surround it.

3.1.2 Massing
I began by creating early massing models of the site and started to work on the L shape design, but I quickly realized that the scale of the site was far too big for a single building use.
With this in mind I had to treat the site as a city block and divide it up into smaller blocks. Traditional inner city blocks range from around 80x80m² up to 120x120m².
With the size of my project I have chosen to create three blocks. The first block, which is on the corner of Wellesley St and Nelson St, is around 51 metres and 55 metres respectively with a total area of 2805m2.

The second block, is situated in the middle of the project and runs 65 metres along Nelson St and is 52 metres deep. It has a total area of 3380m2. The third and final block is placed on the corner of Cook and Nelson St. This block extends 100 metres along Cook St, and then 60 metres up Nelson St. This makes it the largest block in the site at 6000m2. This block is larger than the others due to its position on the site, creating the hard edge or barrier to the busy Nelson and Cook St.
3.1.3 Perimeter blocks concept

The project then developed around the three blocks I had created. Throughout this project I wanted to have a high density of living with the integration of vertical farming, which would provide the residents and community with food and employment. I began to look at traditional styles of urban design and town planning. A planning method worked with was the traditional perimeter block style, very prominent in older European city design. The perimeter block is built up on all sides, traditionally having commercial or retail on the ground floor and living on the upper floors. It then has an opening in the middle that would become a semi private area such as a courtyard for all to use. The advantage of this type of design is that you can create a very high density in a small area without needing to create high-rise buildings.

I started to work on developing this idea of the perimeter blocks in the design and presented it at the first critique.

In theory the perimeter block design worked well in other parts of the world and with more traditional briefs and planning needs, but it did not engage into my site or my brief. I began to focus more on the living and planning side of my brief and stepped away from the equally important aspects of it, such as the vertical farming and food production side of it. Growing towers were created for the production of food and acted as stacked green houses, employing hydroponics as the method of growing plants. But these grow towers became difficult to work around with the perimeter block design as some would have large amounts of solar activity and some would not, such as those situated on the south eastern side of the project.

This image shows the 3rd floor plan on the first block. Lots of circulation areas are needed to access the apartments and grow towers and there the current number of apartments is insufficient to achieve the site density wanted.
On a site with such high levels of sunlight I still found it difficult getting sun into the internal courtyards of the blocks. I created openings in the blocks layout to try and counteract the shading caused by the blocks, but they still remained dark and unpleasant places to occupy, particularly in the winter months. This design also did not correspond well to the site dynamics discovered during the site analysis stages.

This site has very strong desires to break out from the strict construction of the city model and with this design it did not. It created difficult and unpleasant spaces in the internal courtyards as well as large and underutilized area of land on the north side of the site and an uncomfortable relationship with the new Rhubarb Lane development. The grow towers in this design were not prominent enough to act as a formal expression of what this project is about and how it functions. They need to be designed to create a greater visual expression about the project.
3.2 Design outcome

3.2.1 Overall concept and strategies

From working with previous designs, I started to cut away at the structure of the building blocks. I still chose to retain the three blocks as they work well on the site with their positioning and scale, but cut away at them to open them up to the rest of the site.

Doing this greatly improved the relationship with the surrounding site and utilises the sunlight, so that all areas of the site can exploit it. With this manipulation of the existing blocks, the forms of the perimeter blocks transform into a horseshoe, or u-type, shape. These open out the buildings and create a much stronger relationship and connection with the rest of the site. This design also works in collaboration with the site as it works well with the site forces that I developed earlier.

The grow towers, which I was not confident with during the previous design, have been moved to the end tips of the building (Fig 3.14). This places a greater emphasis on their importance and formal expression of them, as I feel they are a critical part of my project. Living, retail, educational and social areas are then situated in the blocks while the blocks still employ a traditional methodology of perimeter block planning.

To create a complete architectural project and help explain it, I have divided the design outcome into four programs and then the four aspects of architecture which create the completed work design.
3.2.2 Apartments

Formal

The formal agenda for the project focuses heavily on a new and more sustainable way of living in our cities and acts as a benchmark for how the public interacts with and discovers it. The apartments aesthetic play a huge role in the project, due to its very public location and size.

As discussed in the previous analysis of the site, the hardedge of the western CBD wall drives the form on the Nelson St façade to be very rigid and intact. As the site loosens and opens up as it travels downhill, it leads the building forms to do the same. The need for large strong masses and forms are not needed on the calmer and more people friendly sides. More openings are designed on these northern and western sides so that apartment users can utilize the morning and midday sun. A double skinned façade on the northern and western side also help to minimize sun penetration during the summer and will be discussed further in the environmental section. This creates enjoyable and useable balconies for every apartment with the incorporation of small herb gardens.

The site and its character drive the footprint of the building with the building fingers breaking out onto the site. These forms are angled to maximize the use of the sun while providing clear links though the site. On the Nelson St and Cook St corner, the
Figure 3.13 Floor plan diagram showing the range of apartment styles and layouts in the project. Each apartment maximises natural light as well as large outdoor areas tailored for small kitchen gardens and quality outdoor space.
expressive form along the Nelson St edge remains mostly unbroken in building mass but is raised up two levels in the corner, creating a break in the building. This serves as a public access point though the building and out on to the public garden and market areas, with the site creating two sides of the building, it gives the building two styles, or faces, and leads you to argue, which is the front or which is the back?

**Functional**

The functional requirement of the apartments is to house the residents in a clean and enjoyable environment while maintaining an environmental and socially positive area. To create a healthier environment, a lower number of lifts are used in the building while higher numbers of stairwells are provided to encourage the users to travel up by their own power, and not that of the lift.

Traditional internal apartment access corridors are not used and all corridors in the project become much shorter in length. Each corridor now becomes a walkway, which takes advantage of external views around the site. The walkways are bigger than traditional access routes and have congregation areas where residents can use as areas to mingle and occupy. This is used to try and slow down the journey that the resident takes home and encourage using the building, not only as a home but as a shared space with other users, and interact socially with one another, creating a greater sense of community. Due to a mixture of economic, social groups and situations as well as family sizes, apartment size and layouts in this project vary between the 292 apartments on site.

Studio apartments cater for a single person or couple and feature an open plan floor plan of between 60-65m² and are single storey. One-bedroom apartments cater for a single person or couple and are 65-70m². The two-bedroom apartment caters from new families or couples and is both one or two storey and around 85m².

The three bedroom apartments are the biggest apartments and cater for families. They are two story and range from 85-100m². These differing apartment sizes are spread out through the project to create a more mixed social order.

Planning and architectural elements greatly influence how people interact in this project which, creates a whole new typology in the way we live and dwell and greatly effects how the project functions socially. In traditional apartment buildings...
Figure 3.20 Site Plan.

Key

1. Wellesley St West
2. Nelson St
3. Cook St
4. Sale St
5. Rhubarb Lane
6. Public Market
7. Orchards
8. Gardens
9. Wetland Reserve
10. Future Development
functions in a slightly different way. Areas where residents live are formed as a double skin, the internal skin is where they live and sleep whereas the outer skin is the one that protects them and acts as the final layer of cover. The double skin façade on this project

Structural
The structure of the apartments is very important as they take the added loads from the intensive green roofing system. The flooring systems are precast double T flooring system which supported by a grid layout of precast concrete walls and columns which then transfer the load onto the columns in the basement. The use of multiple concrete staircases throughout the building will further help to stabilize the buildings structure. An engineer will determine final structural member sizing.

Environmental
With energy consumption becoming high in many inner city developments as large quantities of residents live and work in the chosen area, energy saving initiatives become a huge priority in this project and aim to reduce the greenhouse impacts of the building. To generate these savings smart design is incorporated, such as exposed thermal mass passive design, night purge systems, low energy light fittings and the use of natural light as well as solar power. The building employs a simple double skin façade feature, incorporating an outer skin and inner skin. This idea of double, or twin skinned, façade is used in many new projects such as the NZ1 building. The double skin façade on this project

users drive their vehicles into the underground car park, travel up the lift to their floor and then hurry along the poorly lit and narrow corridor to their apartment, hoping that they avoid eye contact or any kind of human contact along the way. In this project there are low numbers of car parking with an emphasis on not needing a car in the inner city. Bicycle parking or smaller sized car parks are included.
Green roofing systems on top of the apartments play very important roles in this project as they help manage storm water runoff, reduce the building's energy consumption by providing thermal insulation, reduction in 'urban heat island' effect and by replacing the pre existing natural ground cover that the building's footprint has taken and transferring it to the roof top.

This green roofing system will add a load to the building as it is an intensive system. The substrate, which does not contain conventional soil, but is ‘considered being engineered media designed to meet particular physical and chemical characteristics’ 20. With the green roofing system being an intensive system (200mm or more substrate depth) significant engineering has been carried out to ensure that the building's structure can support the weight of the roof. This becomes very critical as this type of intensive green roofing system has high water holding capacities. To assist with Auckland's high annual rainfall water must be able to freely drain off the roof. Roofing on the project will not only incorporate green roofing systems but also use Building-Integrated photovoltaic (BIPV), which aid in the energy generation for the buildings. The rooftops of each building in the project are also open to the buildings residents, acting as another space for them to occupy and enjoy. High efficiency water systems are also utilized in the apartments with low water toilet and shower systems. Grey water from toilet and showers will be filtered and used for irrigation or released back into the ground through the wetland system. Wastewater recycle system is further discussed in the environmental section of 3.2.5.


Figure 3.19 Typical green roof section.
3.2.3 Grow Towers

**Formal**
One of the noticeable features of this project compared to other inner city housing complexes is the introduction of growing food on site. The formal arrangement of the grow towers becomes the foremost visual feature of the project as they are a totally new feature to the urban environment of Auckland. The grow towers being placed on the tips of the apartment blocks, give them a very strong and public presence and importance to the project as they act on many levels such as social, economic and educational. These green towers stand tall with a strong formal agenda that shows its organic structure of ETFE and BIPV paneling and rooftops housing the building’s heart and lungs. The form or these towers are heavily influenced by the function of them.

**Functional**
Auckland’s sub tropical climate makes it idea for many types of vegetables and crops and with the addition of the grow towers, which create a controlled climate giving optimal conditions, large yields of produce will occur over a relatively small footprint. The grow towers not only provide food and revenue but they act as a social tool aiding in Social sustainability, Cultural identity, Empowerment, Accessibility, Stability and Equality. The grow towers help the residents to work together and communicate with one another. This gives users a sense of empowerment that they are helping provide for their family and community as well as giving them greater stability both financially and mentally. The sense of equality is also of great importance for the resi-

Figure 3.21 Exploded view of grow tower and skin.
Figure 3.22 Aerial view of site showing grow towers at the tips of the blocks.
dents and users as it forms a state of equal rights and opportunities within the development with everyone working together to help provide food for one another. Form and lay out of the grow towers is greatly influenced by the sun and function of them. The staggered layout of the grow tower levels means that an abundance of sun reaches every level aiding the plants in their photosynthesise.

Warm group plants will be placed on the higher northern side of the towers. While colder plant group are to be placed on the southern sides. Highly flexible interior spaces are created so that there is the freedom to configure and reconfigure the conditions the crops will be subjected to. Luckily ‘most crops have a fairly broad range of tolerances with regard to tempera-
ture and humidity’ 21, this allows differing crops to be placed on the same room or level if need be. An internal stari system for the grow towers is created so that vertical access can be made easier as well as the use of the lift shaft for the transportation of heavier loads.

**Structural**

Structural loads of the grow towers are kept low with the weight of the floors with hydroponic systems become offset by the lightweight exterior structure and Ethylene Tetrafluoroethylene (ETFE) paneling. This is the same material used for the Beijing Water Cube and the Eden Park stadium in Auckland. ETFE panels are as transparent as glass and do not yellow over time. The ETFE panels weigh 1% of the weight of glass, transmit more light, are self-cleaning and are recyclable. The façade structure has looked at biomimicry and is designed using a Voronoi diagram algorithm, which creates a decomposition of a given space. Much like the structure of a leaf or plant cell. Additional areas on the façades towers incorporate BIPV panels in places where traditional glazing panels would be used. These panels still provide translucency into the space, but also provide power which is used to run the grow towers. Metal columns and beams support concrete floors while the internal climbing structure concrete floors of the tower creates a staircase from which intern acts as a bracing tool for stabilizing the towers.

An engineer will determine final structural member sizing.

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Environmental
A large amount of energy is produced for the project by the grow towers. With the high levels of solar energy on the site the grow towers act as small power stations for the project. They are placed on the ends of the buildings, giving them year round solar exposure. This is not only useful for the photosynthesis of the plants inside the grow towers, but also for the BIPV solar panels which are incorporated into the design of the grow towers.

The grow towers provide not only energy for the rest of the buildings through solar power, but they also provide heating and cooling for the building. This is done through a purge system. This system works with hot waste air that builds up inside the grow towers. Instead of releasing the hot air back into the environment through the cowl chimney at the top of the towers, it is piped through the rest of the building in the floors and ceilings to provide heat to other areas of the building and keep them at a constant temperature.

These purge systems at the top of the grow towers to vent excess hot air also help to control the internal climate of the towers and keep them at an optimal temperature of between 12-25°C throughout the year. Before the excess hot air is released into the atmosphere, it will be determined whether or not it is needed in the rest of the building. This helps with the HVAC system in the building and apartments. In turn, the grow towers act as the heart and lungs for this project.
Figure 3.21 Water cycle diagram

- Rainwater is captured on the roof surfaces.
- Water then evaporates back into the atmosphere.
- The water is then sent through underground filtering tanks.
- Water is then stored for the apartments and grow towers.
- Excess water is then pumped out into the fields or into the wetland areas.
Hydroponic growing systems for are use to produce food in the grow towers which use ‘70-95% less water’\textsuperscript{22} than traditional farming methods. A small selection of the produce that will be grown in the towers hydroponic system;

Warm group vegetables
- Cucumbers
- Peppers
- Tomatoes
- Egg plates
- Green beans
- Asparagus
- Broccoli
- Strawberries

Cool group vegetables
- Carrots
- Lettuce
- Celery
- Cabbage
- Spinach
- Onions
- Spring onions
- Sprouts
- Potatoes
- Mushrooms

\textsuperscript{22} Dickson Despommier, The Vertical Farm: Feeding the World in the 21st Century (New York, NY: St. Martin's Press, 2010), 145

3.2.4 Commercial

Formal
Commercial areas are designed in keeping with the aesthetic of the apartment blocks and grow towers. These spaces make use of the buildings form, layout and large number of public interest and use. Commercial spaces will be in fitting with the ecological theme of the development and include healthy cafes, restaurants and store that supply environmental friendly products.
Functional
The location for these commercial spaces on the ground level of the apartment buildings will provide them with an abundance of customers from the apartment buildings above, the educational centre and the general public who use the space.

Structural
The structural aspect of this area is discussed in structural section 3.2.1.

Environmental
With the café and restaurants being located on site, the environmental impacts of needing to transport produce in from other parts of the country is not needed. This provides fresher food and less cost on transport. Waste products from meals are then turned into energy (fertilizer) for the towers. This closed loop system is designed so that zero to no waste needs to leave the site.

Wastewater from the restaurants and other commercial areas is then feed into the building's wastewater treatment system. The building's wastewater flows into underground filtering tanks where the solids then settle and remain unprocessed. A screen then removes plastics and other solids that are contained in the water. The water is then pumped into gravel filled wetlands where pollutants stick to roots and gravel. The wetlands then fill and drain repeatedly. Once the water is filtered it can go into underground water storage tanks for later use. This tank water then enters a filter where microorganisms convert waste into nutrients for plants, which are then pumped into the building’s grow towers to be used in the hydroponic systems. This system runs in unison with the water system of the apartment blocks.
3.2.5 Site Gardens and Market space

Formal
The formal expression of the site and market place is also of great importance as residents and the public will travel though and use these spaces every day. These areas then become the main public realm of the site.

With this project’s intention to show case what an ecological correct development in the city can be, great detail has been placed on providing enjoyable open spaces with the landscaped gardens and smaller productive fields. This enforces the visualization of this project being an ecological centre in the city.

Functional
The market is placed in the northwestern corner of the site, beside the Rhubarb lane development as both elements feed off each other. The market is placed here because of the high volumes of pedestrian foot traffic from Wellesley St West and the new Rhubarb lane development. Pedestrian and visual links link the market and gardens to the grow towers and apartments. The main function for the markets are that they act as a social tool and provide an area from the city to use. The other main function of the markets is that it creates an area that fresh produce from the grow towers and fields can be sold to the local community.

Structural
The structural requirements of these areas are to provide high quality areas and landscaping for the public to use. The use of paving is to be limited as much as possible but in market areas and pathways with high levels of foot traffic, Gobi block paving is used to provide permeable paving areas.

Environmental
The site gardens and open space play an important roll environmentally and add in site restoration. The site, as it sits currently, is made up of predominantly impervious surfaces. This is because the previous tenant of the site used it as an inner city car park. One of the main principles of ecology is that the land should be brought back to its original state if an ecosystem is to succeed again in that area. With almost 90% impervious surfaces on the site, it makes rainwater and waste-water runoff a major issue.

Auckland has a mean annual rainfall of ‘1250-1500mm’[^23^]. However, nothing is done with this water. It falls from the sky, lands on the ground and is sent down the drain with little or none soaking back into the soil. High levels of storm water runoff can produce flood hazards and produce pollution through contaminants such as petroleum, hydrocarbons, heavy metals and sediments being picked up that then enters our streams and harbor systems.

With the high levels of impervious surfaces on the site, the first step to bring back the natural ecology of the site is to strip back the impervious surfaces with the introduction of gobi block permeable paving in areas on the site as well as rain gardens and wetland areas.

Figure 3.18 View of markets from Wellesley Street towards Nelson st.
A common assumption is that there are abundant supplies of fresh water. Freshwater makes up just ‘3% of the planets water and only 0.6% is usable.24 With such low levels available for human consumption, rainwater on the site will not be treated as a waste product, nor will it be removed from site as swiftly as possible. It will be collected, stored, filtered if need be and then put to use, either for watering of plants or as grey water for toilet systems. Small amounts may be filtered to produce drinking water. Much like the natural closed loop ecosystem cycle, there will be no such thing as wastewater in the cycle.

3.3 Presentation Strategy

The presentation strategy of this project will reflect the project and aim to be a showcase of this design. It will include a power point presentation highlighting and detailing the important stages of design and the final design and why it was chosen. Context and site models will be used to further explain the project and presentation panels displaying features and images of the project.

4.0 Conclusion

4.1 Summary

This project is about producing food and dwelling collaboratively in the urban environment. The idea it is to create a close to home space where families can produce their own food supply according to their abilities and choices and to create a resilient and self-sufficient area. The design aims to be a leading example of future ecological and sustainable developments in the urban environment of Auckland. In the simplest form it will be a hybrid project, merging inner city apartment living with the production of food.

4.2 Appraisal

Through this project and research question, I believe that there is an architectural solution to the problem our cities face. The project has answered the research question and shown how a new resilient and sustainable way of living and producing food in the urban environment can be created and how it will function. This project will be a tool in response to the increasing concern for a sustainable and ecologically balanced way of living in the urban environment. It creates an urban environment for people to live a more ecologically balanced life by having the opportunity to grow their food while making respectful decisions for our climate, our ecological system and society.

I believe this project has a very strong merit, considering what we as a society and planet are facing. Architects need to act as educators to inform the public through designing a more ecological aware way of living if we are to survive on this planet. It has a very powerful relevance for our chosen profession as it greatly affects other sectors such as property and the construction industry.

This project, will also act as a benchmark for future developments. Many of the features can, and should be, adapted to new projects.

24 Johann Bernhardt, A Deeper Shade of Green, (Auckland: Balasoglou Books, St. Martin's Press, 2008), 96
4.3 Future directions

Future directions that would further the research of this project I believe would include, contextual issues of applying or modifying the project to different sites throughout the city. The chosen site for this project was good to work with as it had large amounts of sun and open space for an inner city site. It would be fascinating to see this program developed on a more confined and smaller site.

Further research into the expected yields of crops and vegetables and research on the amount of food would need to be produced to satisfy the project and its users.

Further research into building materials, their life cycle assessment (LCA) and the origin of the materials and their carbon footprints would also be worthwhile in taking this project to a higher level. With the use of the grow towers and their production of plants and produce, the towers generate CO2, which would offset the greenhouse gases in the production of the materials, but the final figures remain unknown at this stage.

Lastly, the economics of this project would need to be researched more in relation to the construction costs and of the residential dwellings and the grow towers, as they would cost more in the initial stages but would be offset in the later years of the development.
5.0 Bibliography


6.0 List of figures

Figure 1.1 Auckland Sustainability Framework.
Figure 1.2 Areas of housing in the central city.
Figure 2.1 Site location map.
Figure 2.2 Site context.
Figure 2.3 Map showing 5 minute walking area.
Figure 2.4 Map showing 10 minute walking area.
Figure 2.5 Map key.
Figure 2.6 View of site from Victoria Street.
Figure 2.7 View of site from Nelson & Cook Street corner.
Figure 2.8 View of site along Nelson Street.
Figure 2.9 Section of 60 Richmond Street.
Figure 2.10 BedZed development.
Figure 2.11 Eden Project.
Figure 2.12 Ivry-sur Seine- Jean Renaudie.
Figure 2.13 Plantagon – Sweco, Sweden.
Figure 2.14 Agro-Housing Knafo Klimor Architects.
Figure 2.15 Spire Edge - Ken Yeang.
Figure 3.1 Mapping context.
Figure 3.2 Site forces.