A MACHINE FOR GROWING

RELOCALISING AGRICULTURE TO AN URBAN CONTEXT

BY

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RELOCALIZING
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In loving memory of
Pauline and Bruce
Teachers, Grandparents, Lycopersiculturists

Mum and Dad

Thank you for always teaching me that dreams are not vanity but are there to be achieved

My Family

The support through this journey has been nothing short of amazing

The Boys

A great five years, a great few beers

And lastly to Tane Moleta

Forever the optimist, I would never have got to this point without your wisdom and encouragement

ABSTRACT

Agriculture is the most fundamental industry to our survival. With out being able to produce good nutritional food we can not exist. But increasingly this industry and the role it plays in our lives is changing due to its industrialisation driven by the access to cheap and, currently, abundant energy resources. Cheap fuel has given rise to large-scale, fossil fuel intensive, globalised food distribution systems that undermines the role of local food production in a sustainable food network. This thesis proposes that by integrating agriculture back into our communities we can create a more sustainable, secure and accessible food production system.

This thesis explores ways that we can use architectural design to relocalize agriculture into an urban context. It investigates how architecture could be used to develop a framework that could support local food production in an urban environment. Through exploring the relocalisation of agriculture the project develops architectural characteristics that enable it to integrate with its surrounding contexts. This integration is further explored by developing an environment to facilitate public engagement with the processes that the framework supports.

Fig 0.01. Cargo ships and tankers move through Tanjung Perak, the main port in Surabaya, Indonesia. The facility's principal exports are sugar, tobacco, and coffee. -7.182276027°, 112.718361577°

PERSONAL STATEMENT

Within our family there has always been a focus on good healthy locally grown produce. My grandfather owned and operated a tomato growing business in the suburbs of Christchurch. My father and his sisters worked there from a young age, as did my sisters and I. At home fruit and vegetables were grown to varying degrees of success and others came from a local allotment. Whilst I never really grasped significance of having access to good local produce, I distinctly remember the social connection. Food was as much about engaging with the local community as it was about consuming.

Over time the tomato production was forced to scale down as the larger distributors began importing tomatoes from large-scale operations in the northern parts of Australia. The imported products did not offer the same diversity nor the same flavour, but they were cheaper, and with the globalised transport network and cheap fuel it became more cost effective to import from abroad rather than source from local small holdings .

This illustrates our current problem, in the search for cheap, uniform produce we have given up sustainability, diversity, accessibility, security and even quality. We no longer see where our food comes from let alone have the ability to engage with it. Decentralised urban agriculture cannot compete with large centralised farming operations without the development of an urban agriculture framework.

This is the problem that this thesis seeks to explore.

CONTENTS

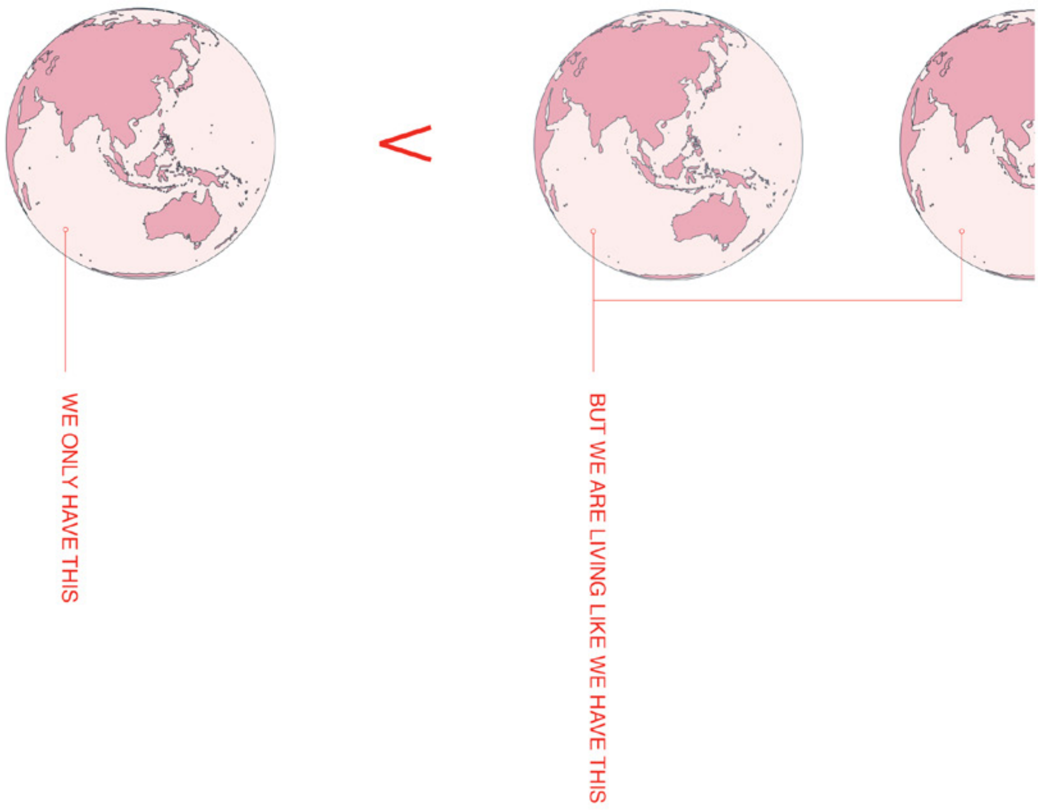
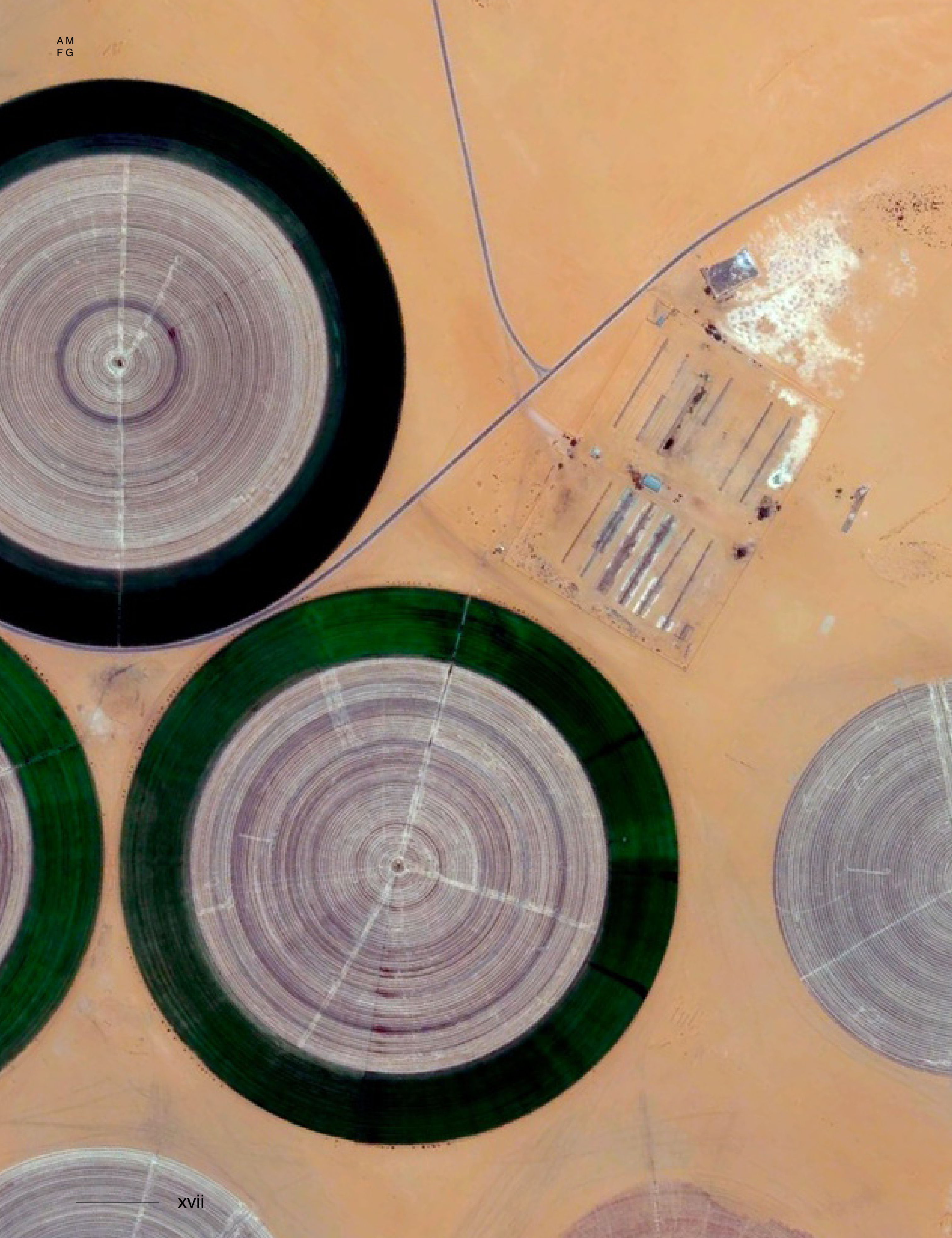


Fig 0.02. A DIAGRAM ILLUSTRATING THE AMOUNT OF GLOBAL BIOCAPACITY NEEDED TO SUSTAIN CIVILISATIONS CURRENT CONSUMPTION

"I THINK WE ARE FUCKED"

EMMOTT

Fig 0.03. The Kufra Basin in the Sahara Desert of Libya is one of the most heavily irrigated oases in the world. The Libyan government enacted a plan in the 1970's to enable agricultural cultivation in the desert by extracting water from the Nubian Sandstone Aquifer System, a non-renewable source of fossil water located beneath the surface. Because only 2% of Libya's land receives enough rainfall to be cultivated, the aquifer is now nearly dried up. 24°11′N 23°17′E



1. INTRODUCTION

1.1 PROBLEM STATEMENT

"There is an imperative need for a fundamental change in the way the world grows, processes and consumes its food." (Wake Up Before It Is Too Late, 2013)

The industrialisation of our food system has led to a global food production and distribution that is reported to contribute to the widespread degradation of our ecology. "It is this transition of the fundamental way that our food system operates that has made our food more insecure, inaccessible and unsustainable then it ever has been." (Pfeiffer, 2006) The IAASTD reports concluded that chemical-intensive industrial agriculture has tarnished the natural resource base on which human survival depends and now threatens water, energy and climate security. (Ishii-Eiteman) I believe to future proof our agriculture industry their needs to be a necessary shift towards an integrated system that uses agro-ecological knowledge and core design principles to redevelop our industrialised system.

"Despite the clear logic and economic rationale for moving more rapidly towards sustainable agriculture, the transition will require a supportive policy environment and enabling conditions that could help level the playing field between conventional and sustainable agriculture practise." (*Wake Up Before It Is Too Late*) In this thesis I am interested in exploring or enabling the conditions to create a level playing field, by exploring, through architecture, how we can begin to facilitate a shift in the current paradigm. Many of the issues [1] that we

[1] In order to transform agriculture and the broader food system, agriculture knowledge, science and technology (AKST) need to recast to address the past (unsolved), present and future challenges of food and nutrition security, poverty and hunger and preserve rural livelihoods, health and the environment. (Wake Up Before It Is Too Late)

Fig 1.04. At the Port of Long Beach in California, a prolonged labor dispute between the longshoremen's union and ship owners has brought crippling delays to sea freight in and out of the United States. The hold up is wreaking havoc for retailers, food companies, farmers and manufacturers. For example, in order to bypass the shipping logjam and address a global shortage of French fries, McDonald's flew 1,000 tons of frozen fries to Japan.

currently face can be addressed by relocalising agriculture. (Pfeiffer, 2) As 90% of the world's current civilisation now lives in cities, this relocalisation means there is an opportunity for architecture to play a part in this development by enabling agriculture to be re-established in an urban context.

By shifting towards local urban production and distribution network we can re-establish our current fundamentally flawed system, transitioning from a "conventional, monoculture-based and high-external-input-dependant industrial production towards mosaics of sustainable, regenerative production systems that also considerably improve the productivity of small-scale farmers." (*Wake Up Before It Is Too Late*) Solutions to issues such as security, accessibility, economy and sustainability are addressed by condensing, integrating and operating agriculture at a local scale.

"Such a system will engender a fundamental alteration to the fundamentals of our relationships to food and its production." (Sorkin, 285) It is proposed that the benefits of bringing food production back to the city will do more then just create a future proofed food network, it will fundamentally change the way that we engage with our food. (Sorkin, 285) This thesis proposes that to construct a solution the inter-connected relationships and systems of agricultural practise need to be explored through architectural design, to develop a built framework that can provide a platform for urban agricultural development.

1.2 QUESTION

What role can architecture play in order to achieve a ‘re-localisation’ of food production in an urban context, and how can we explore this through a body of design work?

1.3 AIMS

The fundamental aim of this thesis is to use design to investigate ways that an architectural framework can bring agriculture back into close proximity to habitation to create a more sustainable food network.

1.4 OBJECTIVES

This research has developed three key objectives to act as the criterion on which to analyse the success of the design outcomes.

To use architectural design to create a deployable building framework that facilitates the development of urban agriculture.

To be able to integrate this architectural framework into a local urban community utilising existing infrastructure to distribute to a wider context.

Explore through design, how we can facilitate public engagement with a production system and its processes allowing the inhabitants to engage more actively with what they consume.

Fig 1.05. URBAN AGRICULTURE IN HONG KONG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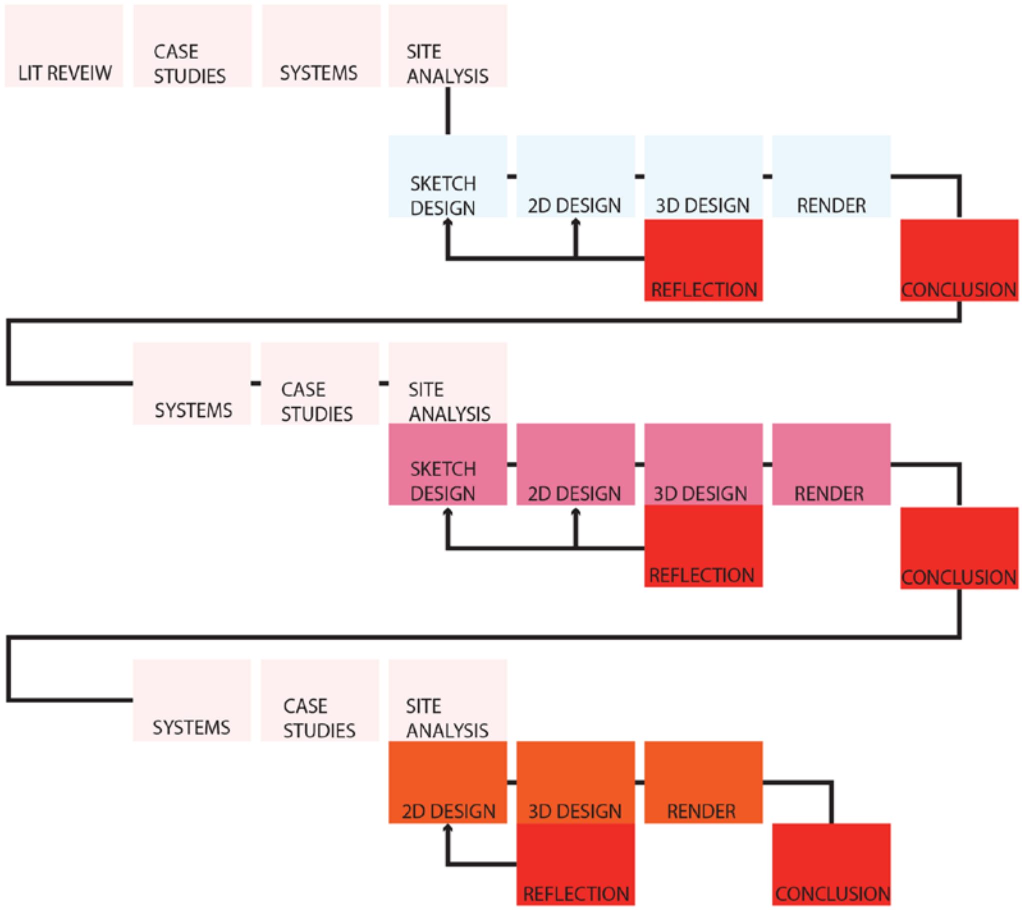
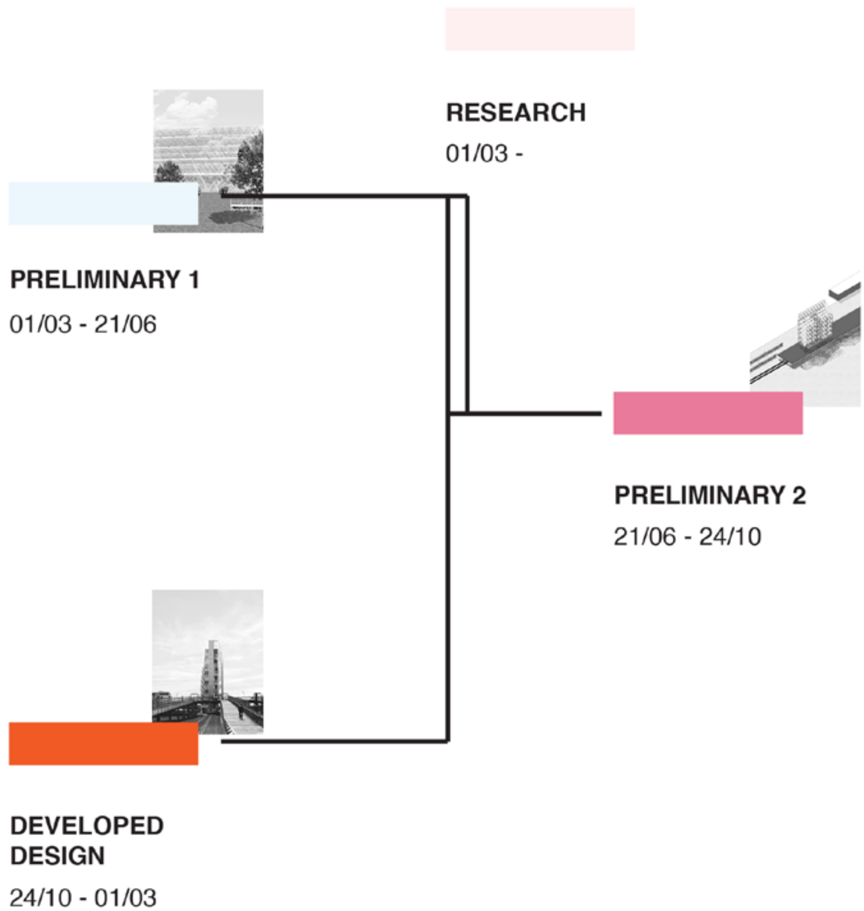
1.5 DESIGN METHODOLOGY



The research in this thesis has predominantly been undertaken in in a designerly manner. That is in studio, using typically design tools to produce outcomes that can be assessed against more scholarly research. The balance of the work is 80% studio practice and 20% text. Text has been produced predominantly after the act of design and is used to inform and guide subsequent design studies. A survey of literature The Trade and Environment Review 2013, A Green Revolution and The Vertical Farm conducted at the beginning has helped galvanise ideas and to challenge assumptions. Whilst case studies have been used through out to provide examples of how these ideas can be implemented through architecture, helping to progress design ideas.

Fig 1.06. METHODOLOGY DIAGRAM

1.6 DESIGN TIMELINE



The design work was produced in 3 key stages that were prepared and presented for formal review. Each stage uses both 2D and 3D tools to develop the design, which is continuingly reflected on in order to move the design forward. The reviews, along with critical reflection are summarised at the end of each design chapter. These summaries reflect upon the successes and failures of each design stage to provide a platform to further develop and refine the architectural outcome in the following chapter.

Fig 1.07. DESIGN TIMELINE

1.7 SCOPE

1.8 THESIS STRUCTURE

This thesis has been undertaken based on the data that New Zealand lives far beyond the earths bio-capacity limits. Reports and data that are specific to both New Zealand as well as further abroad creates the base of the research which informs the direction of this thesis. Where local data was unavailable more general global trends were applied to highlight the need for urban agriculture.

The scope of this thesis is to propose ways we can use architecture to solve current problems in our food production/distribution network. It explores factors such as location, form, integration and engagement to develop a design that will achieve the aims and objectives previously stated. The thesis references appropriate sources to justify the approach to sustainability and agriculture design.

This research investigates the social and architectural implications of urban agriculture, not just the ability to grow and supply local produce but also how creating a public interface changes the way that we engage with our food. The design exploration is not looking at the technical or financial implementation of the design outcome.

Chapter 1. Introduction

This section offers an introduction to the thesis background and problem statement, which is then formalised through the thesis research question, its aims and objectives.

Chapter 2. Research

This section communicates my research and analysis through; literature review, case studies, site analysis and technical analysis. To identify successful and unsuccessful approaches, architectural or otherwise, that have been proposed or realised in response to the problems that our world faces.

Chapter 3. Part 1 – Preliminary design I

An initial design study that uses various digital methods to start to formalise architectural solutions to the problems identified during the initial thesis research. This chapter explores how the influence of systems and processes can inform successful design outcomes. Designs are explored primarily through two-dimensional drawings.

Chapter 4. Part 2 – Preliminary design II

This section reflects on the conclusions of Part 1. Introducing new case studies to look at how a wider distribution network may work with a localised production system, the site analysis is explored through plans and photographs to investigate more specifically transport infrastructure as a point of integration. It explores through design ways in which an architectural framework can start to integrate successfully into an urban context. This is primarily communicated via isometric drawings to express the building form and its relationship to its context.

Chapter 5. Part 3 – Developed design

This chapter builds on the conclusions of part two. Focusing on a specific site to test, through design, how this architectural framework might engage with its immediate surroundings and how it can reactivate otherwise underutilised infrastructure. It also explores how the architecture can create a public interface with the production systems to facilitate an environment where the occupant can engage with the process. This is explored through detailed models that are rendered to communicate the qualities of the designed spaces.

Chapter 6. Conclusion

A summary of the overall design process highlighting the successes of the project but also analysing the design outcomes to understand what the next step might be.

2. RESEARCH

2.1 LITERATURE REVIEWS

WAKE UP BEFORE IT'S TOO LATE - The Trade Environment Review 2013

Wake Up Before it is too Late is a report published for the 2013 United Nations Conference on Trade and Development. The report is a key paper in the context of analysing the current global agricultural situation and stating the significant paradigms shifts that need to happen if we are to create a secure food network that minimises, if not reverses our global impact. The report takes a holistic view of agriculture, in a global sense, by highlighting how agriculture and broader global issues such as climate change, poverty, economic, social and gender inequity, poor health and nutrition, and environmental sustainability are all inter related and need to be solved by leveraging agricultures multi-functionality. Multi-functionality is defined as the "inescapable interconnectedness of agriculture's different roles and functions." (Mcintyre et al.) That is that agriculture is not an isolated practise it is interconnected to our environment, economy and culture.

The paper outlines the fundamental approach that needs to be adopted in order to create a systemic paradigm shift from conventional agriculture to sustainable agriculture. It suggests that by through policy reform and enabling conditions agro-ecological systems can replace our current agriculture practises. It is the implementation of these systems rather then a direct focus on climate change that will create a more beneficial outcome. (*Wake Up Before It Is Too Late*) The multi-functionality of agriculture means that holistic reform can solve more than just environmental issues, it can contribute broadly to all facets that inter relate with the industry.

This report defines the theoretical base for the direction of this thesis. Through agriculture reform many of the issues that we currently face can begin to be addressed in a positive light. It is by enabling conditions to facilitate this paradigm shift that architecture can play a role in the sustainable food movement, at the same time informing our cultural imperatives.

THE VERTICAL ESSAY

Vertical farms are a proposed architectural typology that have been conceived as a fundamental development of a 'green city'. The farms aim to vertically integrate current agricultural systems into high-rise structures in order to reduce their physical footprint. In Dickson Despommier *The Vertical Essay* The suggests that with the population expected to reach 9.2 billion in 2050 this may be the only alternative to produce enough food to survive the earths growing population.(Despommier) The potential benefits of developing urban farms include; year round crop production, no weather related crop failures and no use of herbicides, pesticides or traditional fertilizers. (Ruby, 286) Despommier suggests that a vertical farm covering a single city block and rising 30 stories high could produce enough nutritional produce to feed 10000 people daily (Despommier). This finding situates the production of food firmly into the field of architecture. It illustrates the ability for urban agriculture to support a community by condensing and relocalising.

But the realisation of the proposed vertical farm is not as straightforward as it seems, as pointed out by Stan Cox in his critique of Despommier. "Even if vertical farming were feasible on a large scale, it would not solve the most pressing agricultural problems; rather, it would push the dependence on of food production on industrial inputs to even greater heights. It would ensure that dependence by depriving crops not only of soil but also of the most plentiful and ecologically benign energy source of all: sunlight." (Cox) This critique raises a serious point about the proposed density of urban farming. For an urban operation to be financially feasible it has to condense current agriculture practises but in a way that does not trade off its ability to be supported by renewable energy. Cox calculates that verticals farms reliant on artificial light would in fact have a negative sustainable impact. (Cox)

Whilst there is a strong argument for bringing agriculture back into the cities, it is the architectural framework that does not currently provide the support for a sustainable operation. They are solid structures that do not allow light to fully penetrate nor pass completely through the structure. This thesis will use the theoretical basis of the vertical farm concept to test the success of the architectural designs. It will use the critiques of previously proposed designs to develop a new architectural framework that can bring agriculture back into the city in a feasible way.

CUBAN FOOD REVOLUTION

The Cuban food revolution provides an important precedent on how to effectively transition from a globalized outsourced food production network, to a self-sufficient localized production and distribution system. Born from necessity rather than self-awareness, Cuba was forced to reinvent their food supply network after the collapse of the Soviet Union, their former major trading partner.

Cuba's relationship with the Soviet Union and its reliance on imported produce compromised the nation's food security. Before the collapse, 60% of the islands agriculture was developed as sugar, tobacco and citrus crops to export to the Soviet Union, in turn relying on their trading partner to supply them with food staples, fuel and fertilizer. After the collapse, almost over night Cuba lost 85% of its trade. This did not just affect the Cuban food supply, but it affected their own agriculture operations as they no longer had the fuel or fertilizer their current system relied on. (Pfeiffer, 56)

The food system in Cuba was forced to shift towards a mosaic of locally owned and operated smallholdings. This system promotes diversity security and accessibility. The ability of the government to facilitate this shift was vital to reducing the casualties from the collapse of their food network. Downscaling and diversifying were paramount to forming a new resilient robust network. This move was facilitated by the government's ability to disseminate knowledge to the community through distributed educational centres throughout the country. (Pfeiffer, 56)

Cuba has become the benchmark for sustainable localised production and distribution. By up skilling and educating the national population Cuba secured its food production, created an accessible food distribution system and shifted to a sustainable holistic small-scale diversified production system. It provides an important framework for a secure, sustainable, local and diverse food production network.

This thesis will draw on the principles employed in Cuba's agriculture redevelopment and apply them to the development of an urban agriculture architecture. It is the development of knowledge and skills that allowed Cuba to adapt and prosper. This architecture seeks to similarly create an environment that educates and provides the knowledge for people to start growing their own produce in the city.

Fig 2.08. SELLING PRODUCE ON THE STREETS OF HAVANA, CUBA

2.2 CASE STUDIES

R128 HOUSE

R128 is the built manifesto of Werner Sobek. Practising as both a structural engineer and an architect, Sobek conceived R128 as an ode to his sustainable design philosophy, a physical manifestation of his triple zero approach. (Sobek, 41) Triple Zero refers to zero consumption, zero emissions and zero waste.

Drawing inspiration from both Mies van der Rohe's Farnsworth House as well as Phillip Johnsons Glass House, the modernist design focuses on transparency and lightness, allowing the building to connect intimately with its natural surroundings. The transparency also creates a sense of intimacy within the structure. The lack of internal doors and walls produces a spatial fluidity within the interior allowing natural light to permeate from one area to another.

Sobek designed the house not as a passive structure but as an active one. He did not want to compromise the design intent by restricting the house to passive design; rather he sought to utilize technology and materials to create an active home that performed sustainably. The home captures solar energy through water panels on the roof which transfer solar energy to heat sync to be stored and rereleased in colder months. (Sobek, 41) These systems along with photovoltaics allow the home to achieve zero net energy consumption.

The construction of the house that makes it a unique sustainable design system; R128 was conceived as a fully recyclable product to be assembled, used, then dissembled at the end of its life cycle. Sobek designed a modular jointed steel construction system that does not require welding nor permanent connections. This unique system allowed the whole structure to be bought to site on one truck and erected within four days. (Hawthorne) It is this fundamental shift in how Sobek approached the life cycle of the building that makes it a truly sustainable solution. The principles inform a design approach that looks at complete life cycle of the building. This is a key design approach that my design will explore.

Fig 2.09. R128 HOUSE

EDEN PROJECT

This project relates to the field of urban agriculture by demonstrating a building design that focuses on the best growing environment for the plants within. The Eden Project is one of the most iconic botanical projects found anywhere in the world. Making use of an abandoned china clay quarry in Cornwall, England the iconic biomes house a 35-acre global garden. The project demonstrates a relationship between architecture and nature, a relationship that was conceived to educate the public and allow us to celebrate our relationship with and dependence on plants. (Austell, 4)

The domes were constructed with maximum efficiency and environmental impact in mind. The geodesic shapes mimic the natural structure of honeycombs, by utilizing this hexagonal structure the building maintained optimum strength allowing it to reduce the amount of steel the structure required. The skin of the building is made from ETFE panels. These panels form a giant air pocket around the dome providing both insulation and transparency. (Austell, 47)

This project demonstrates a strong relationship between architecture and agriculture. The architecture was conceived to maximise the growing conditions of the plants that the project cultivates. It also seeks to facilitate an engagement with the public. These are both core principles that I will draw upon in my own design approach.

Fig 2.10. EDEN PROJECT

2.3 KEY TERMS

AQUAPONICS

Aquaponics is an agro-ecological growing system that combines aquaculture and hydroponics in an interdependent relationship. "Aquaponics is the cultivation of fish and plants together in a constructed, recirculating ecosystem utilizing natural bacteria cycles to convert fish waste to plant nutrients." (Bernstein, 10) This bacterial process amalgamates two production cycles that, as standalone systems have significant drawbacks and operational requirements, to a single virtually fully enclosed cycle. The recirculating system does not require any soil because it uses water as the growing medium for both fish and plants. The water is fully recycled through the system in order to preserve the precious resource. It therefor allows plants and protein to be grown where there is little access to land, nutrient rich soil and fresh water.

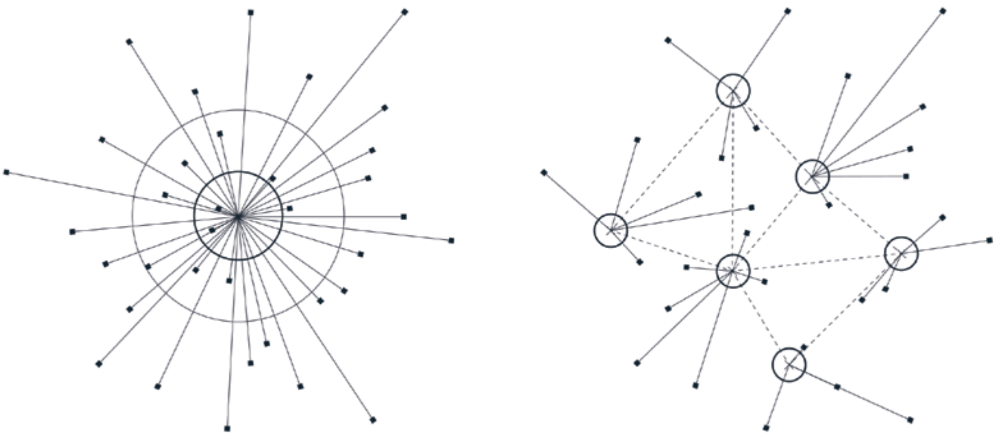
3 acres of productive aquaponics can produce 450 tonne of organic produce annually. (AQUAPONICS 101) Growers such as, Sweet Water Organics, in the United States have developed successful business models where they have converted existing urban structures into aquaponics systems that are able to grow and distribute their produce locally. This project and others have provided a singularly important influence on my project.

PERMACULTURE

Permaculture refers to an agriculture movement developed in the 1970's by Bill Mollison and David Holmgren, it describes an "integrated, evolving system of perennial or self perpetuating plant and animal species useful to man." (Holmgren,4) It is an idea that focuses on the integration of variety of fields to create a more holistic approach to our environment. Holmgren revisits the definition in his book 'Permaculture' recognising that permaculture has developed beyond the original scope to be defined as "Consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for provision of local needs." (Holmgren, XIX)

Permaculture looks beyond agriculture as an isolated practise; instead it approaches agriculture and the broader idea of sustainability as an interdisciplinary issue that needs to bring together a diverse range of skills ideas and techniques. Permaculture does not confine itself to a sustainable farming practise, instead it creates a framework of knowledge to allow sustainable practises to be applied. "Thus the permaculture vision of permanent (sustainable) agriculture has evolved to one of permanent (sustainable) culture." (Holmgren, XIX)

Fig 2.11. AQUAPONICS GROWING SETUP



CENTRALISED DISTRIBUTION DECENTRALISED DISTRIBUTION

GLOBALISATION

Our current globalised food network relies on mass production and centralised distribution to fill global supply demands. Food is no longer confined to a localised network of production and distribution. The shift towards Globalisation developed due to the abundance of cheap fuel. Cheap fuel allowed commercial scale operations to transport consideration out of the equation making it more cost effective to mass produce in specialised regions and then distribute globally through a centralised network. The result is a highly volatile, highly energy intensive and disconnected system. The production is confined to a single region making it more susceptible to climatic variations such as droughts and flooding, spreading of disease, as well as being highly dependent on fragile supply lines, which have proven to be susceptible to political unrest. (Cockrall-King)

Alternatively, localisation refers to a network operating at a local scale. It is a particularly important in terms of our food production and distribution systems. Although local is hard to define, it is a principal based on operating with in a community context .(Brain) Decentralised localised production and distribution network offers better solution to the current shortcomings in the way we grow, process and distribute food. It promotes diversification, accessibility and engagement.

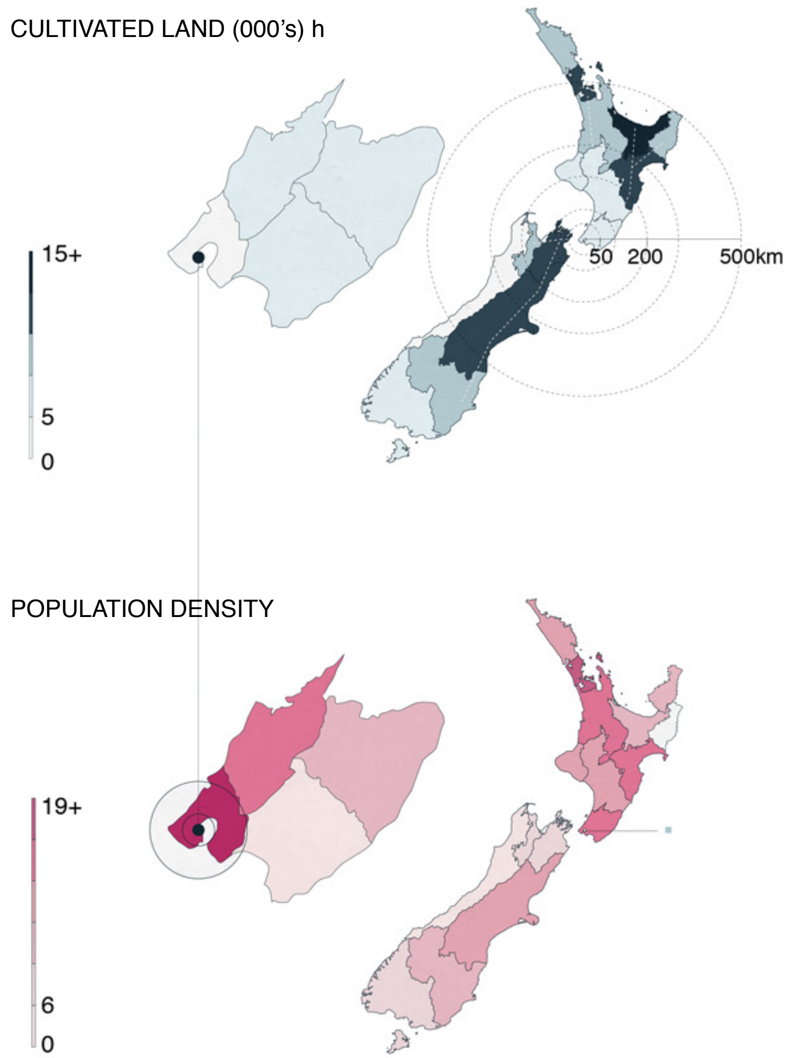
Fig 2.12. DIAGRAM OF A CENTRALISED SYSTEM VS A DECENTRALISED SYSTEM

RENEWABLE ENERGY

Until the development of the industrial agriculture revolution our food was grown only using the energy that could be provided by the sun, either directly through photosynthesis or indirectly by eating plants that had grown using photosynthesis. Since the industrial development some reports suggests that to produce 1kj of food energy requires the input of 10kj's of fossil fuels. But this energy source is non-renewable and running out. We have to move back to systems that rely on solar energy as their primary source. A paper published on Solar FAQ's calculates that based on technical potential and area accessibility solar thermal is the only energy source that can completely support the earth's energy demands. Solar thermal refers to capture of solar energy in heat form that can then used locally or converted to electrical or chemical energy to be stored or transported. (Crabtree, 8)

This thesis will use this principle to maximise its solar energy exposure and ability to store and transmit this energy through out the building. By using water as thermal (3x more efficient then concrete) thermal energy can be reticulated throughout a structure and stored using heat exchangers. (Water)

2.4 SITE ANALYSIS



The site analysis highlights the gap between Wellington's high population density and it's production capacity. With the second highest household density in New Zealand, Wellington relies heavily on imported produce to supply the central city.

Fig 2.13. PRODUCTION AND POPULATION MAPS

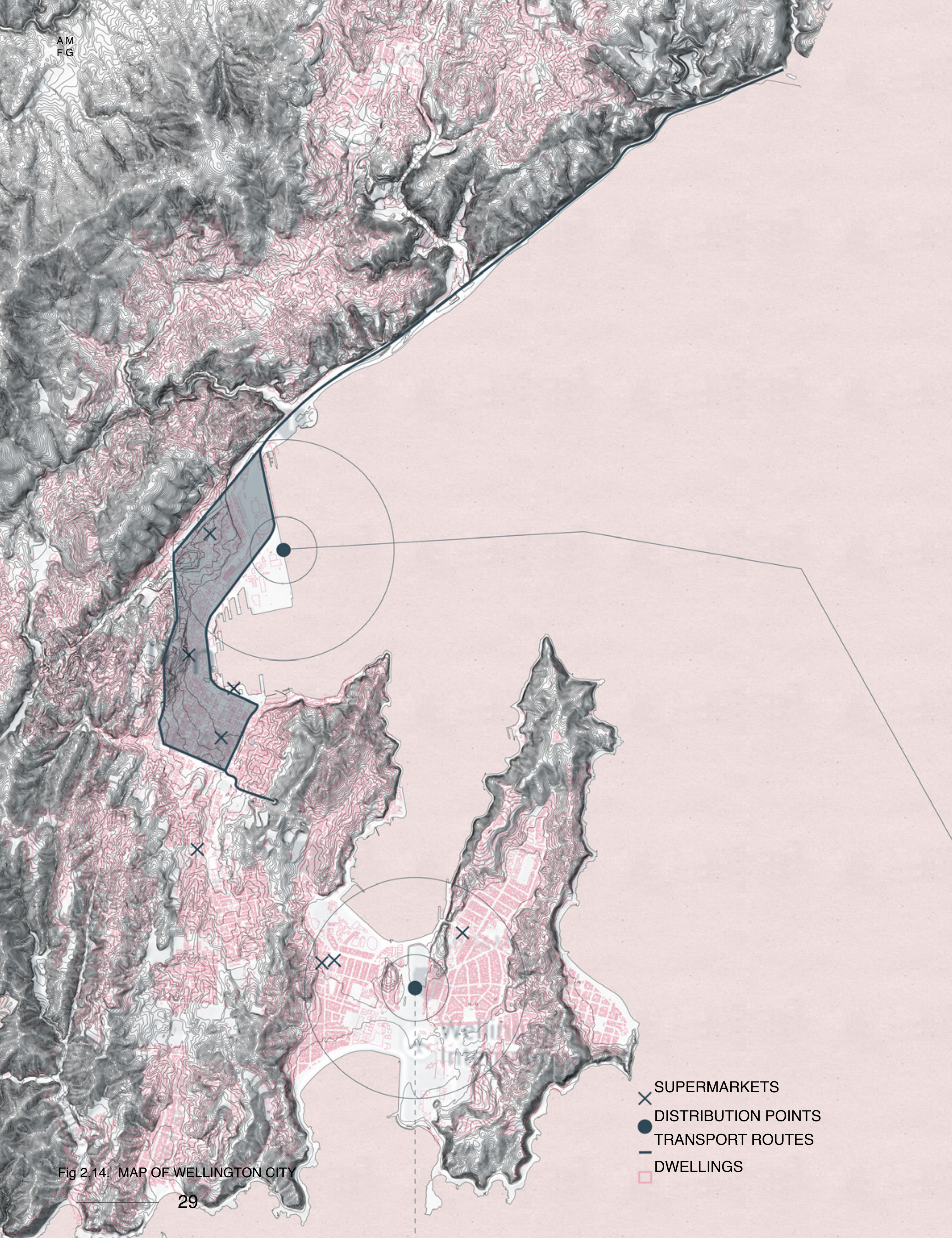


Fig 2.14. MAP OF WELLINGTON CITY

3. PART ONE

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PRELIMINARY DESIGN ONE

"This order is now bound to the technical and economic conditions of machine production which today determine the lives of all the individuals who are born into this mechanism, not only those directly concerned with economic acquisition, with irresistible force. Perhaps it will so determine them until the last ton of fossilized coal is burnt." (Weber)

3.1 PROJECT OBJECTIVES

To produce - The preliminary design seeks to create a deployable architectural construction system that can be sited in an urban context to grow and distribute fresh produce.

To create a framework that has the spatial flexibility to support a diverse range of programs from residential to industrial. Creating a self-sufficient decentralized micro community.

Fig 3.15. TIERED RICE PADDIES IN CHINA

3.2 DESIGN APPROACH

The architecture I explore seeks to reconnect the inhabitants with the very processes that have become foreign to them as globalisation separates our food production from our urban centres. This design looks to refine industrial agriculture typologies bringing them in to an urban context to be engaged with at a public scale.

The preliminary design phase began with a strong emphasis on researching and designing ways to minimise inputs whilst maintaining or increasing agricultural outputs. Specifically looking at how architecture can be designed to facilitate a reduction in energy consumption through better construction systems and natural environmental controls. This research into renewable energy sources and how to best utilize them manifested into a similar design approach as Sobek's R128 house referred to in the case studies. By creating a lightweight structural system that promotes transparency the built structures can maximise their solar gain.

Formal studies were used to investigate the most effective structural layouts. These studies of form were influenced by natural structures and arrangements to help understand the optimum conditions required for growing produce.

3.3 DESIGN OUTCOME

STRUCTURE

The structural system employed for this stage of the research is a diamond truss structure. The system utilises a diamond module as the principle structural form. The diamond is derived from existing pitched roof glasshouse systems but is further refined to maximise the strength and allow the structure to stack vertically. By making the structural system more efficient it reduces the amount of material required, this allows for a thinner structural members and a more transparent construction system (Sobek, 41).

The construction system uses pin joints to avoid any permanent connections, this gives the structural an ephemeral life span as it can be assembled and disassembled as required. By avoiding permanent connections, the structural system becomes easier to adapt and recycle. This approach considers the whole life span of the design, reducing the focus on a permanent intervention and moving towards a more responsive temporal construction system.

Steel is the primary structural material. Although steel is a valuable natural resource that is non-renewable and high in embodied energy, if used appropriately it is the most resource efficient option. This principle is in line with Werner Sobeks teachings of resource efficiency outlined in the previous case studies.

EXPLODED STRUCTURAL DIAGRAM
PIN JOINTED MODULAR STEEL SYSTEM

1 - MODULAR JOINT
2 - GLAZED FRONT
3 - DIAMOND MODULE
4 - SET BACK SECOND FLOOR

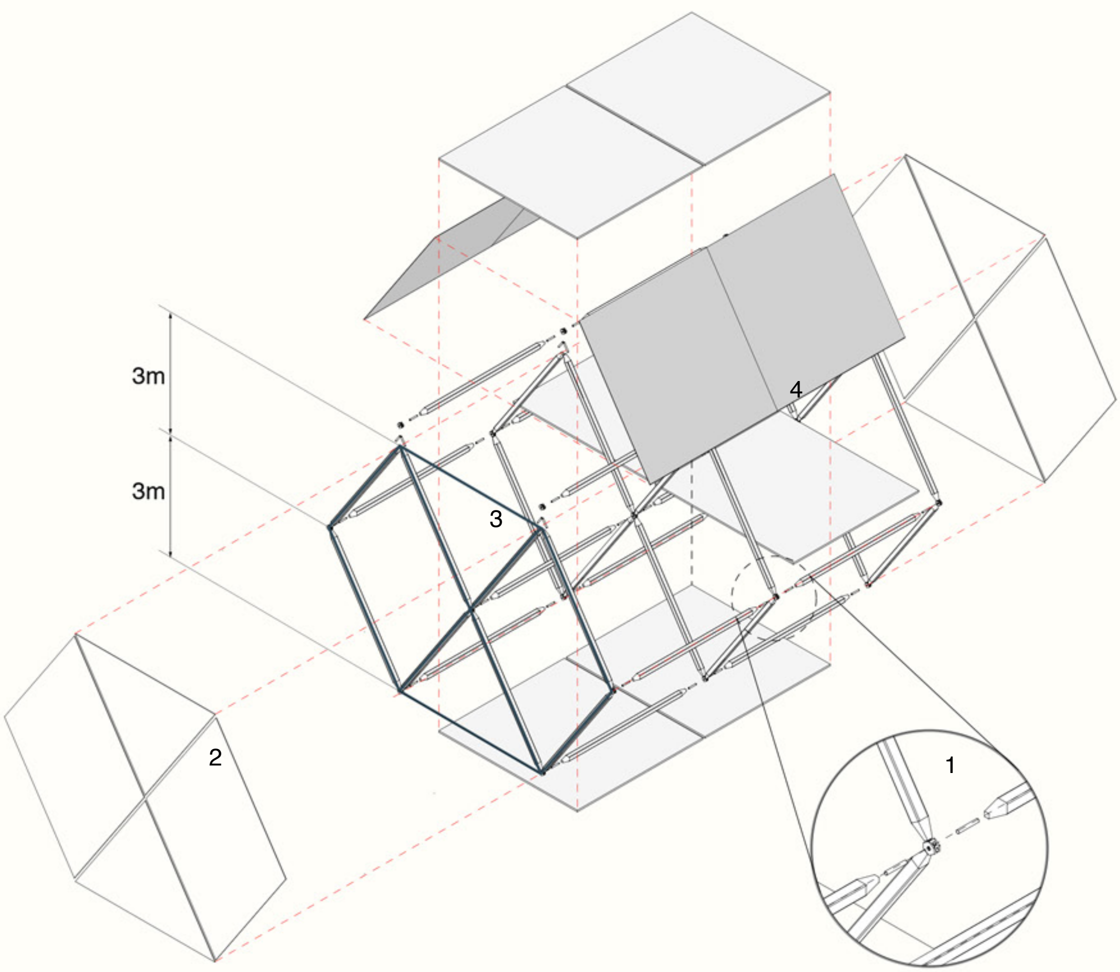


Fig 3.16. EXPLODED STRUCTURE

EXPLODED FORM DIAGRAM

1 - INDOOR/COVERED GROWING SPACE
2 - OUTDOOR PLANTERS
3 - PUBLIC SPACE
4-CUTOUTS IN PLATFORMS

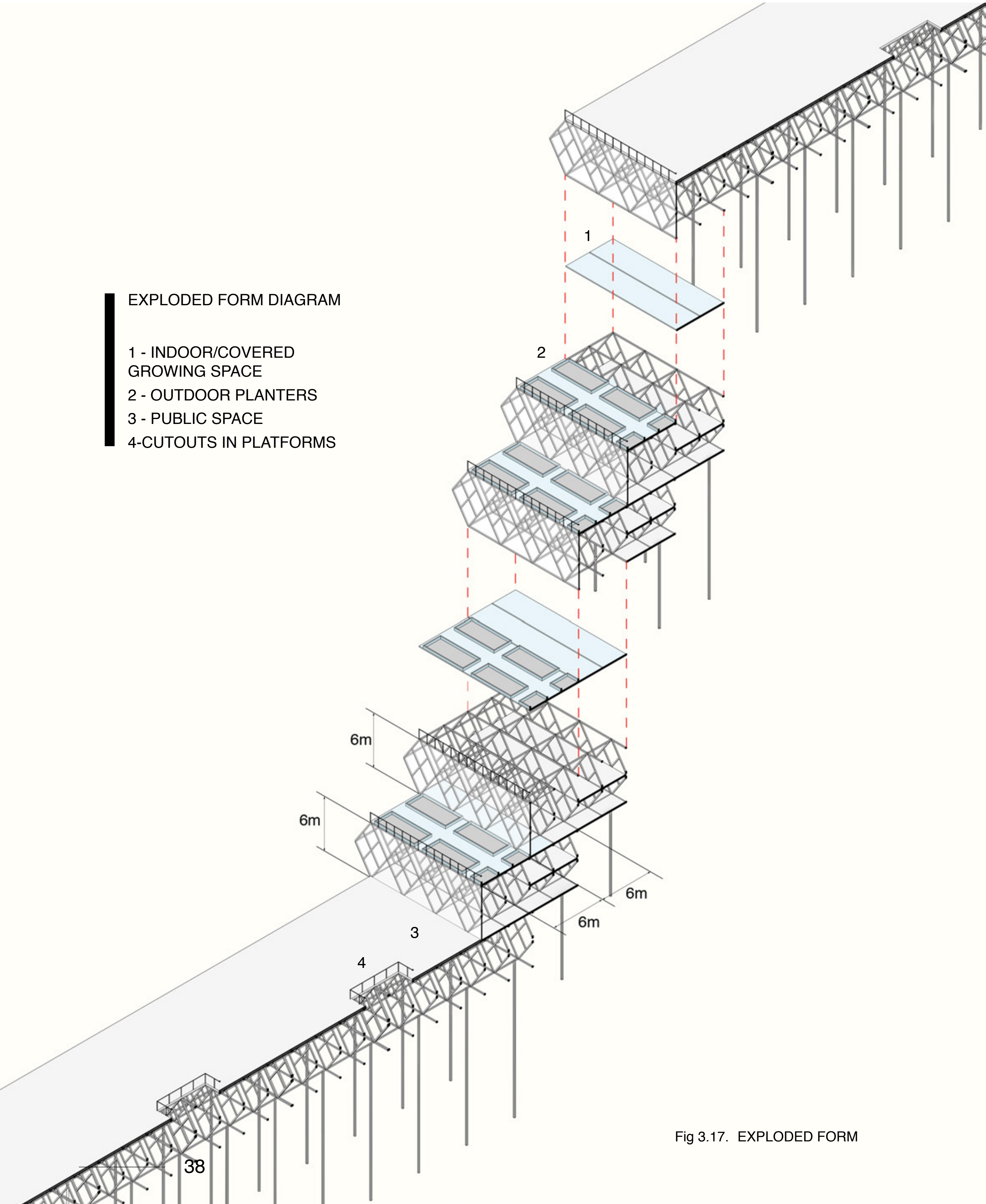


Fig 3.17. EXPLODED FORM

FORM

The designed form is tiered inverted and conical. This form allows the building components to stack vertically to increase its site density whilst still maintaining maximum solar gain. The overlapping tiers have a maximum depth, equal to the height of the vertical step, to allow sun to fully penetrate the extents of the building. Where the two levels overlap creates a different growing environment to grow those plants that are more sensitive to sun.

The form reflects the construction technique utilized in rice paddy farming in parts of Asia. The tiered system maximises the usable area and sun catchment whilst creating a vertically integrated growing framework that can utilize gravity as a mechanism to reduce other external energy input.

The tiered steps not only act as arable areas to grow produce but they also foster interaction and movement through the architecture. The steps act as horizontal corridors along the structure, promoting movement between the various programs.

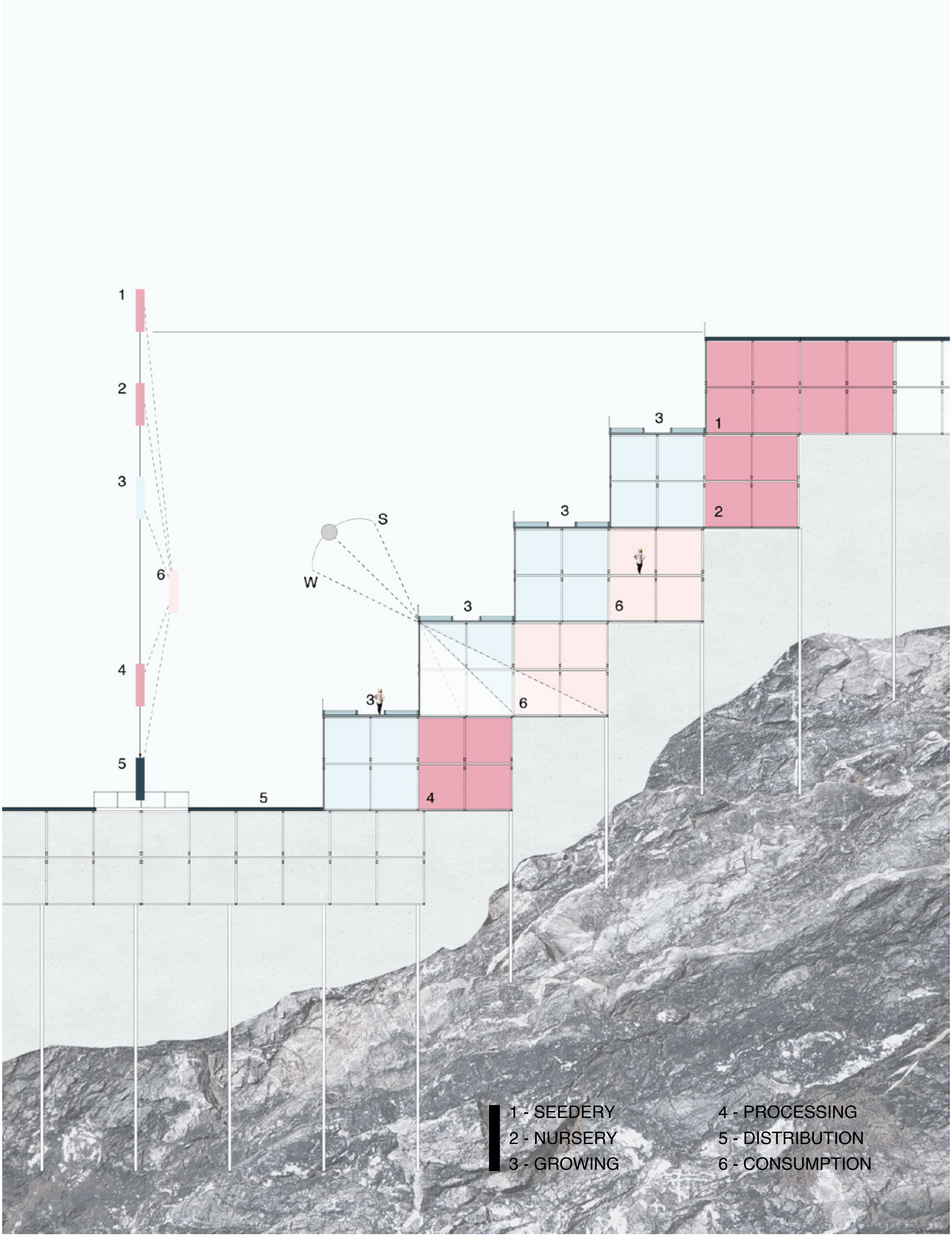


Fig 3.18. PROGRAM DIAGRAM

PROGRAM

The proposed design seeks to utilise the form and construction system to condense the current food production operation. By utilizing a system of vertical integration to maximise density and minimise the distance involved in the current production and distribution system. By reducing these distances into a localised rather then globalised network, the energy required to relocate and distribute food is dramatically reduced.

The concept design investigated ways to condense current industrial scale farming and processing industries into an urban scale that could be integrated with traditional urban typologies, such as retail, hospitality and residential. The benefits of integrating various typologies into one community is to create a local distribution network where outputs of the production and processing cycles are fed directly into other site programs. Incorporating residential housing into the program provides a local consumer base for the integrated programs.

3.4 APPLYING TO SITE CONTEXT

Fig 3.19. A location that met the site criteria was an area on Mt Victoria set behind Wellington College. The site provided a natural topography to support the tiered form. It was oriented to capture sun throughout the day, is large enough to support the mixed use program and sits with in the city's urban limits.

The design process began with out a specific site in mind. Because of the intended nature of the project as decentralized interconnected micro communities, designing to a specific site would have inhibited the ability to design systems and infrastructure that could be deployed in a range of contexts and locations. To fully test the developed systems, the proposed intervention was applied to a specified site to test how it might integrate into the urban context.

As the form and construction developed the requirements for a site became more defined. These key parameters were the criteria for choosing a site that would support the architectural framework. Orientation, topography and proximity to an urban context were the key parameters in locating a site that the design could be applied to.


NW
7:30
7:30
S
100m

Fig 3.20. DESIGN APPLIED TO A SPECIFIC SITE


N

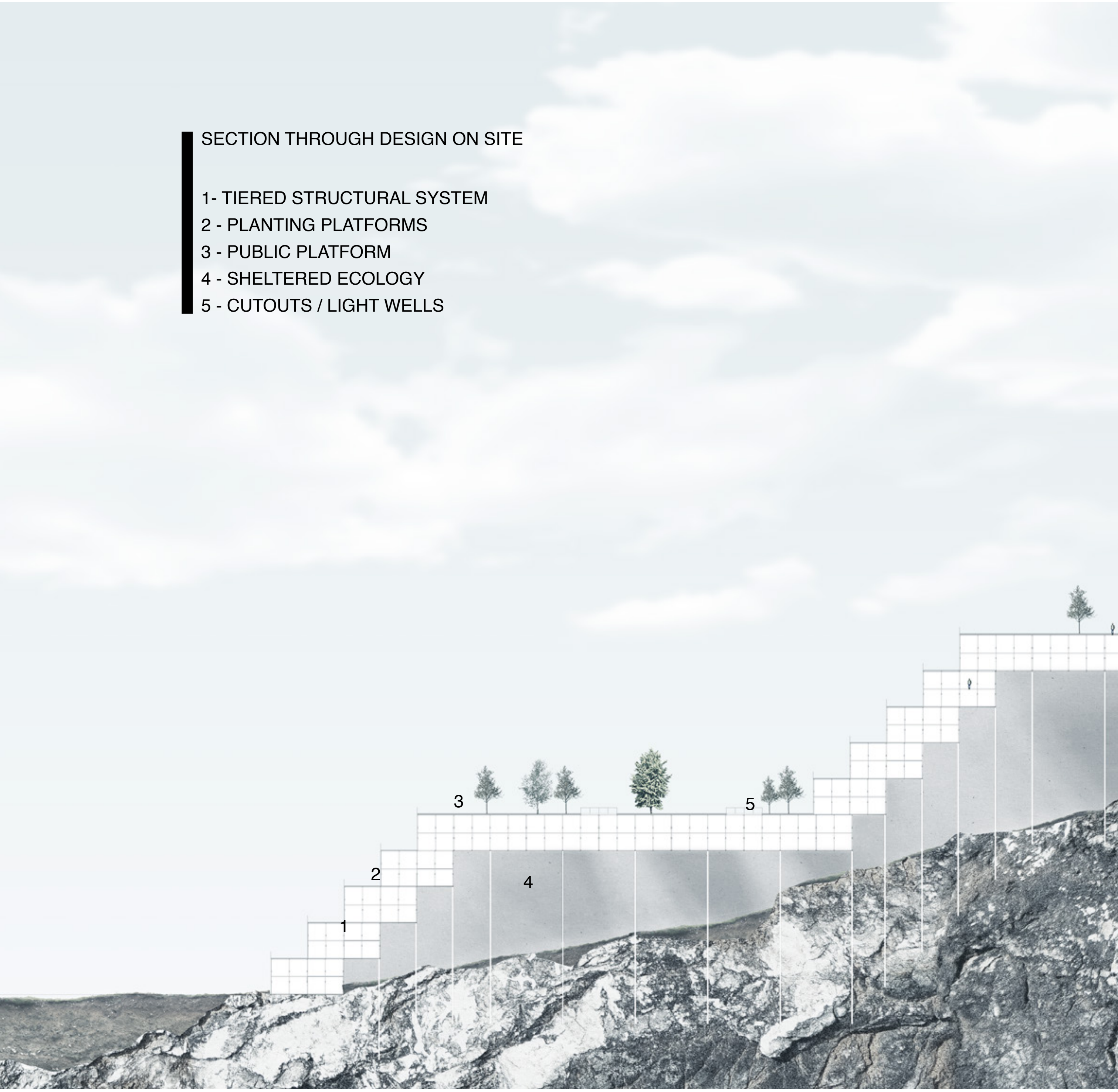
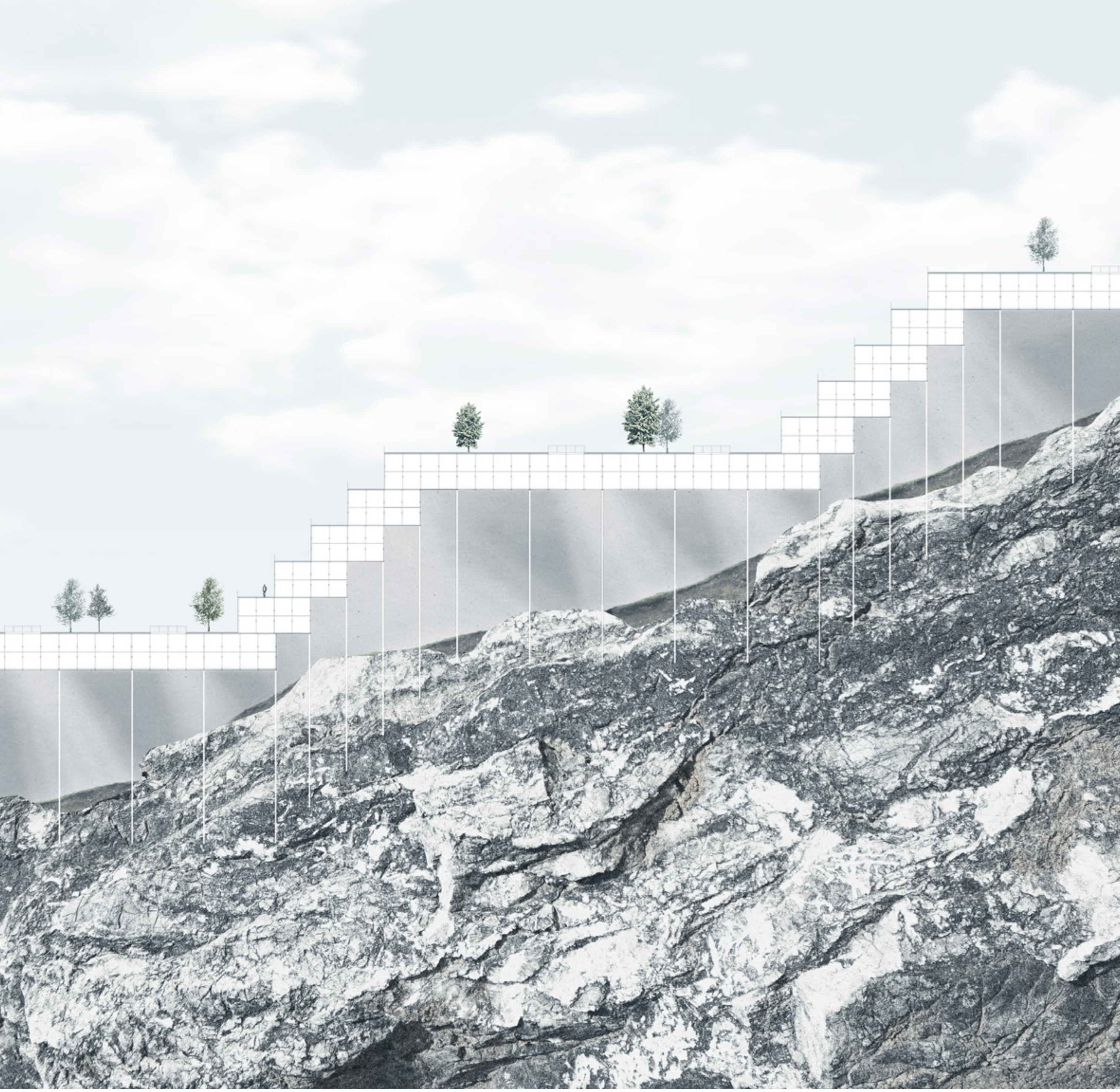


Fig 3.21. SECTION THROUGH SITE



3.5 DESIGN SUMMARY

The design summary is based on my own critical reflection as well as feedback from examiners from the June review.

The construction system is successful in creating a lightweight architectural framework that is able to maximise solar gains. The lightweight framework also creates a design transparency that connects the inhabitants to the systems within.

The tiered building form maximises growing area in a vertical system but the system has a large building footprint that could not be deployed a variety of urban contexts. As the vertical farms highlight, site footprints need to be minimised in order for an agro-urban typology to work in a dense urban environment.

The required site parameters became to specific through the design process. All though the construction system was successful in achieving a deployable framework the parameters required for it to work limited the opportunity for it to be integrated into an urban context.

The program did not explore opportunities to use space more dynamically. Cross programming was explored to create an active environment but the relationship between these programs and the space they required throughout the day was not developed within the design. Space could be used more effectively by understanding the demands of each program and how this shifts throughout the day.

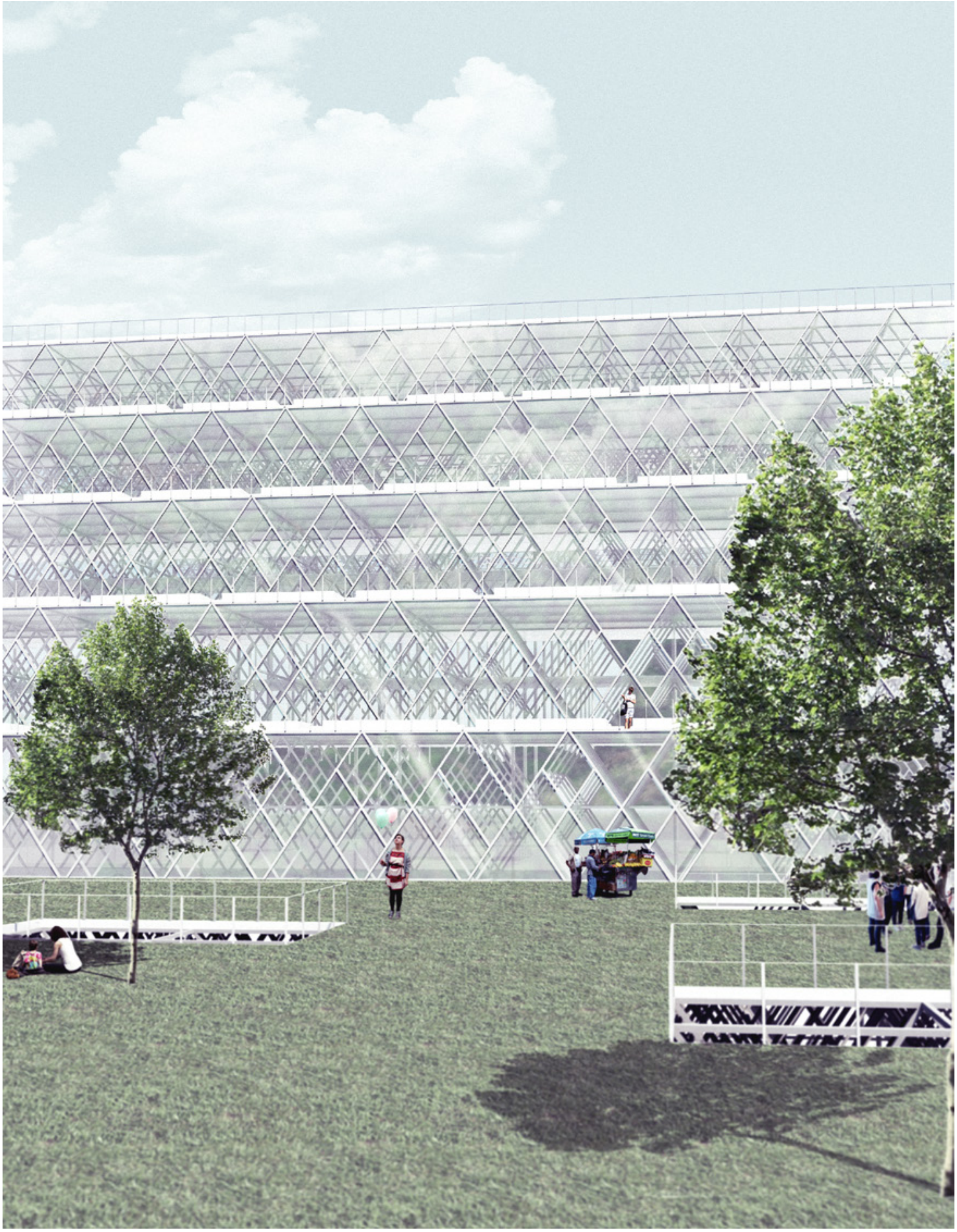


Fig 3.22. RENDER SHOWING HOW THE STRUCTURE IS INHABITED

4. PART TWO

-

PRELIMINARY DESIGN TWO

INTERGRATION
NATION

"If agriculture were fully integrated into urban life, it could conceivably produce a revitalized and verdant environment, where communities are interlaced with gardens, orchards, park lands, and open water ways." (Pfeiffer, 72)

4.1 PROJECT OBJECTIVES

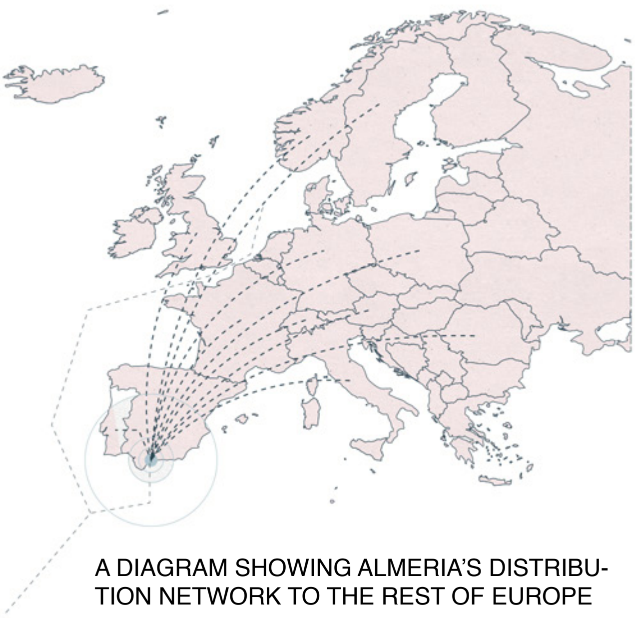
To integrate an architectural construction framework into a local urban community utilising existing infrastructure to distribute to a wider context.

The research needs to identify a non-specific, but locally applicable site location in which a systemised building structure can be inserted.

To further develop this systemised constructional framework to investigate ways that the building system can integrate into its urban contexts becoming part, temporarily, of the urban fabric. It will seek to develop a distribution network that connects the temporal architecture to the local community. The focus will be on both pedestrian access as well as access to infrastructural transport routes.

The interaction with the site context will look to be enhanced by developing a mixed use program. The design needs to incorporate diversified programs to activate the structure and help build a more intimate relationship between the inhabitant and the produce that it grows.

4.2 CASE STUDIES



A DIAGRAM SHOWING ALMERIA'S DISTRIBUTION NETWORK TO THE REST OF EUROPE

ALMERIA

30 km south east of Almeria, on the Spain's east coast, is expanse of greenhouses that covers an area of over 26,000 hectares. The area is so vast that the concentration of polyethylene structures can be seen clearly from space.

This region is responsible for over half of Europe's supply of fresh fruit and vegetables as 70% of what is produced is distributed beyond the country of origin. This indicates the productivity of the area but this hub of productivity has not always been the case. 35 years the region was a dry and arid landscape, the agriculture development only exists through heavy application of fertilizer, hydroponics systems and the plasticulture tunnels (Kaushik).

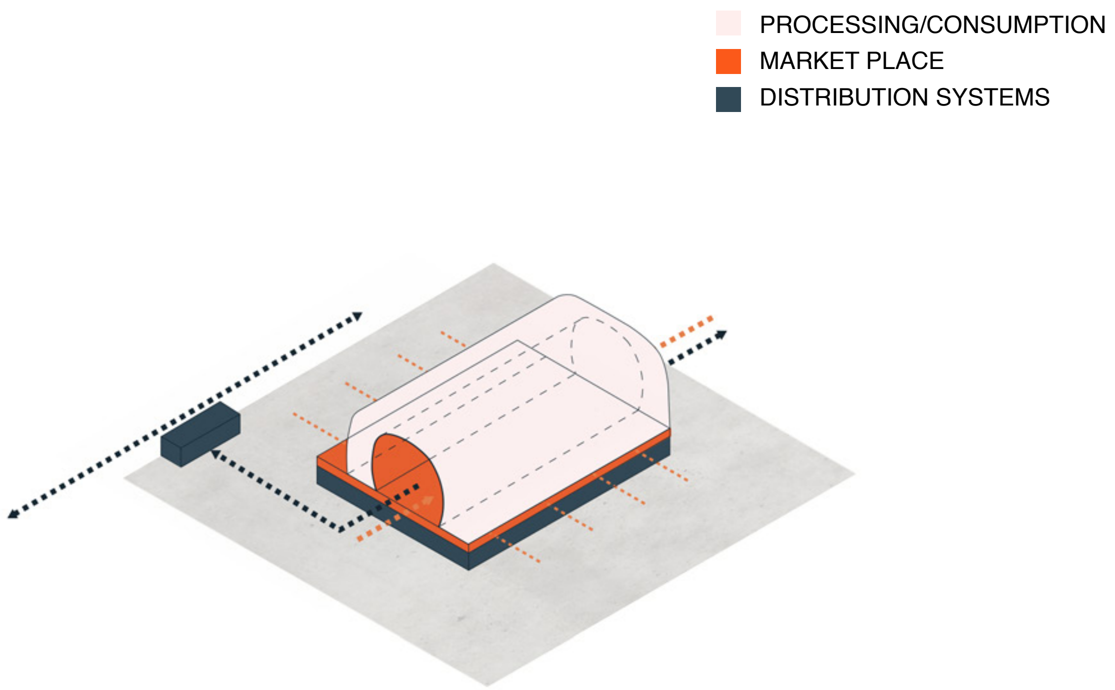
Because the fruit and vegetable production is so concentrated it makes Europe's fresh produce security extremely susceptible to disease, natural disaster and climate or political change. The dependence on a single region to export food around Europe demonstrates the flaws in our globalised food network. It compromises security, accessibility and diversity, depends on temperamental supply lines and concentrates the food economy outside the country of consumption.

Fig 4.23. DIAGRAM ILLUSTRATING DISTRIBUTION

A M
F G

Fig 4.24. AERIAL VIEW OF ALMERIA GROWING TUNNELS

Fig 4.25. ROTTARDAM MARKET HALL



ROTTARDAM MARKET HALL

Designed by MVRDV the market hall in the heart of Rotterdam city sought to develop the existing market place typology to increase the quality and the density of the programming. The solution was to incorporate apartments, restaurants, markets and parking into a single structure. The design fully integrates the diverse programs to enhance and make the most of the synergetic possibilities of the different functions (MVRDV).

The distance that the market hall distributes produce and goods to is implemented on a variety of scales. The hall supplies the cafes and restaurants that are housed within the same structure, whilst it uses pedestrian access public transport and vehicular network to distribute to a wider context.

This project demonstrates the benefits of cross programming to bring density and diversity to the building program. Along with strong distribution links that focus on pedestrian access the design acts as a communal gathering and distribution hub for a wider community. These are key functions to the success of my design outcome.

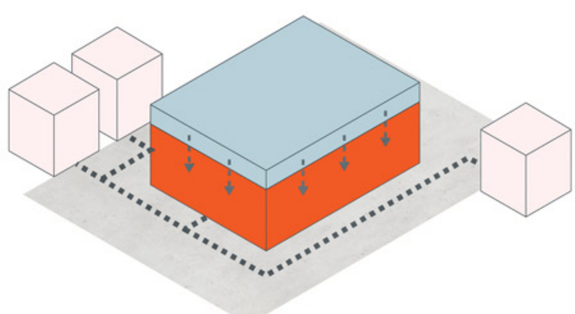
Fig 3.26. DIAGRAM OF ROTTARDAM MARKET HALL FUNCTIONS

Fig 4.27. IMAGE SHOWING THE GROWING SPACE ON TOP OF THE FOOD FROM THE SKY SUPERMARKET

FOOD FROM THE SKY

The objective of this urban agriculture intervention conceived by Azul-Valerie was "To grow life, Food and Community in our most cemented places and to bring the Heart back in our supermarkets."(Azul-Valerie) The community project illustrates a beautiful unison between food production and distribution. In the dense metropolis of London, food from the sky demonstrates how unused space can be activated as an exercise in permaculture. Volunteers transformed unused space on top of a super market, in the suburb of Crouch end, into a thriving vegetable patch. All the produce is sold through the supermarket store below.

The community project also acts to educate and engage the community; the project runs permaculture workshops and school tours this would be a highly beneficial characteristic to deploy in my current research.



PROCESSING/CONSUMPTION
MARKET PLACE
DISTRIBUTION SYSTEMS
GROWING AREA

Fig 4.28. DIAGRAM ILLUSTRATING THE GROWING AND DISTRIBUTION SYSTEMS OF 'FOOD FOR THE SKY'

4.3 DESIGN APPROACH

To begin the second preliminary stage, the design focused heavily on exploring existing city infrastructures. Similar to Azul-Valerie's' 'Food from the sky' and the Rotterdam Market Hall projects, the importance of being able to distribute the grown produce back into the community through symbiotic production/distribution relationship was key design driver.

Rather than integrating with an existing typology the design sought to explore new or reimagined architectural systems that are able to respond to the existing urban condition. By looking at the broader city context the aim was to develop the architecture so that it could be a truly decentralized system that can be deployed in many urban contexts.

The design was approached as a kinetic structure that utilized a movable program to maximise the usable space throughout the day. Ways for the architecture and the programs to expand and contract according to their demand were explored through design precedents.

Fig 4.29. SELLING PRODUCE ON THE STREET, CUBA


10,11
9
8
7
6
5
4
1,2,3

Fig 4.30. SITE ANALYSIS

4.4 SITE ANALYSIS

Once the need to define a more generalised site with less specific parameters was identified, I began by looking for patterns or reoccurring motifs in the urban frame. Identifying areas that could support a generalised architectural framework. The parameters became less specific, focusing more on infrastructure, corridors and movement rather than existing centralized locations.

What this analysis began to identify was the negative social and environmental impacts that large arterial transport networks had on the fabric of the city. Although supporting large volumes of traffic, this transport infrastructure seemed largely underutilised for such significant land. Often positioned on the outer edge of the cities core, these arterial networks severe lateral connections with what lies beyond. Because of their place in the traditional urban fabric these networks provide an opportunity to deploy a building system that is relevant to many urban contexts.

THE LARGE SCALE TYPOLOGIES AND HEAVY TRAFFIC VOLUME ON THE EDGE OF KENT AND CAMBRIDGE TERRACE.

Fig 4.31. PHOTO SERIES 1,2,3

PHOTO'S SHOWING THE VAST OPEN SPACES OF THE TRANSPORT NETWORK.

Fig 4.32. PHOTO SERIES 4,5,6

LARGE INFASTRUCTURE ON THE WATER FRONT THAT HAS THE POTENTIAL TO BE REPURPOSED.

Fig 4.33. PHOTO SERIES 7,8

LARGE SCALE SPACES SURROUNDING A VITAL TRANSPORT HUB.

Fig 4.34. PHOTO SERIES 9,10,11

Fig 4.35. THREE KEY SITE TYPOLOGIES

4.5 DESIGN OUTCOME

FORM

The architectural language of design two was conceived to integrate with the city as positively as possible. The design seeks to maximise solar gain but at the same time retain solar access for its immediate surroundings. The architecture has to achieve a level of transparency both internally and externally to be successful. Internally it has to provide as much natural energy as is available for the production of food, whilst externally it needs to create transparency to interact harmoniously with its surrounding environment. The buildings transparency also acts to engage the public by creating a design language that allows the building to be easily understood and the systems and processes inside to be highlighted.

To achieve this language, the form of the building has been designed as a thin elongated structure that is elevated above the existing ground plane. The thinness of the structure allows the building to run parallel with existing infrastructural networks, occupying the space above and between the existing urban fabric. By elevating the structure, it allows it to coexist in the same space as these transport networks that it occupies.

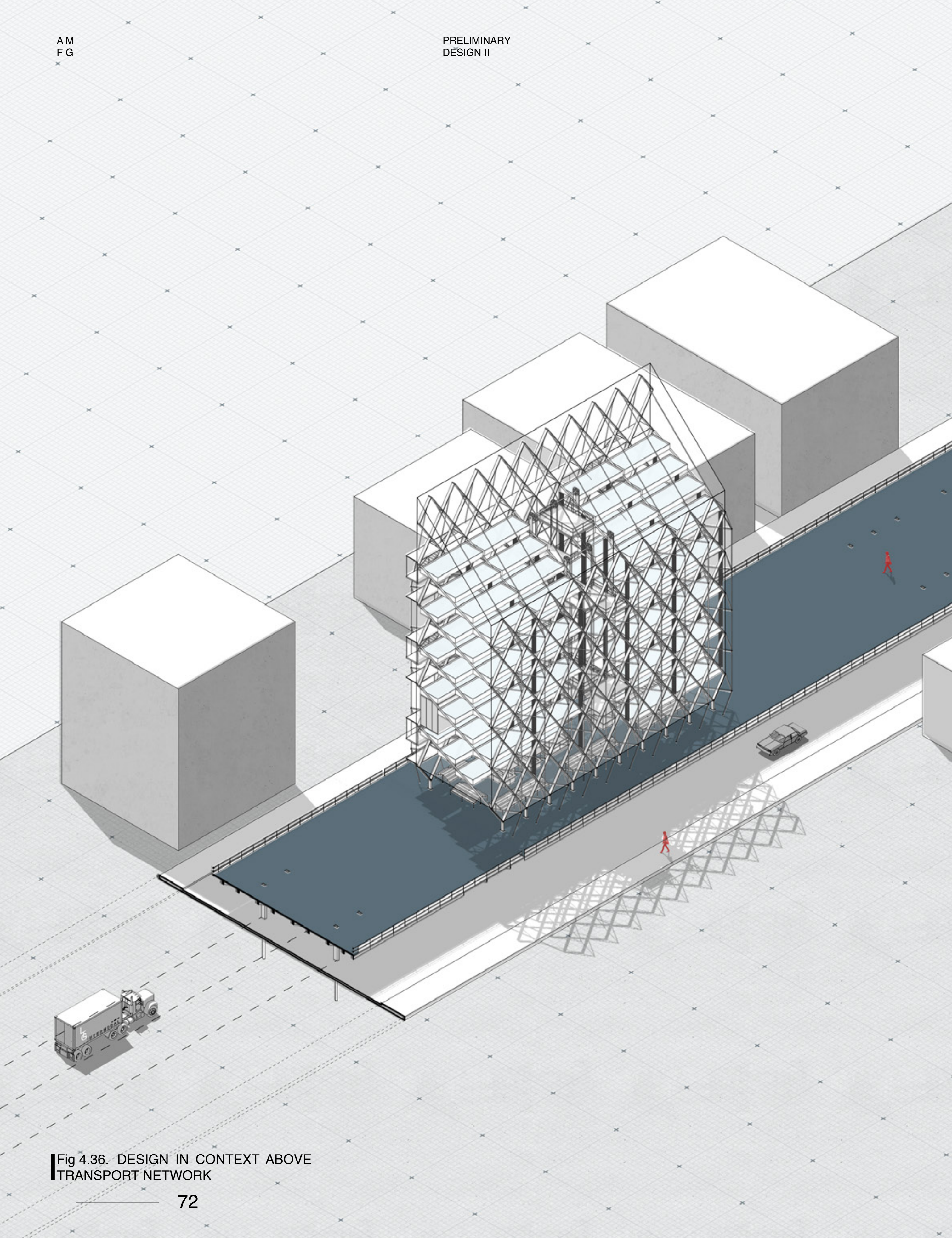
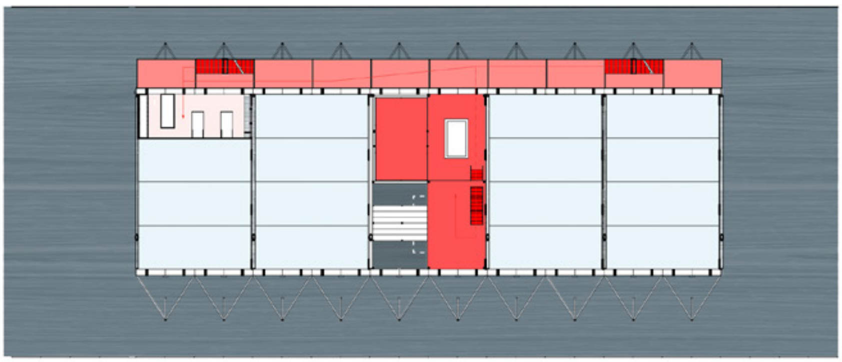
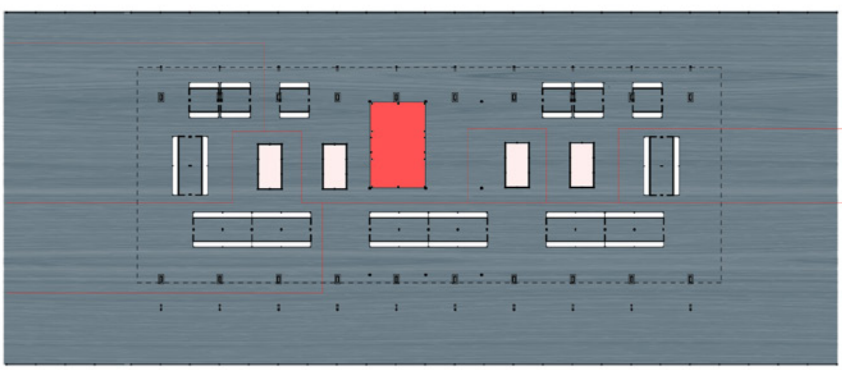


Fig 4.36. DESIGN IN CONTEXT ABOVE TRANSPORT NETWORK

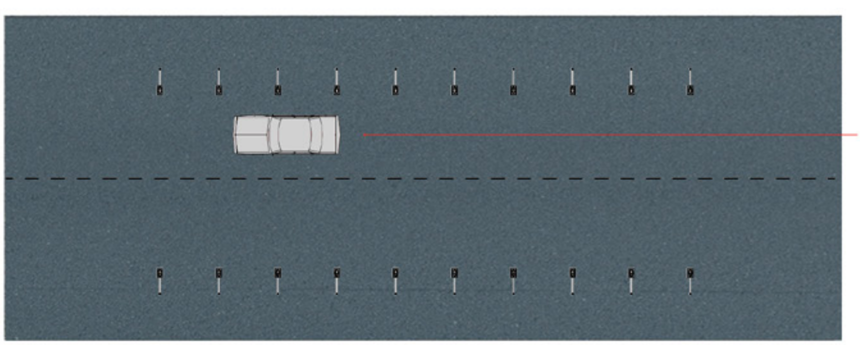
GROWING TANKS
CIRCULATION
MARKET FOR DISTRIBUTION



LEVEL THREE PLAN - CAFE AND WATER TANK



LEVEL ONE PLAN - DISTRIBUTION PLATFORM



GROUND LEVEL PLAN

Fig 4.37. PLANS

CIRCULATION PATHS

PRIMARY CIRCULATION MOVES THROUGH THE CENTER OF THE BUILDING WHILST THIS IS SUPPORTED BY A SECONDARY SYSTEM ON THE BACK FACE

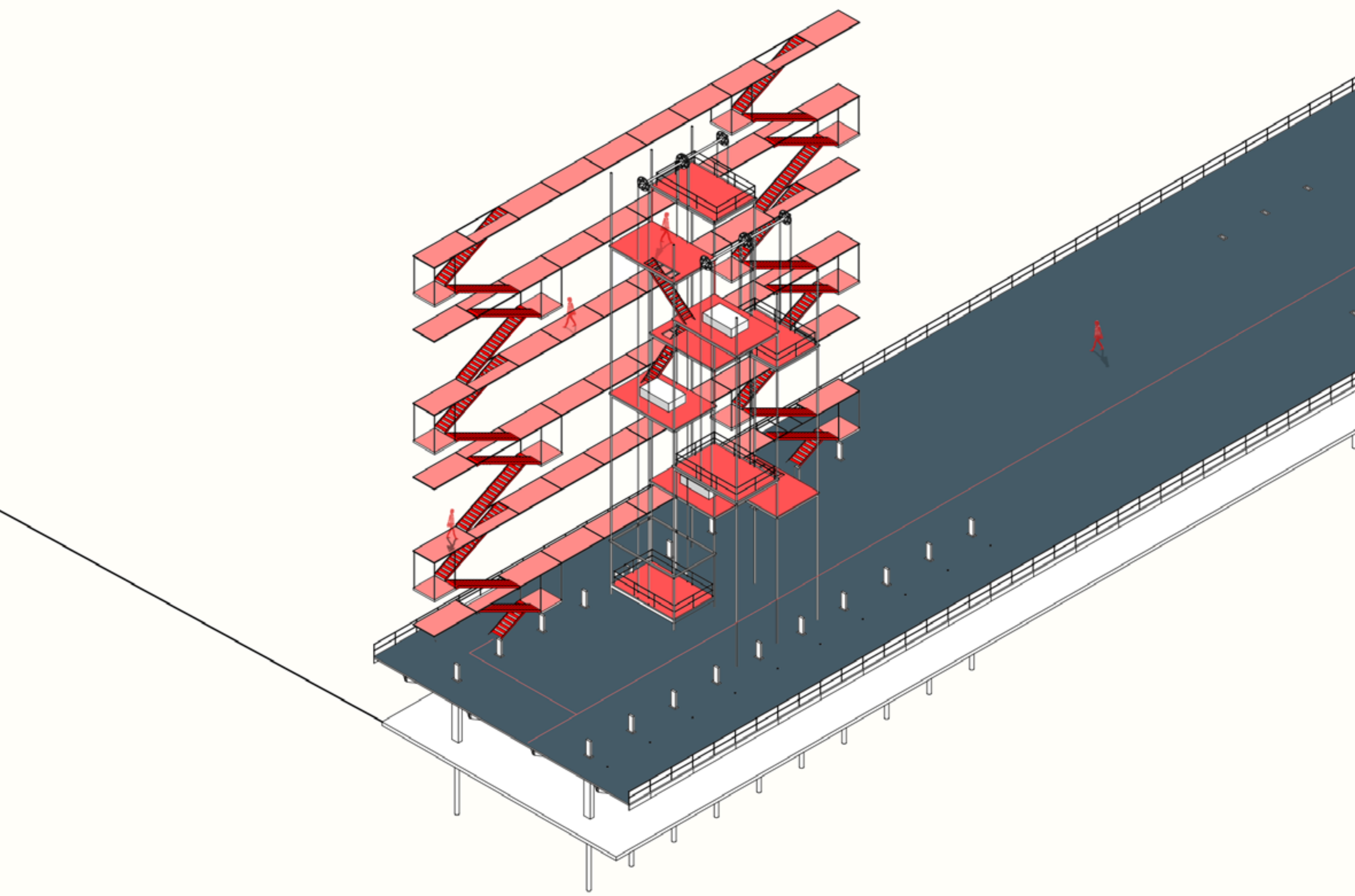


Fig 4.38. DIAGRAM OF CIRCULATION PATHS

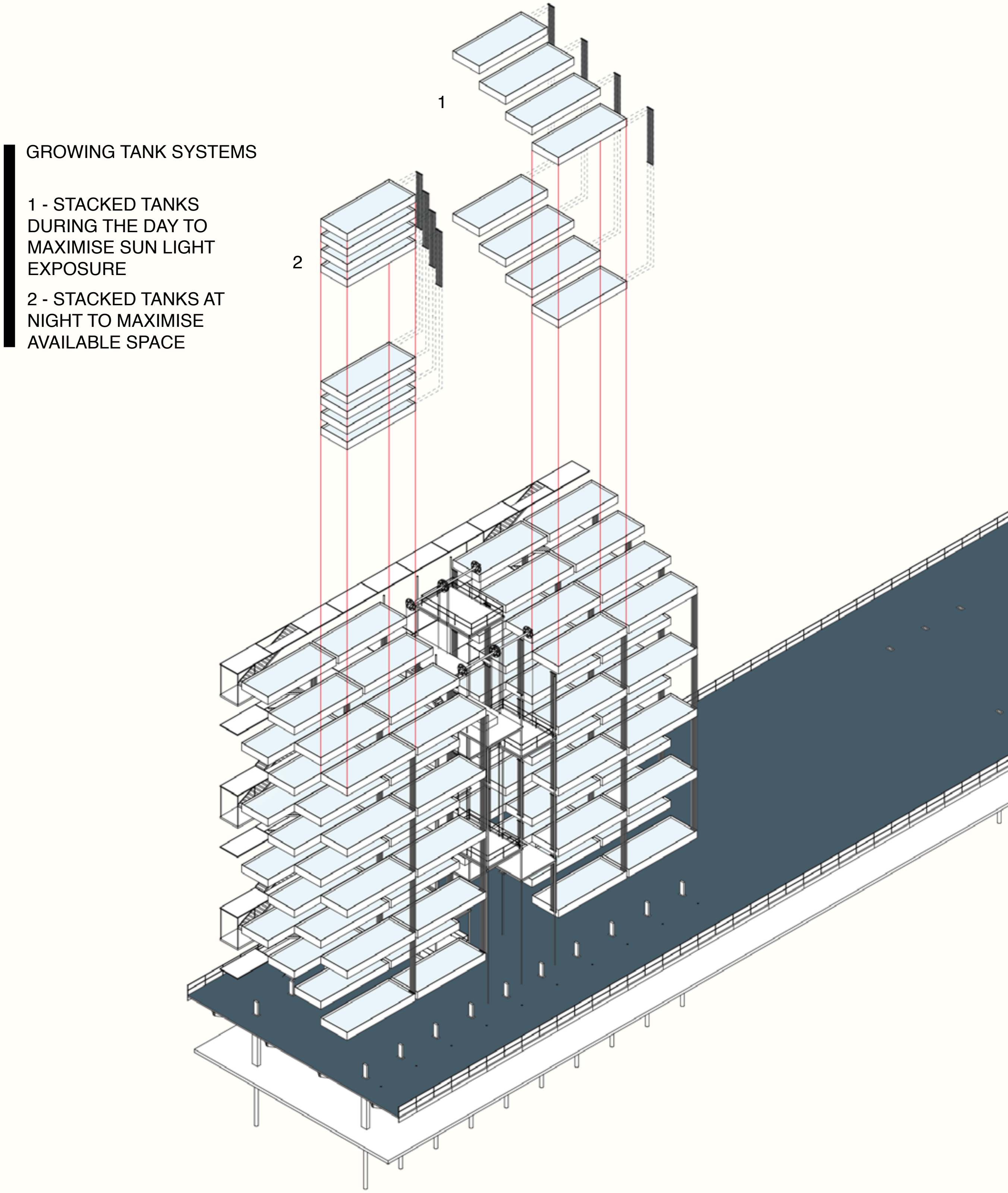


Fig 4.39. DIAGRAM OF GROWING SYSTEMS

ELEVATION, STACK EFFECT AND PRODUCTION TO DISTRIBUTION DIAGRAMS

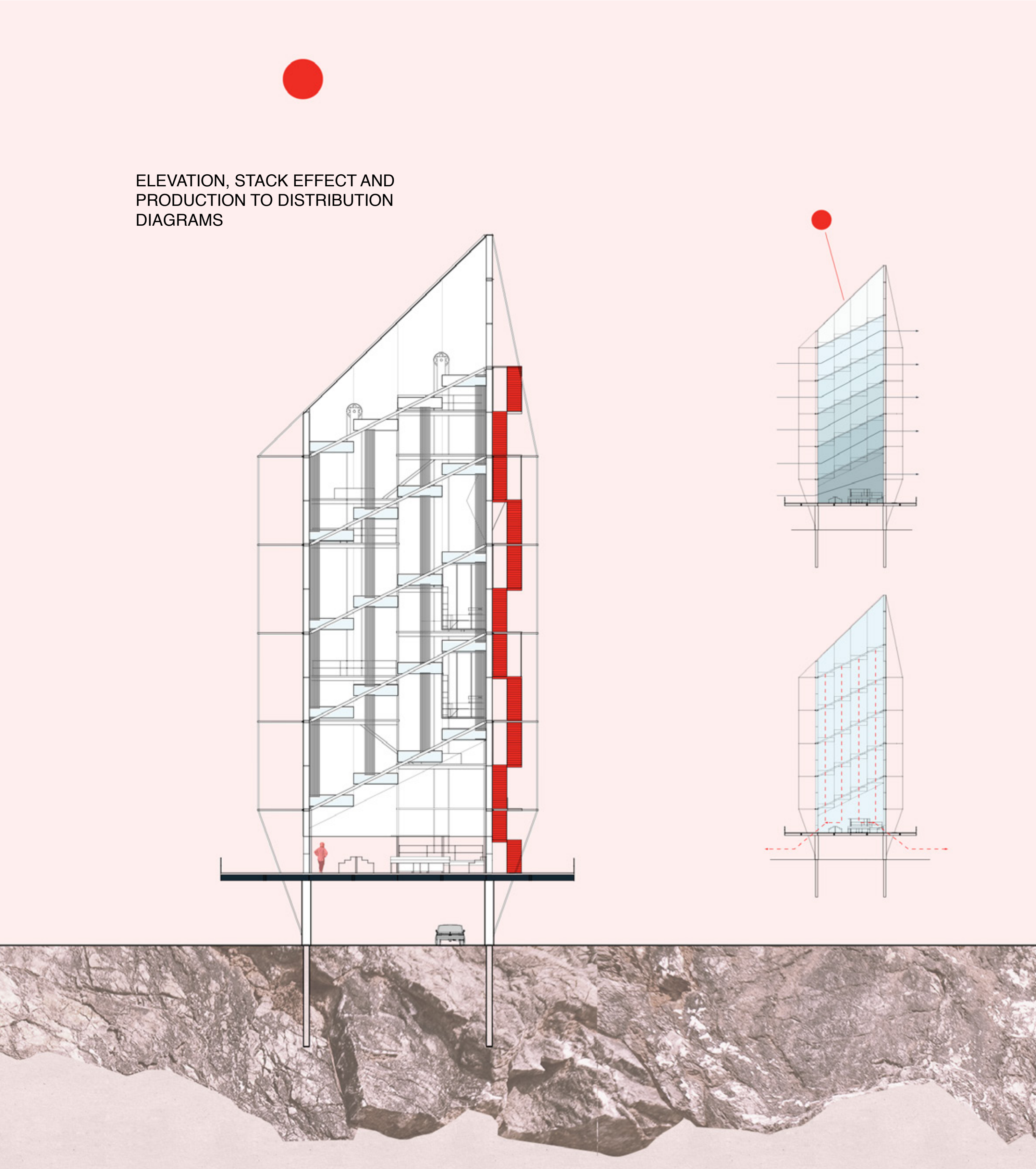


Fig 4.40. ELEVATIONS

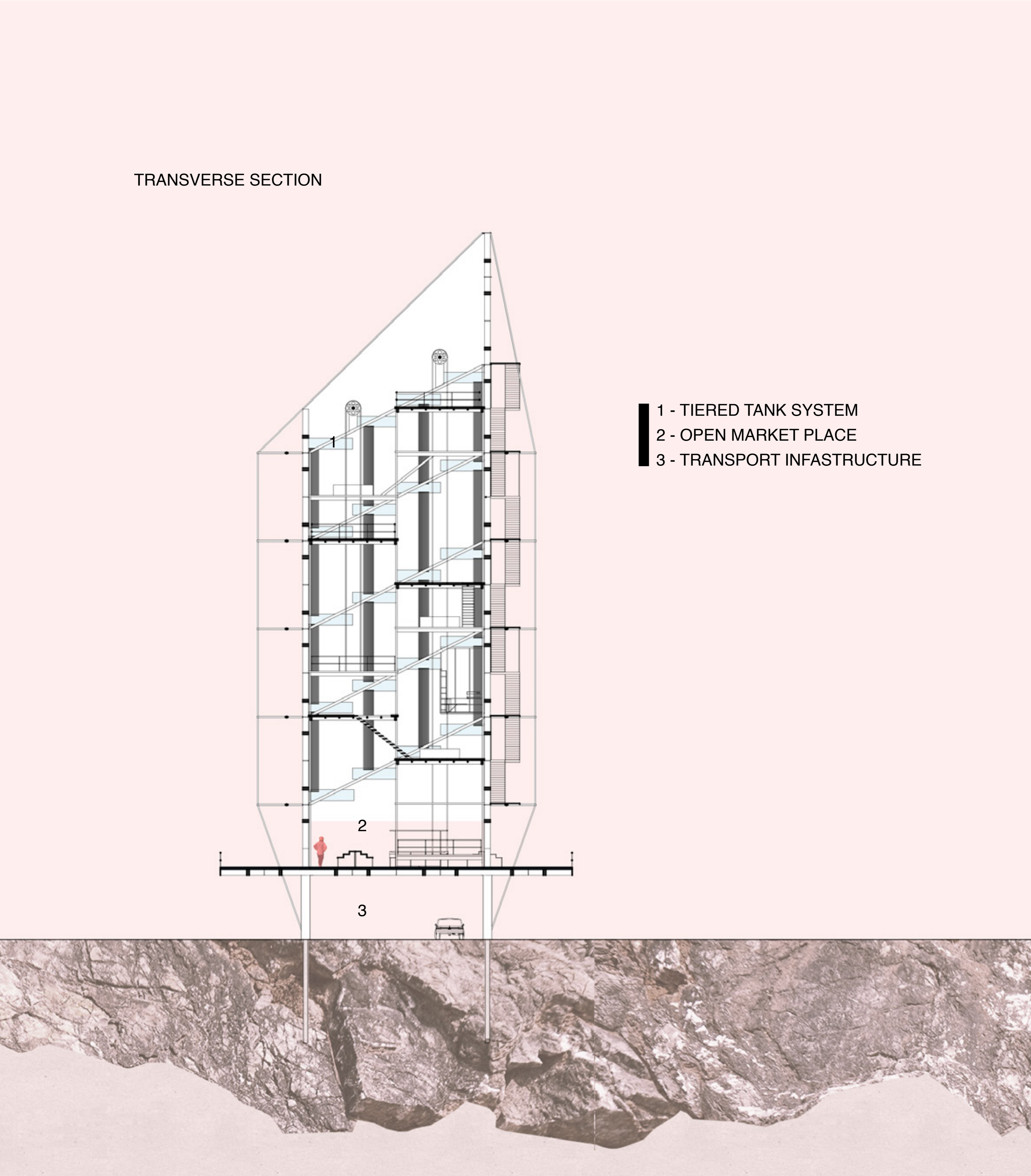


Fig 4.41. SECTION

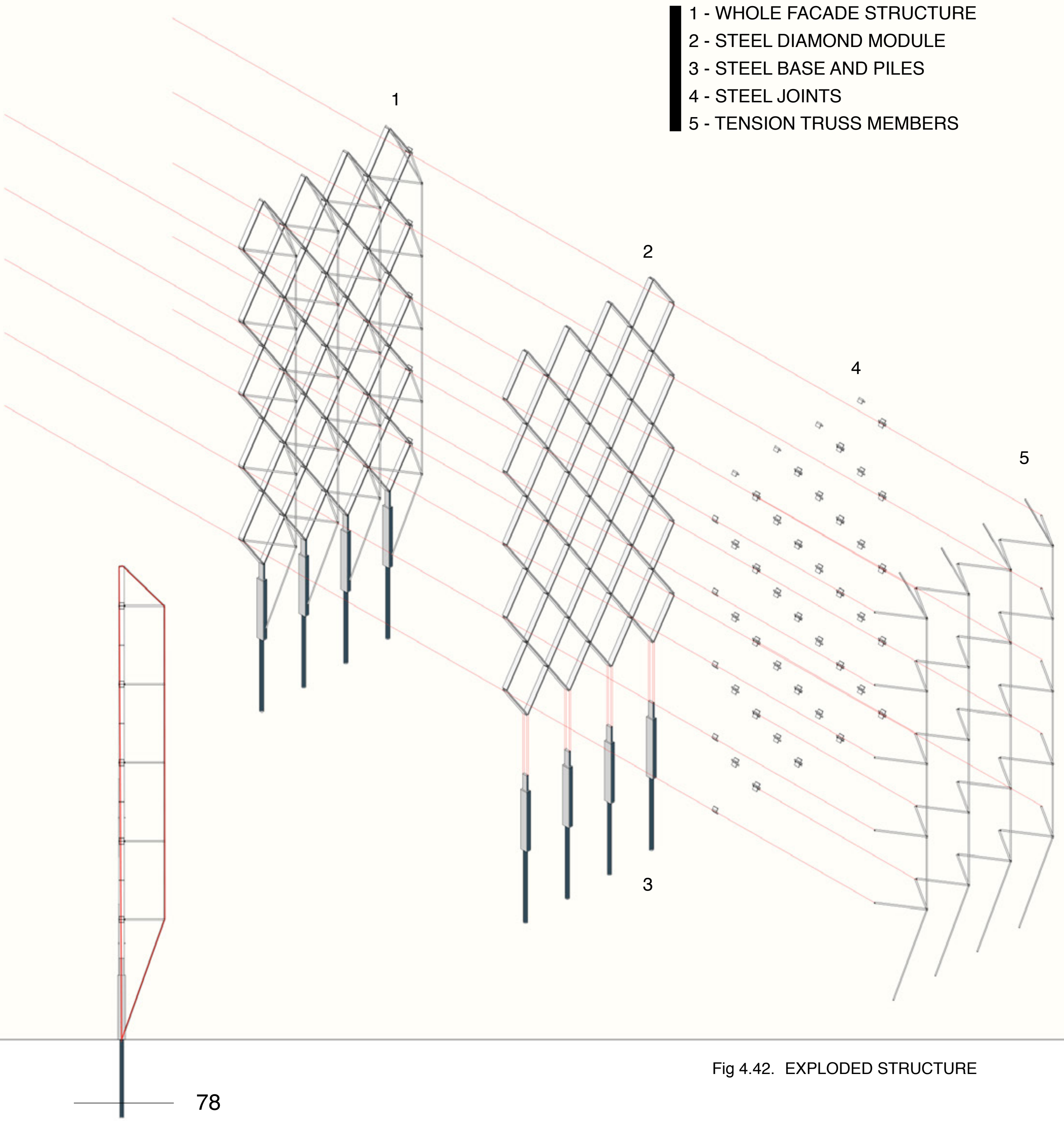


Fig 4.42. EXPLODED STRUCTURE

STRUCTURE

The structural system is a development of the system in design one. It adapts the same diamond module system for the external façade structure. But due to the change in the form of the design, the structural system shifts away from a truss based design to a structural skin system. The change in structural system is designed to reduce the internal structure, moving the load bearing capacity to the external skin to create a more transparent interior.

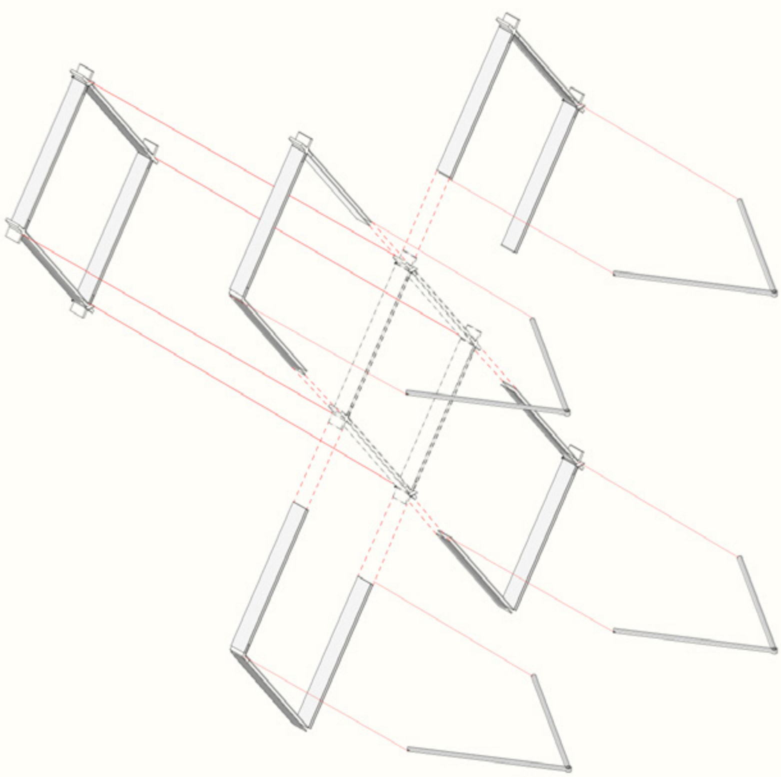
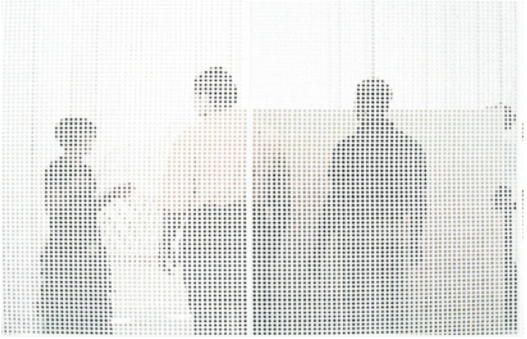
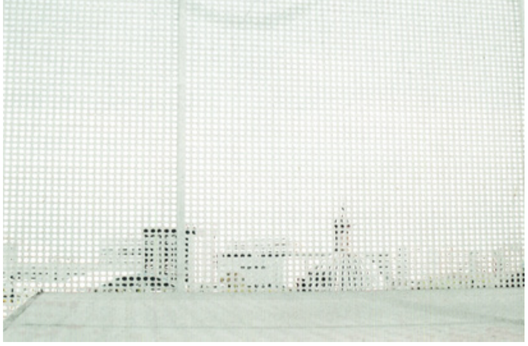


Fig 4.43. EXPLODED STRUCTURE DETAILED





CONSTRUCTION

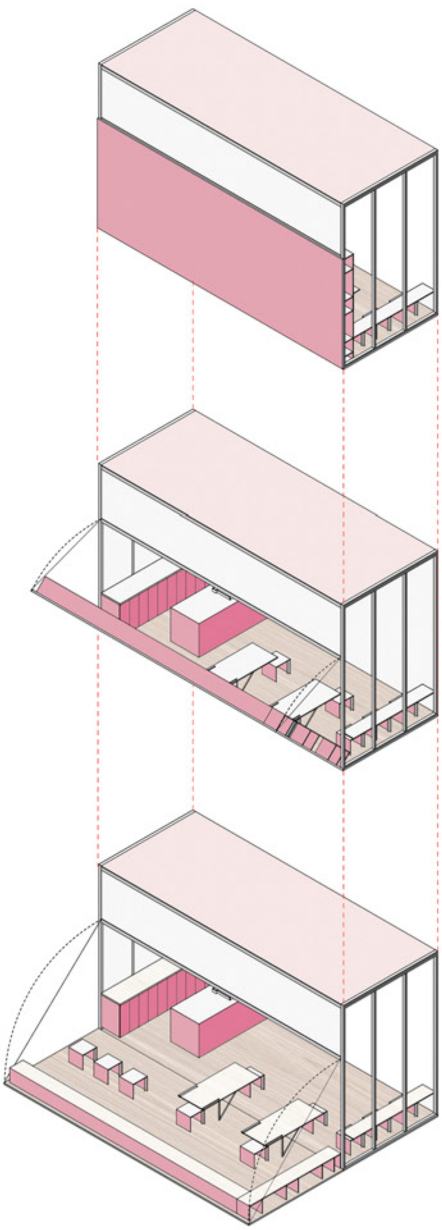
The construction of the building references temporary scaffold structures and work by the SANAA to inform decisions on materiality and composition. To complement the temporal language of the structural system and maximise the transparency with in, the design continues to use thin steel members and perforated steel sheet as the primary materials to create the habitable spaces. Timber is used for more intimate surfaces, such as furniture, to soften the spaces that are more inhabited.

Fig 4.44. IMAGE OF SCAFFOLD STRUCTURE
Fig 4.45. SANAA MATERIALTY EXPERIMENTS

DESIGN PRECEDENT

A unique design showing how a structure can accommodate a variety of programmatic functions. With the ability to expand and contract when needed.

Fig 4.46. DESIGN PRECEDENT FOR KINETIC SPACE



CAFE ISO SHOWING THE TRANSFORMATION THROUGHOUT THE DAY. IT CAN FUNCTION BOTH CLOSED AND OPEN BUT PROVIDES MORE AREA TO INHABIT WHEN IT IS OPEN.

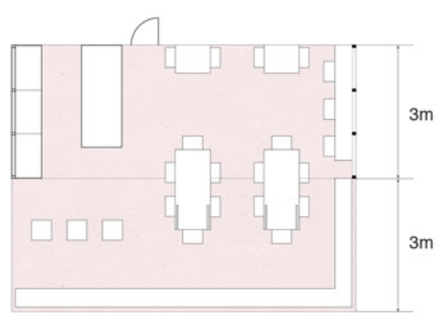


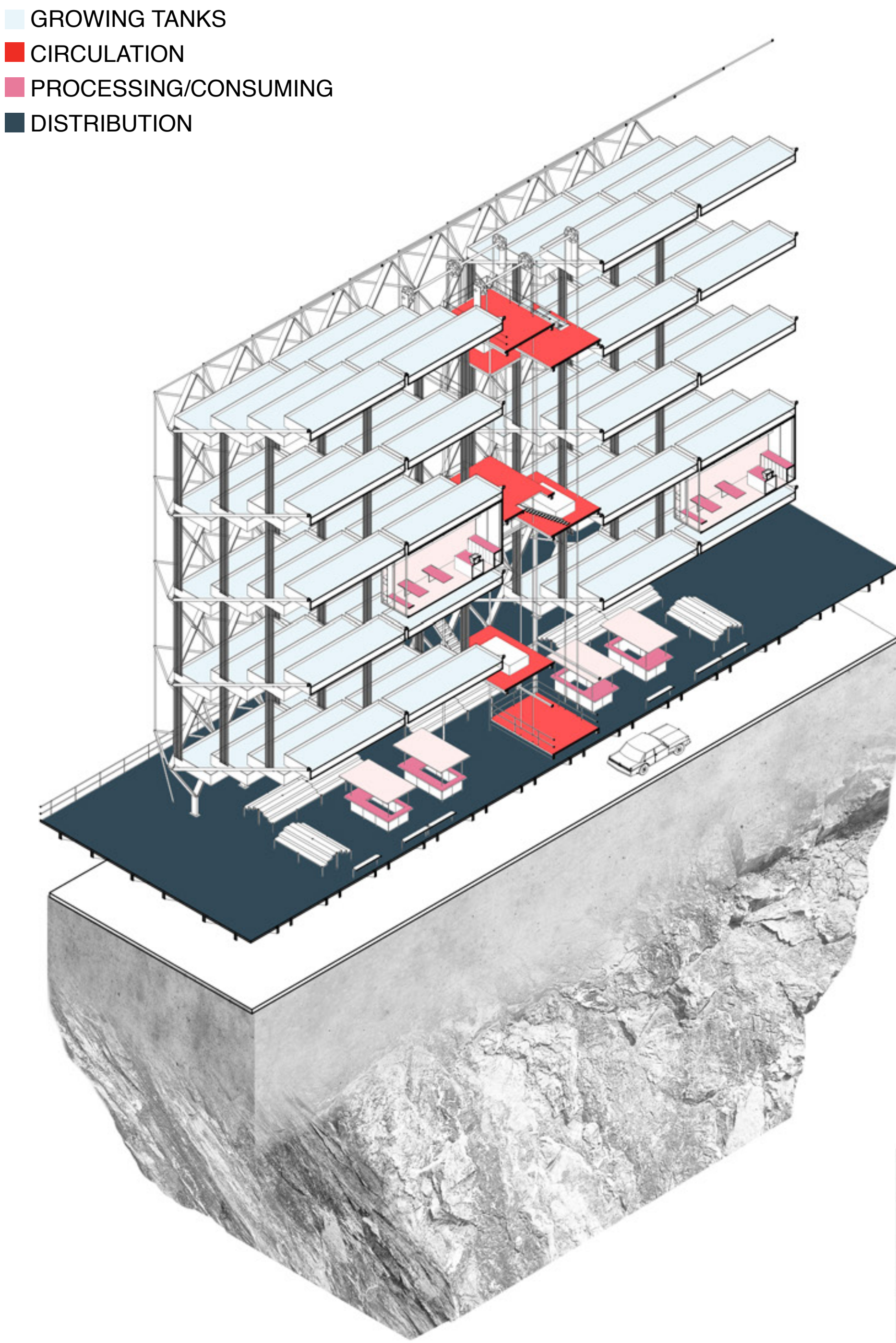
Fig 4.47. CAFE ISO AND PLAN

PROGRAM

The building program takes cues from both the food from the sky project as well as the Rotterdam Market Hall. In a similar approach to these projects this design seeks to create a architectural framework to grow produce and distribute to the local community. The produce is grown in the vertical structure whilst the elevated platform acts as the thorough fair and open market place. Pfeiffer singles out the importance of an accessible market place to urban agriculture in his book "An integrated market place is an essential mechanism for revitalising urban agriculture." (Pfeiffer, 72)Produce is grown, harvested and processed in the structure and then distributed to the public via the elevated market platform.

To balance the demands of the various interior programs with the requirements of the growing organisms was the primary motivation when designing how the space would be inhabited. The solution is a responsive architecture that can adapt in order to fulfil the needs of both, based on variety of external and internal inputs. The program is there for a kinetic mechanism that is sensitive to the programmatic demands, but one that maintains priority to the growing organisms rather than the habitable space.

The primary spatial mechanism is the growing tanks; these tanks define the spatial variations that occur within the structure. By becoming tiered the tanks create maximum efficiency for growing but it also facilitates unique spatial qualities. Negative space is created underneath the tanks that is used to accommodate other parts of the program throughout the day.



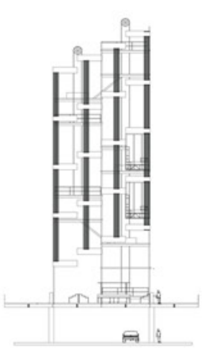


Fig 4.48. PROGRAM ISO - DAY

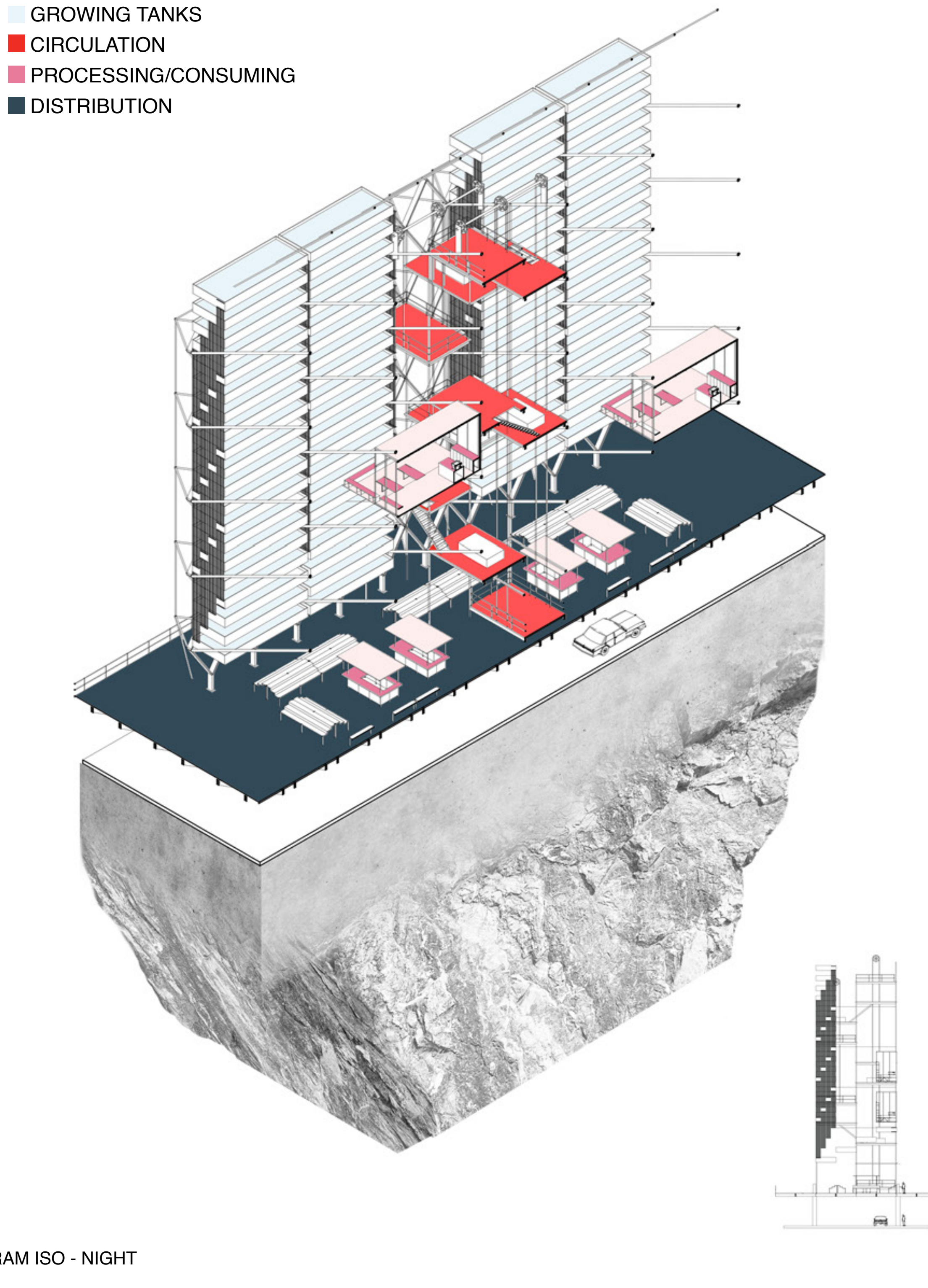


Fig 4.49. PROGRAM ISO - NIGHT

GROWING SYSTEM

The growing system is created to support an aquaponic arrangement. This involves using alternating stacked tanks to combine plants and fish in a symbiotic relationship. The tanks are fed via a reticulated system as well as fresh rainwater, utilising gravity to move water vertically through the system.

In order to maximise growth these tanks disperse themselves during the day, becoming tiered across the entire width of the structure. Through doing this they are able to maximise the available space, allowing sunlight to penetrate the entirety of the building.

DISTRIBUTION

To facilitate the distribution of locally grown produce was a key objective for the second design phase. The buildings context places it on top of existing transport infrastructure but how it connects one to the other is the key mechanism to transform the system from a pedestrian network to one that can connect to the broader community. Positioned above the road networks the design creates an urban bridge for pedestrian movement and can be embedded into inner city residential areas to supply the local community but it does not provide the opportunity to tie directly into the vehicle transport network as there is no place to stop.

INTERGRATION

A large part of the design focus was exploring, through design, ways that the architecture could be integrated with the surrounding context. Design one didn't achieve this integration because it was a self sufficient intervention that was designed to support the people that lived within its boundaries. Instead the Rotterdam Market Hall was used as inspiration to influence how the design could integrate into the urban environment and create distribution systems using existing transport and pedestrian networks.

This example influenced the program, location and relationship with the surrounding context of the design. The elevated platform was designed to assist pedestrian movement from there use of cross programming to create an active and thriving environment which supported a wider community.

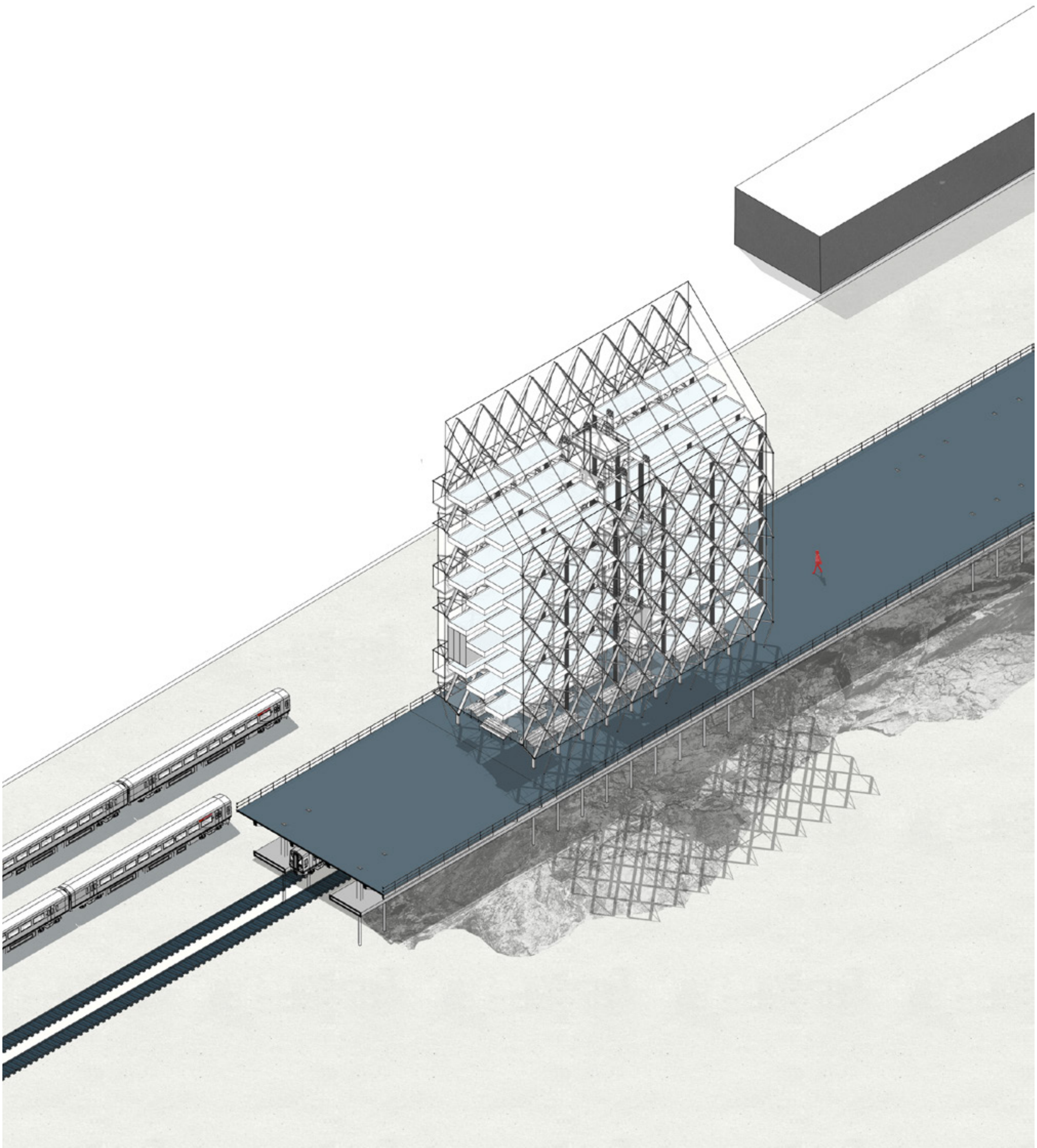


Fig 4.50. DESIGN IN CONTEXT - TRAINSTATION

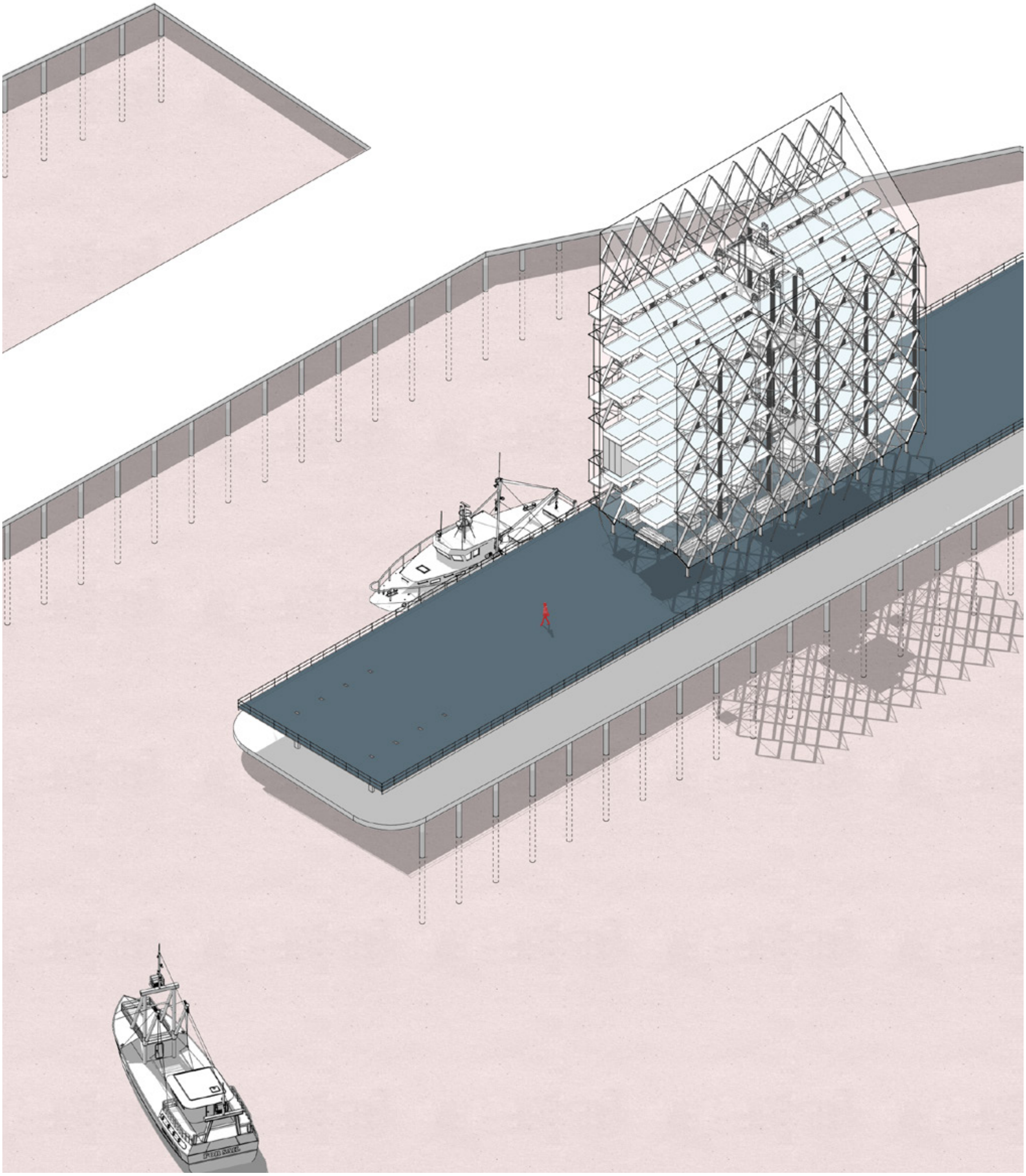


Fig 4.51. DESIGN IN CONTEXT - WHARF

4.6 DESIGN SUMMARY

The summary from design two is based on feedback received from reviewers and my own critical reflection.

The production and distribution system began to hint at a strong design outcome. The elevated market platform and the production tower are strong and pragmatic architectural features that reflect the objectives that they sought to achieve.

The market promenade was effective in creating an area of occupation and movement that allows the occupants to engage with the structure. But how it connects with its surrounding context was not fully explored. This limited its ability to integrate at a pedestrian level.

The kinetic based program did not support am effective and balanced relationship between the occupants and the organisms. Whilst it explored opportunities to maximise unused space it did so at the expense of refined architectural outcome. The solution worked to maximise the growing of the plants but the reviewers felt that it compromised the design of the other programs.

The program could explore more organic influences to develop better ways to distribute the growing system throughout the structure and influence how people are then able to move within the structure.

5. PART THREE

-

DEVELOPED DESIGN

ENTER THROUGH
THE ORANGERY

“We forget that, historically people have eaten for a great many reasons other than biological necessity. Food is also about pleasure, about community, about family and spirituality, about our relationship to the natural world, and about expressing our identity. As long as humans have been taking meals together, eating has been as much about culture as it has about biology.” (Pollan, 8)

5.1 OBJECTIVES

To engage – Explore through design how architecture can facilitate public engagement with a production system and its processes.

The developed design needs to go beyond the notion of a 'Machine for Growing' purely as an agriculture context, seeking to build upon the established framework and deployable construction system to create a mechanism for engagement. The design needs to expand on the idea of growth as not just a physical property of plants but a growth in a broader sense of public knowledge and skills.

It has to create a public interface to provide an opportunity to learn and actively engage with the architecture and its programs. It has to create environments to allow both passive and active education of the food systems.

The developed design needs to explore how the architectural framework could integrate into a specific site. Exploring, through design, what the standard modular frameworks needs to allow it to adapt to the existing site parameters.

5.2 CASE STUDIES

VEJLSKOVGAARD - AN AGRICULTURE BUILDING OF THE FUTURE

LUMO Architects have designed a new agriculture building with the purpose to "put an end to industrialized and inhuman livestock operations, and secondly to develop a new brand for sustainable and transparent agriculture. The building achieves this through a redesigned layout and structure. The building is configured around a star layout that condenses traditional systems and opens the building to the landscape. The use of large spanning structure to create a spacious open plan maximises the ability for light to penetrate and fresh air to circulate.

This building provides an example of how well-designed structures can create a better environment for agricultural production as well as using transparency to enhance its engagement with its surroundings. These ideas of transparency to foster engagement are key to the success of my own design.

Fig 5.52. VEJLSKOVGAARD AGRICULTURAL BUILDING

PASONA URBAN FARM

Designed by New York's Kono Design the renovation of the eight storey Japanese office was envisaged as part office part urban farm. The design intent was to create a building that incorporated agriculture into the core programming of the office both inside and out. Internally 20% of the floor area is allocated to growing produce. The produce is then harvested and used in the buildings cafeterias to cater for the firm's employees. Externally the office is clad in a variety of plants to help communicate the buildings intent. The idea of the design was to help educate the local community and workforce by highlighting the concept of urban farming in Japan. "One way to encourage this is to not just tell urban communities about farms and plants, but to actively engage with them through both a visual intervention in their busy lifestyle and educational programs focusing on farming methods and practices that are common in Japan." (Kono Designs)

By introducing the growing systems into an everyday context I hope to use the same principles to engage and educate the public and the inhabitants of the design.

Fig 5.53. PASONA URBAN FARM

Fig 5.54. AN EXAMPLE OF URBAN AGRICULTURE IN CHRISTCHURCH

5.3 DESIGN APPROACH

The approach to the final design phase was to continue to develop and refine the architectural outcomes from the preliminary designs. The second design stage had successfully explored the key principles of the design that with further exploration could produce a strong architectural outcome.

By applying the design to a specific site rather than a generalised site typology the architecture is able to explore further architectural mechanisms that would allow the deployable construction system to integrate with its specific context. The chosen site provided existing movement and corridors, buildings and infrastructure that created parameters to design to.

To change the building from a vessel for growing plants to one that created an environment for public engagement with the food system, the structure had to create a balance between growing conditions and human occupation. The decision was made to push the façade out to create intimate spaces between the growing systems and the glass façade. The idea referenced the ideology of the slow food movement. It is about creating spaces off the main circulation path for people to stop and enjoy their food. In this way engaging with the system and learning through passive observance.

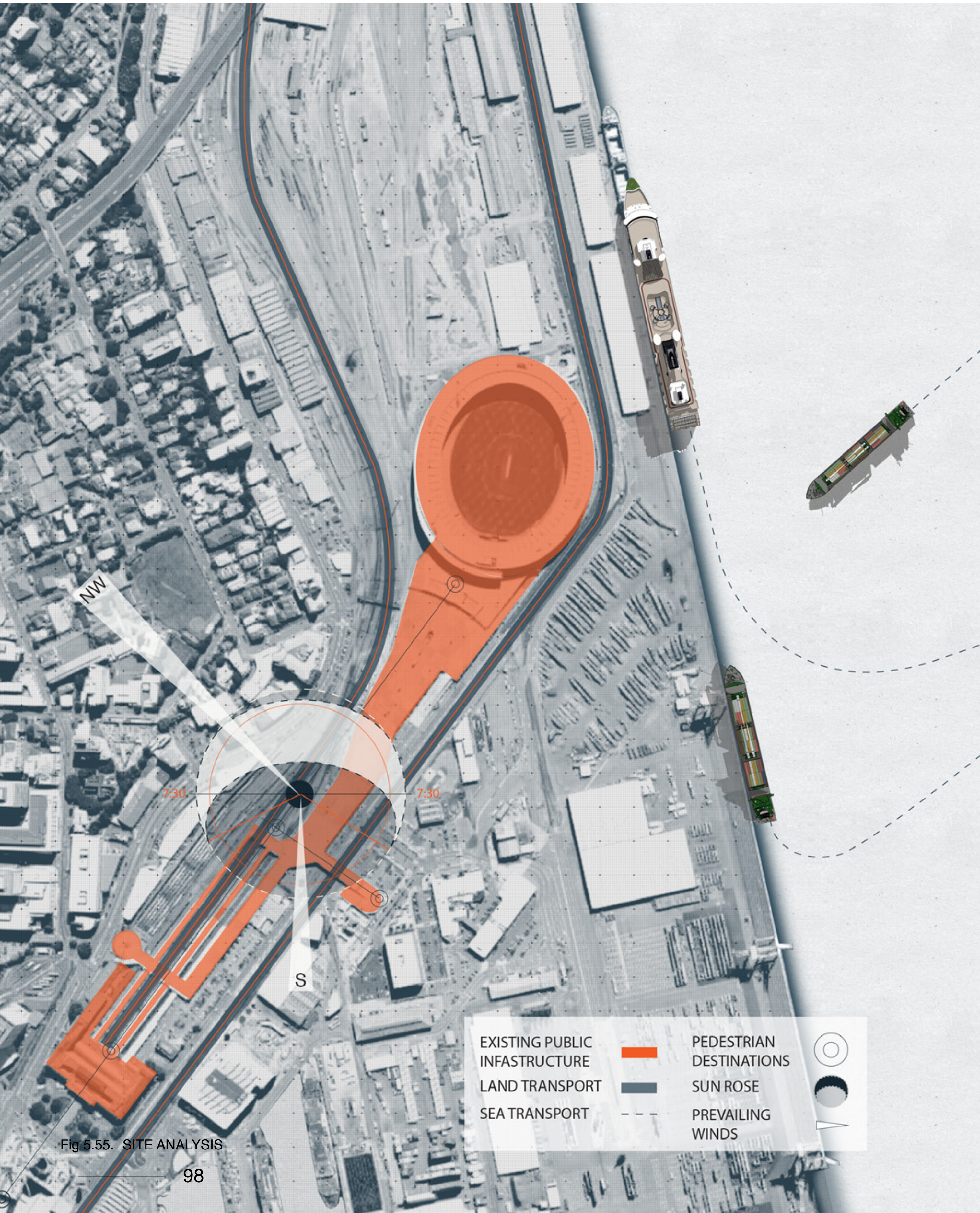
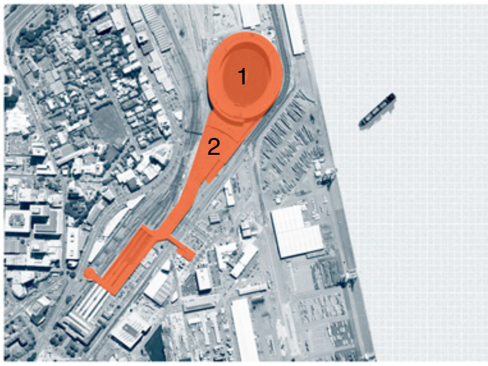
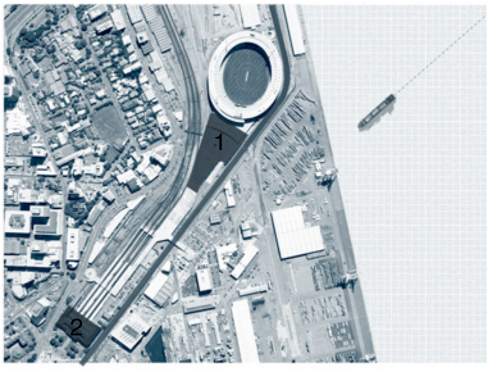


Fig 5.55. SITE ANALYSIS

5.4 SITE ANALYSIS



PUBLIC INFRASTRUCTURE
1 - STADIUM
2 - CAUSEWAY



TRANSPORT INFRA-
STRUCTURE
1 - CARPARK
2 - TRAIN STATION

URBAN TYPOLOGIES
1 - INDUSTRIAL
2 - COMMERCIAL
3 - RESIDENTIAL

Fig 5.56. SITE ANALYSIS TWO

Fig 5.57. SITE PHOTO - CAUSEWAY

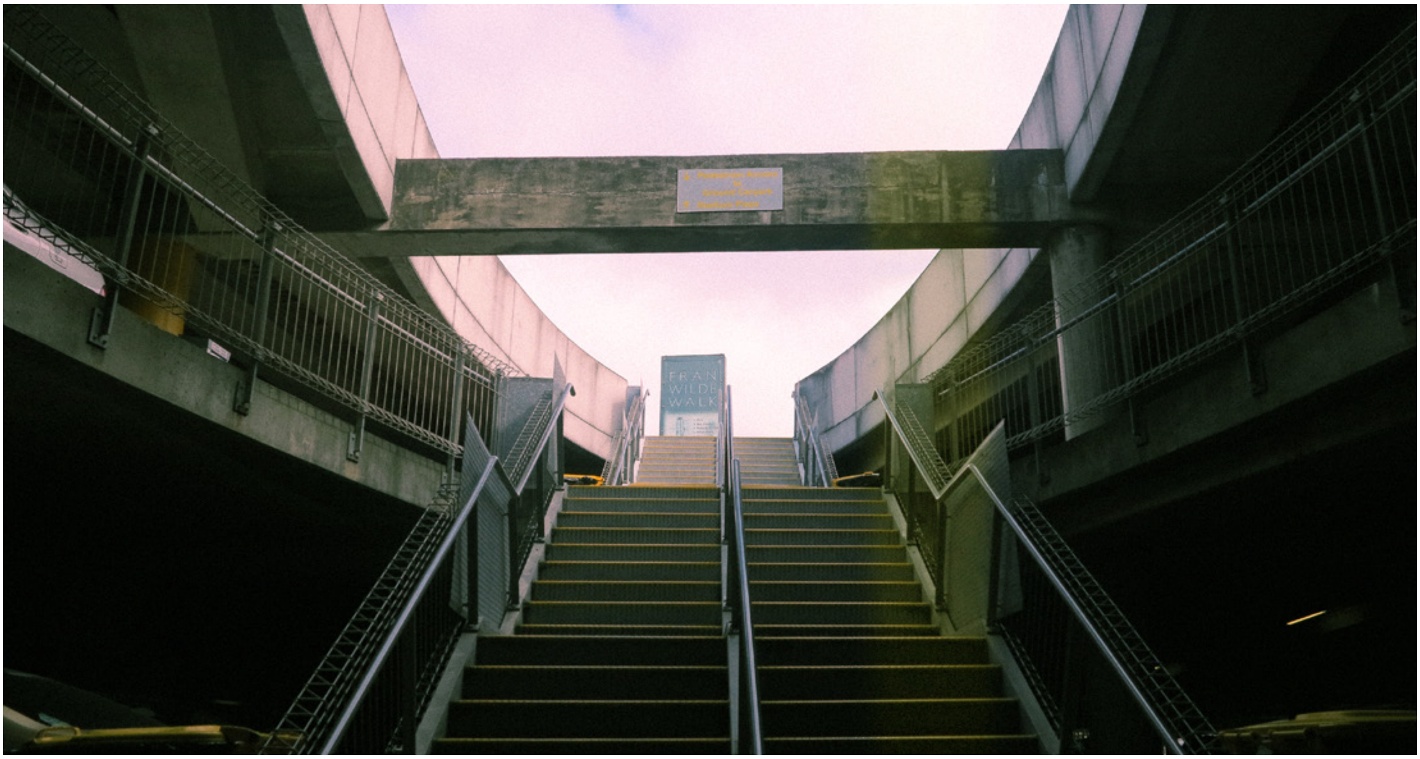

Westpac | STADIUM

■ EXISTING TRAIN STATION.

Fig 5.58. SITE PHOTO - TRAIN STATION

ACCESS RAMP FROM THE EXISTING TRAIN STATION PLATFORMS TO THE CAUSEWAY.

Fig 5.59. SITE PHOTO - ACCESS WAY



FROM THE CARPARK LOOKING UP AT THE CAUSEWAY - THIS PHOTO ILLUSTRATES THE PERMANENCE OF THE EXISTING INFRASTRUCTURE.

Fig 5.60. SITE PHOTO - CARPARK UNDER THE CAUSEWAY

ON TOP OF THE CAUSEWAY LOOKING BACK TOWARDS THE CITY. THIS PHOTO HIGHLIGHTS WHAT A BARREN SPACE IT IS WHEN THE STADIUM IS NOT IN USE.

Fig 5.61. SITE PHOTO - CAUSE WAY FACING THE CITY

THESE PHOTOS ILLUSTRATE THE DIVIDE THAT THE TRANSPORT INFRASTRUCTURE CREATES IN THE CITY. NOT ONLY THROUGH THE INFRASTRUCTURE ITSELF AND THE VEHICLES THAT THEY SUPPORT BUT ALSO THROUGH THE EDGE CONDITION THAT SEEMS TO THRIVE IN ITS PRESENCE. THE FINER GRAIN OF THE CITY CORE TENDS TO GIVE WAY TO LARGE INDUSTRIALISED BUILDINGS THAT BORDER THE NETWORKS EDGE.

Fig 5.62. VENN DIAGRAM ILLUSTRATING THE DESIGN INTENT

5.5 DESIGN OUTCOME

FORM

The development of the form from the preliminary design to the developed design was driven by the shift away from a more pragmatic agro-architecture towards one that facilitates engagement. The form was manipulated to create spaces between the skin and the growing systems to allow people to dwell within the structure. The form creates variations in size that can accommodate a range of activities, from singular occupation to larger groups. The structure was extended vertically to amplify the stack affect in order to create a broader range of growing environments, from citrus groves at the top to leafy greens at the bottom. The roof of the design was optimized to capture rainwater that it uses to feed the growing system. These semi translucent structures also maximise the light entering the building.

The façade took cues from the work of SANAA using a tessellated glass skin to retain a level of transparency "the movements of the people inside the building are visible from without, the sequence of events becomes part of its external appearance." (Hasegawa, 9) In this way I wanted the processes within to be engaged with from beyond.

Fig 5.63. DESIGN IN CONTEXT ONE

Fig 5.64. SITE PLAN

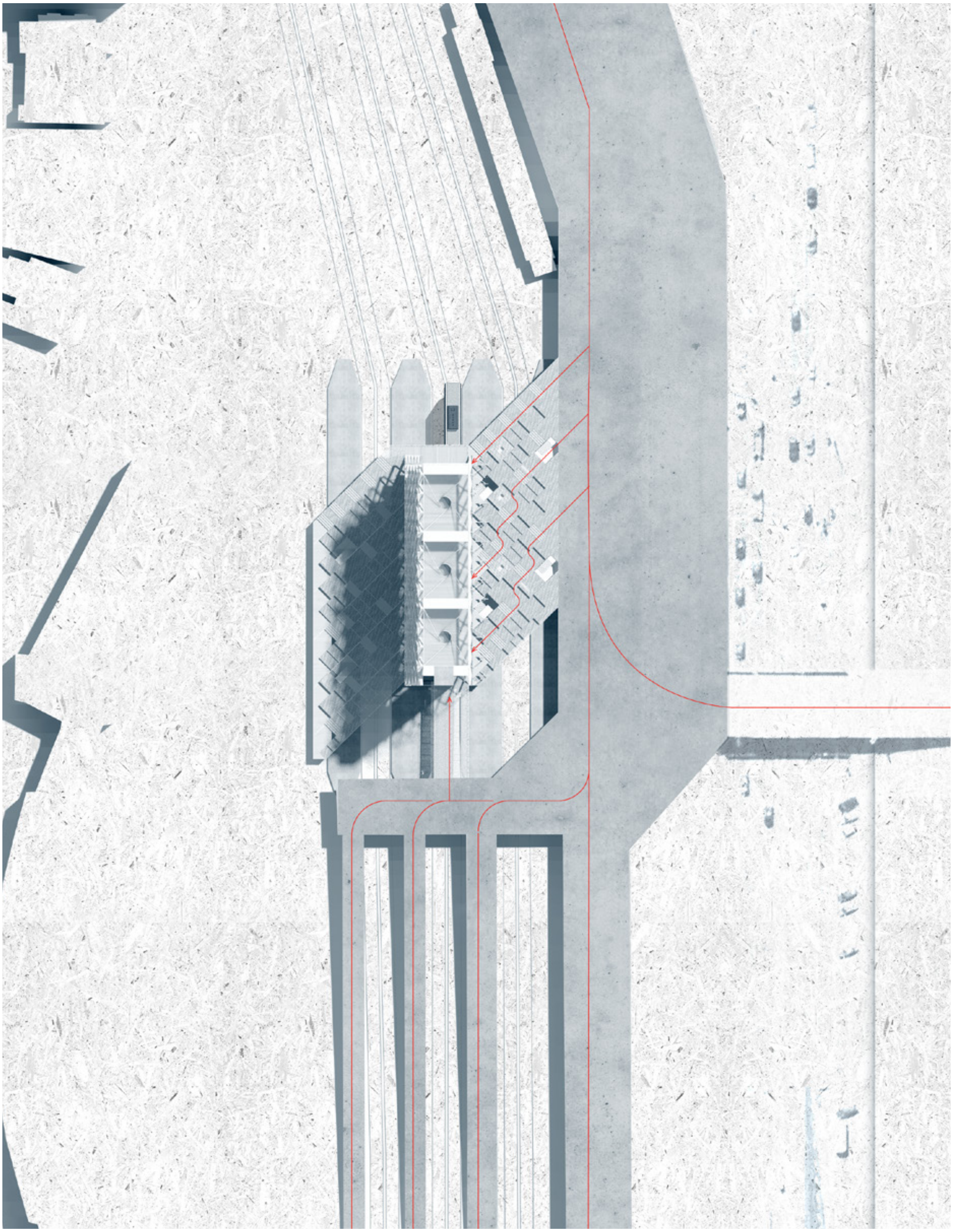
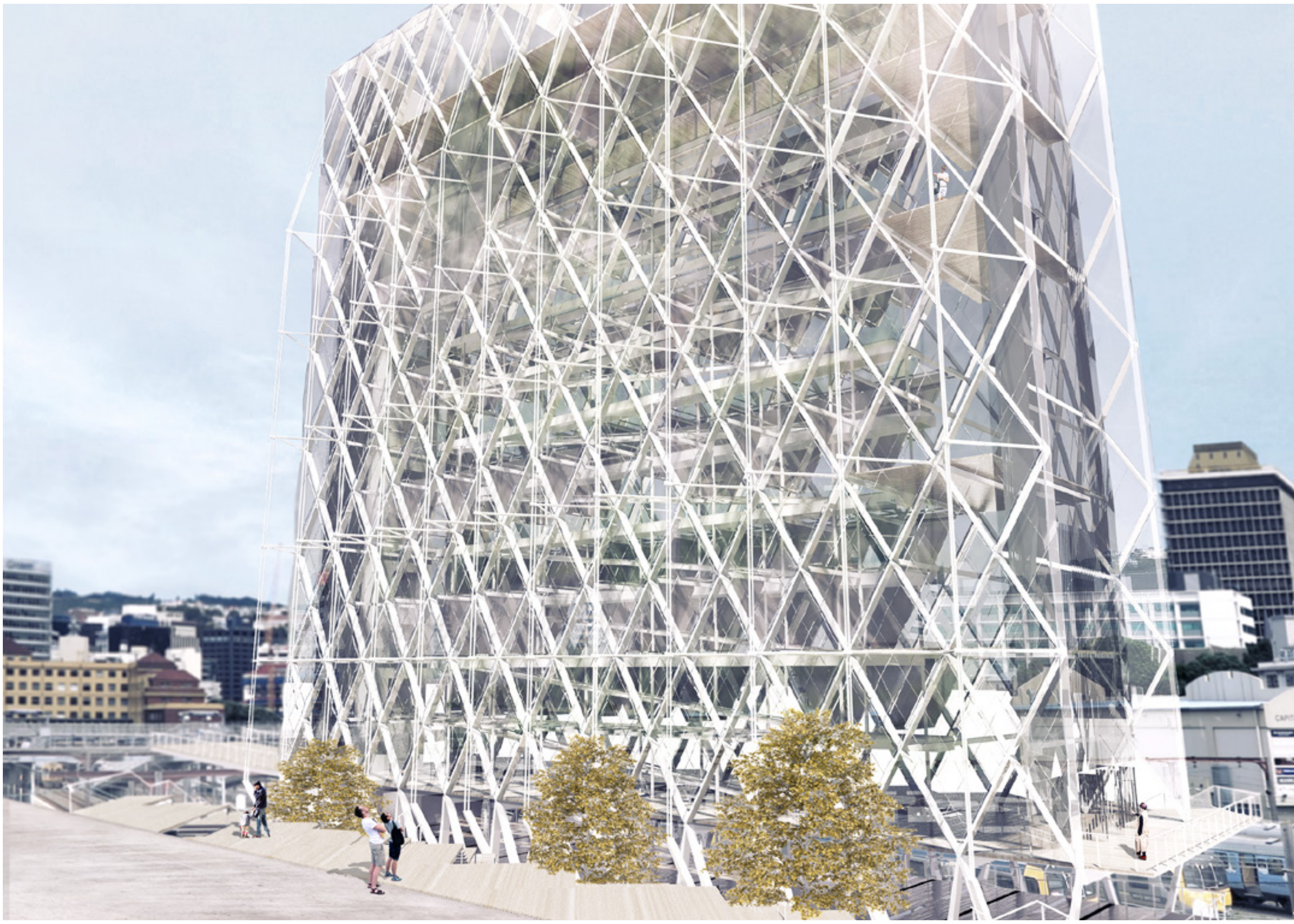


Fig 5.65. ROOF PLAN

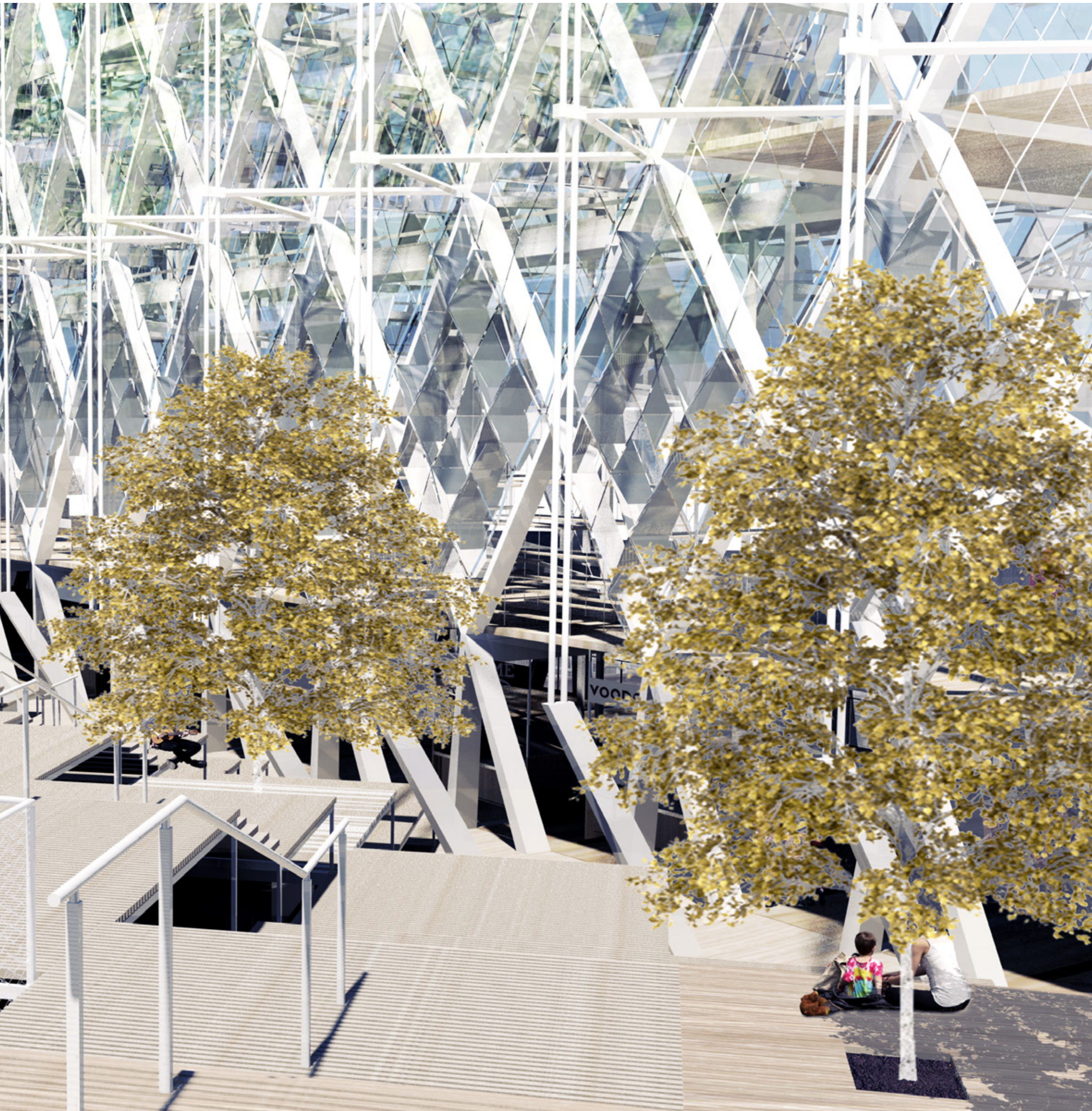


SHOW CASING THE GLASS FACADE
COMMUNICATING THE PROCESSES
WITHIN THE STRUCTURE.

Fig 5.66. IN CONTEXT TWO

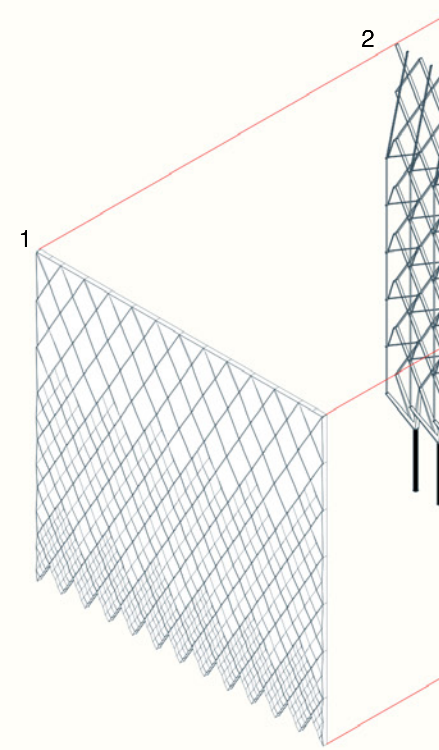
APPROACHING THE BUILDING
FROM THE CAUSEWAY.

Fig 5.67. DESIGN IN CONTEXT 3



EXPLODED STRUCTURAL DIAGRAM

1 - DOUBLE SKIN GLASS FACADE EAST
2 - TENSION TRUSS STRUCTURAL FRAME
3 - TOP FLOOR DIAPHRAGMS
4 - STRUCTURAL CIRCULATION CORE
5 - BOTTOM DIAPHRAGMS
6 - STRUCTURAL FRAME
7 - DOUBLE SKIN GLASS FACADE WEST
8 - WATER CAPTURE TENSILE CANOPIES
9 - SPACE THAT THE STRUCTURAL FRAME ENCLOSES



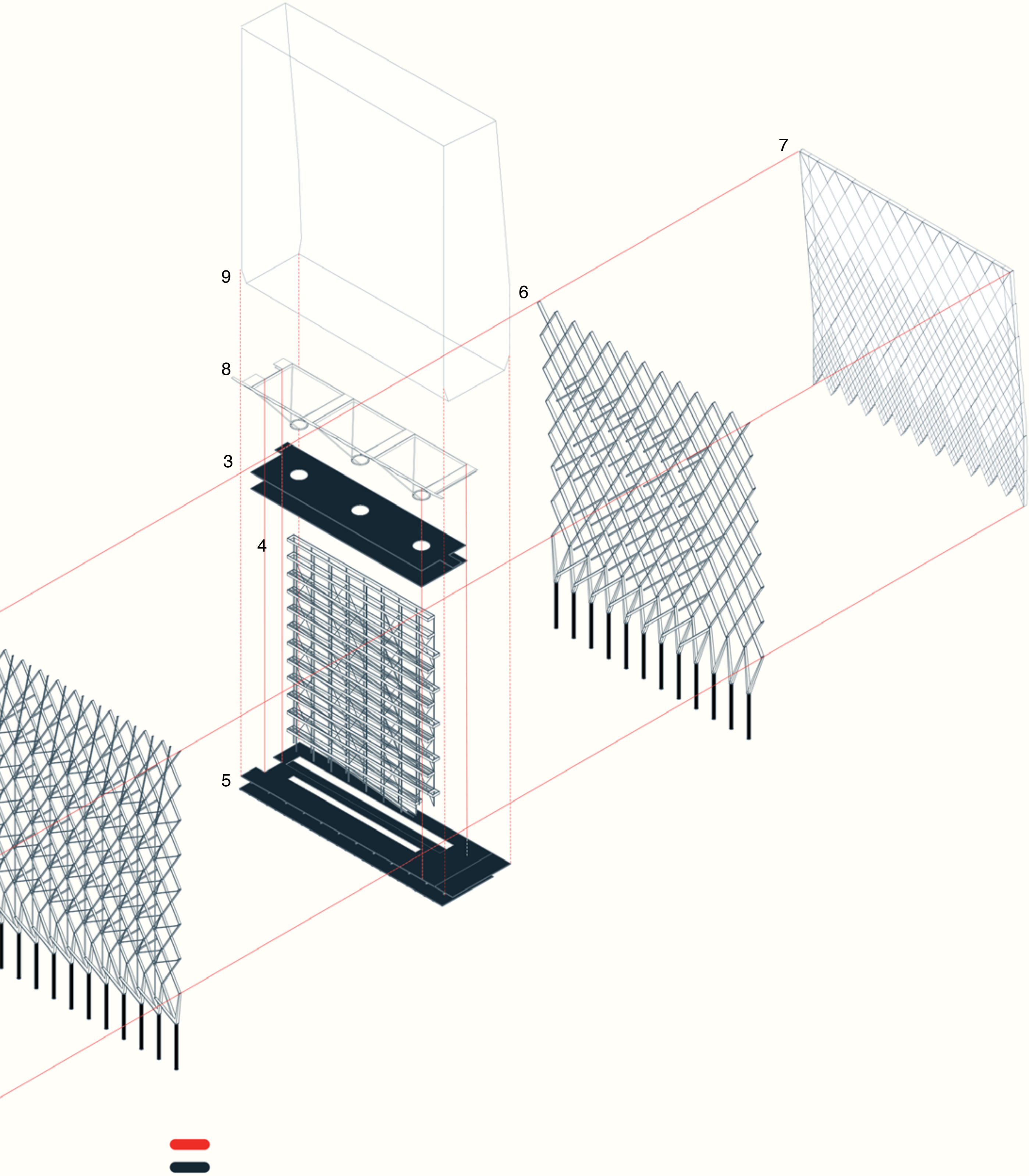


Fig 5.68. STRUCTURE EXPLODED

THE BUILDING CIRCULATION ACTS AS THE PUBLIC INTERFACE. THE CENTRAL CIRCULATION CHANNEL AND TRANSPARENT STRCUTURE ALLOW THE INHABITANTS TO ENGAGE WITH THE SYSTEMS AS THEY DESCEND THROUGH THE STRUCTURE.

DIAGRAM SERIES SHOWING THE DEVELOPMENT FROM THE PRELIMINARY DESIGN ONE. BY MOVING THE CIRCULATION INTO THE CENTER OF THE BUILDING CREATES A MORE TRANSPARENT AND ACCESSIBLE DESIGN.

Fig 5.69. CIRCULATION DEVELOPMENT

1 - LIFT ACCESS TO THE TOP OF THE STRUCTURE

2 - SECONDARY STAIR ACCESS

3 - PRIMARY ACCESS RAMPS DESCEND THROUGH THE STRUCTURAL CORE

4 - ACCESS RAMP FROM THE CAUSEWAY

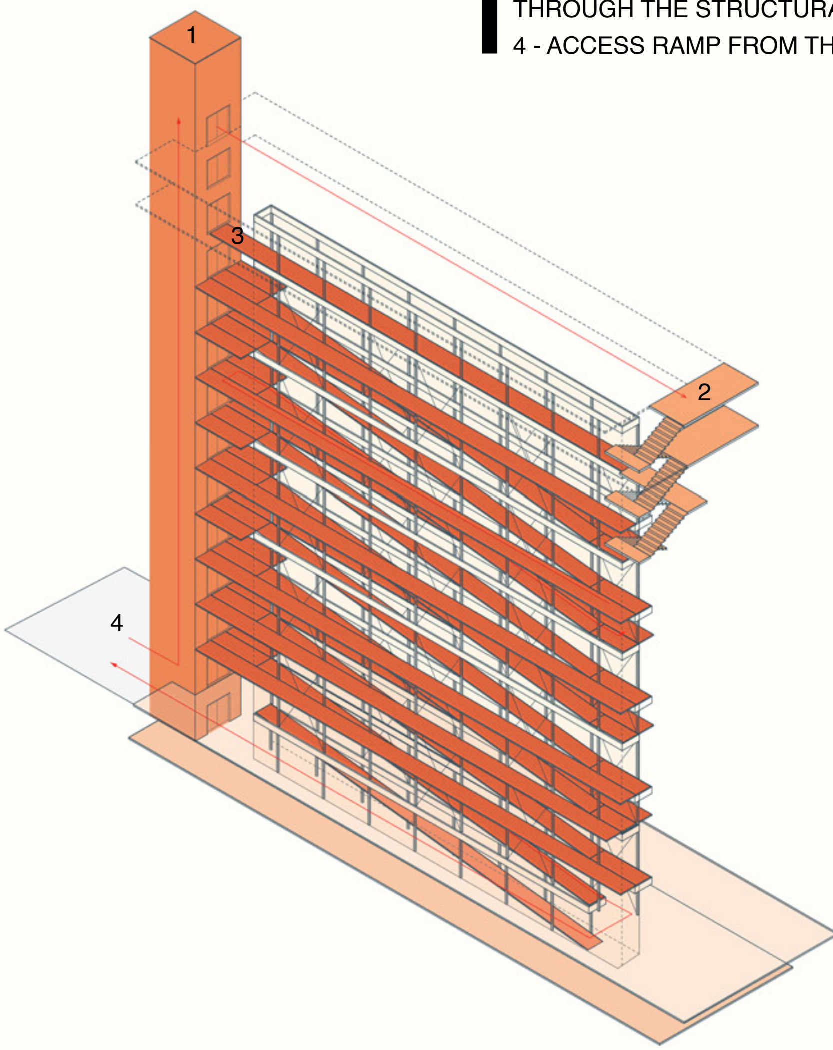


Fig 5.70. CIRCULATION DIAGRAM

THE AQUAPONIC SYSTEM RELIES ON FRESH RAIN-WATER COLLECTED VIA THE ROOF CANOPIES. THE WATER IS FEED THROUGH THE SYSTEM, ACTING AS THERMAL MASS TO ABSORB SOLAR ENERGY AND RETICULATE IT THROUGH OUT THE STRUCTURE. THE WATER PASSES THROUGH A HEAT TRANSFER SYSTEM AT THE BASE BEFORE PASSING BACK INTO THE START OF THE SYSTEM.

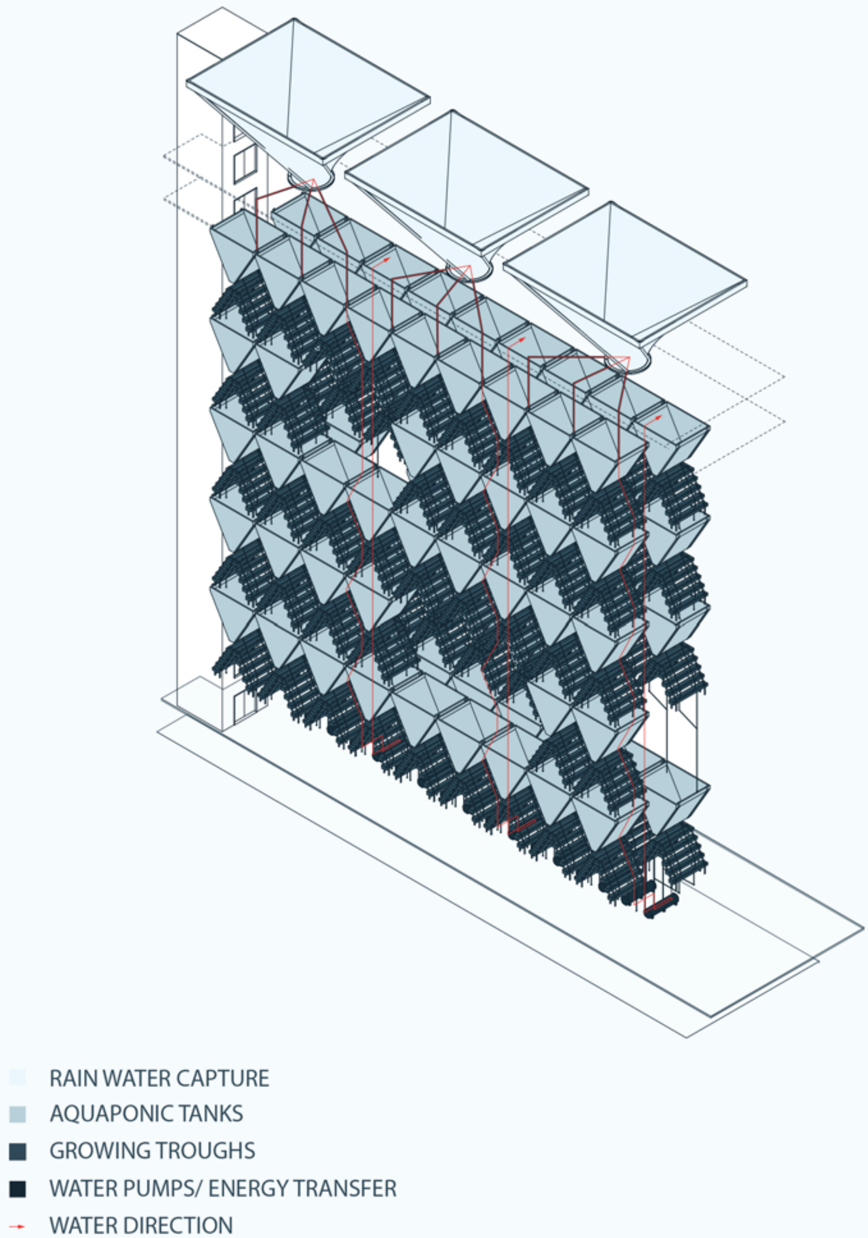


Fig 5.71. DIAGRAM GROWING SYSTEMS

1 - HABITABLE SPACE CREATED UNDERNEATH THE PLANTING TROUGHS

2 - SPACE TO ACCESS THE PLANTING TROUGHS AND MOVE THROUGH THE GROWING SYSTEM

3 - HABITABLE SPACE CREATED BY ANGLING THE FACADE. ALLOWS INHABITS TO MOVE AWAY FROM THE CIRCULATION PATH INTO MORE SECLUDED AREAS

4 - THE FORM OF THE GROWING SYSTEM HAS BEEN DEVELOPED TO MAXIMISE IT'S ACCESS TO SOLAR ENERGY

5 - THE FORM OF THE FISH TANKS IS DESIGNED TO ALLOW LIGHT ACCESS TO THE GROWING TROUGHS NELOW

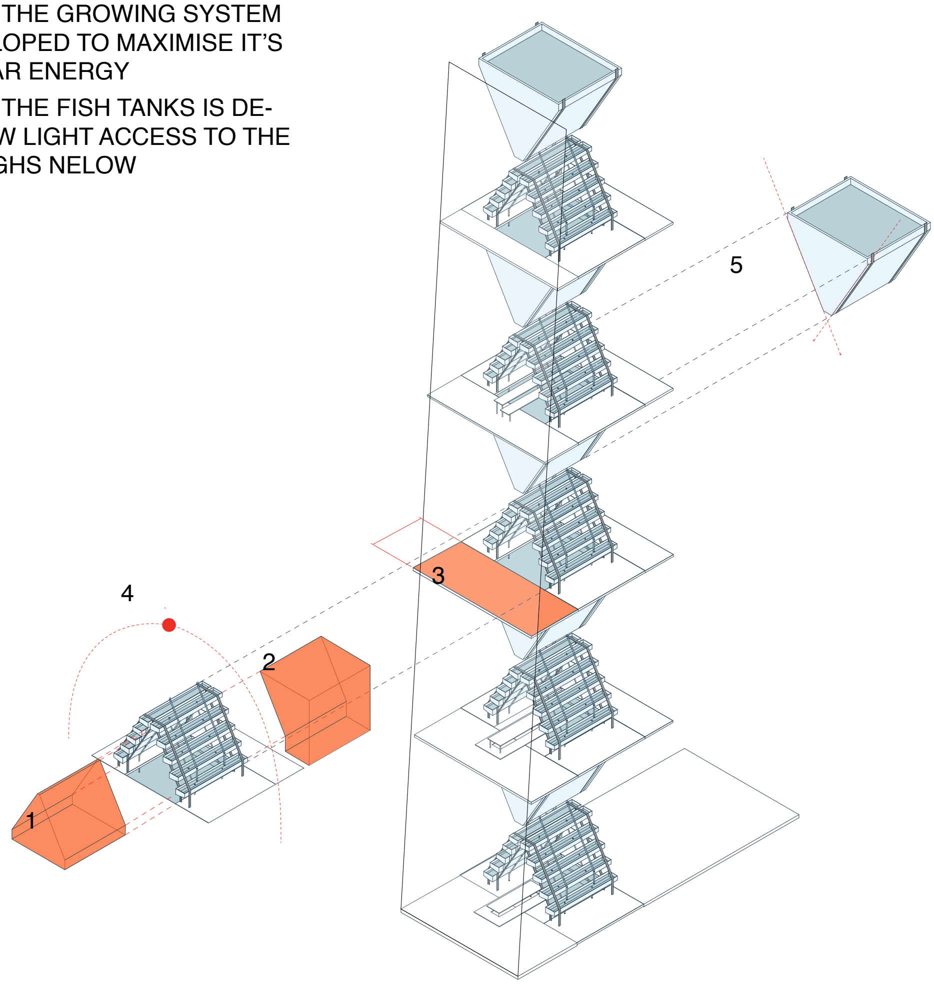


Fig 5.72. DIAGRAM GROWING SYSTEMS AND THE HABITABLE SPACES THAT THEY CREATE

THE GROWING SYSTEMS ARE DESIGNED AS PLACES OF INHABITATION TO ALLOW ONE TO DIRECTLY ENGAGE WITH THE PRODUCE THAT SURROUNDS THEM.

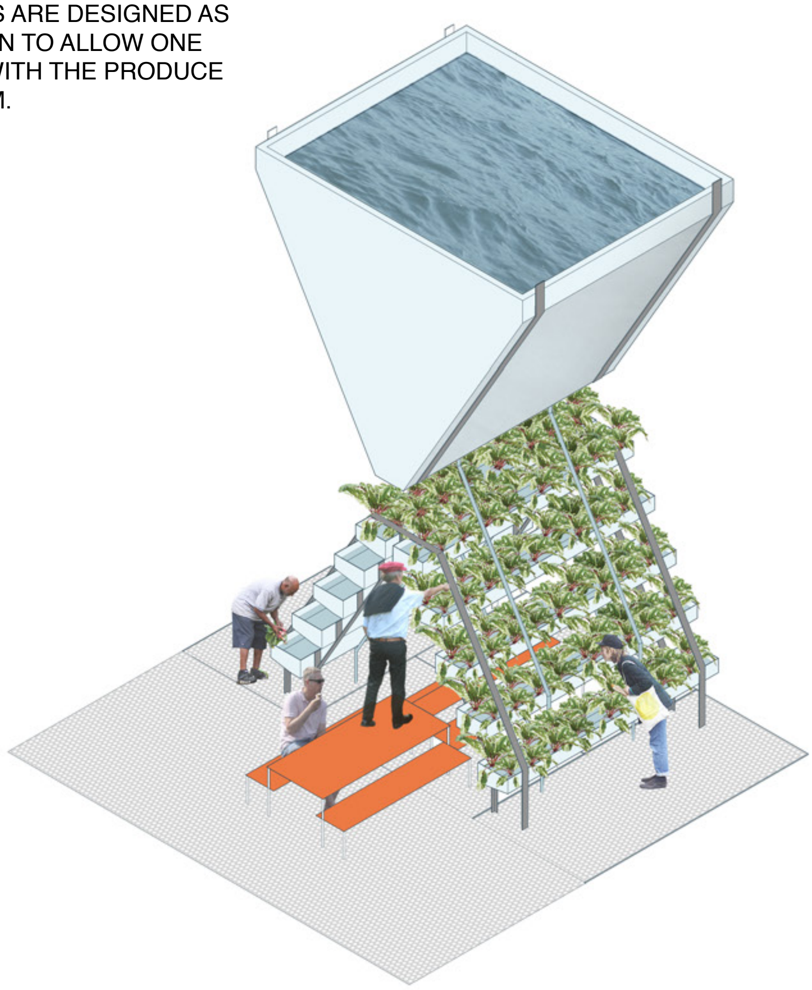


Fig 5.73. INTERACTION WITH GROWING SYSTEM

AREAS FOR PROCESSING ARE DISPERSED THROUGHOUT THE STRUCTURE. THE GRADIENT OF COLOUR INDICATES ITS POSITION WITH IN THE FOOD CHAIN. THE INITIAL PROCESSING IS IN THE SEEDERY AND NURSERY, AFTER THE PRODUCE IS HARVESTED IT IS PORCESSED FURTHER TO IN ORDER TO BE BOUGHT OR CONSUMED.

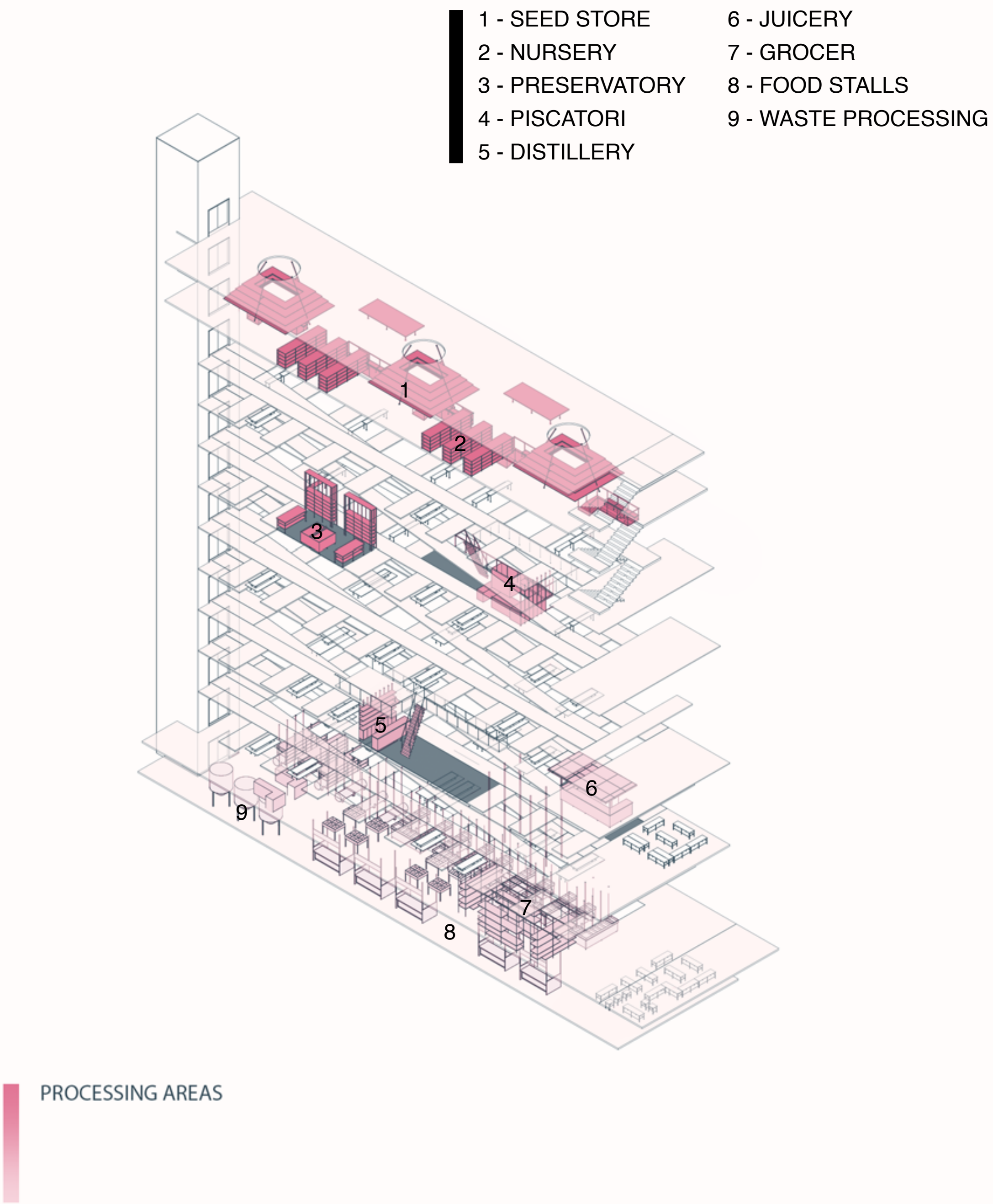
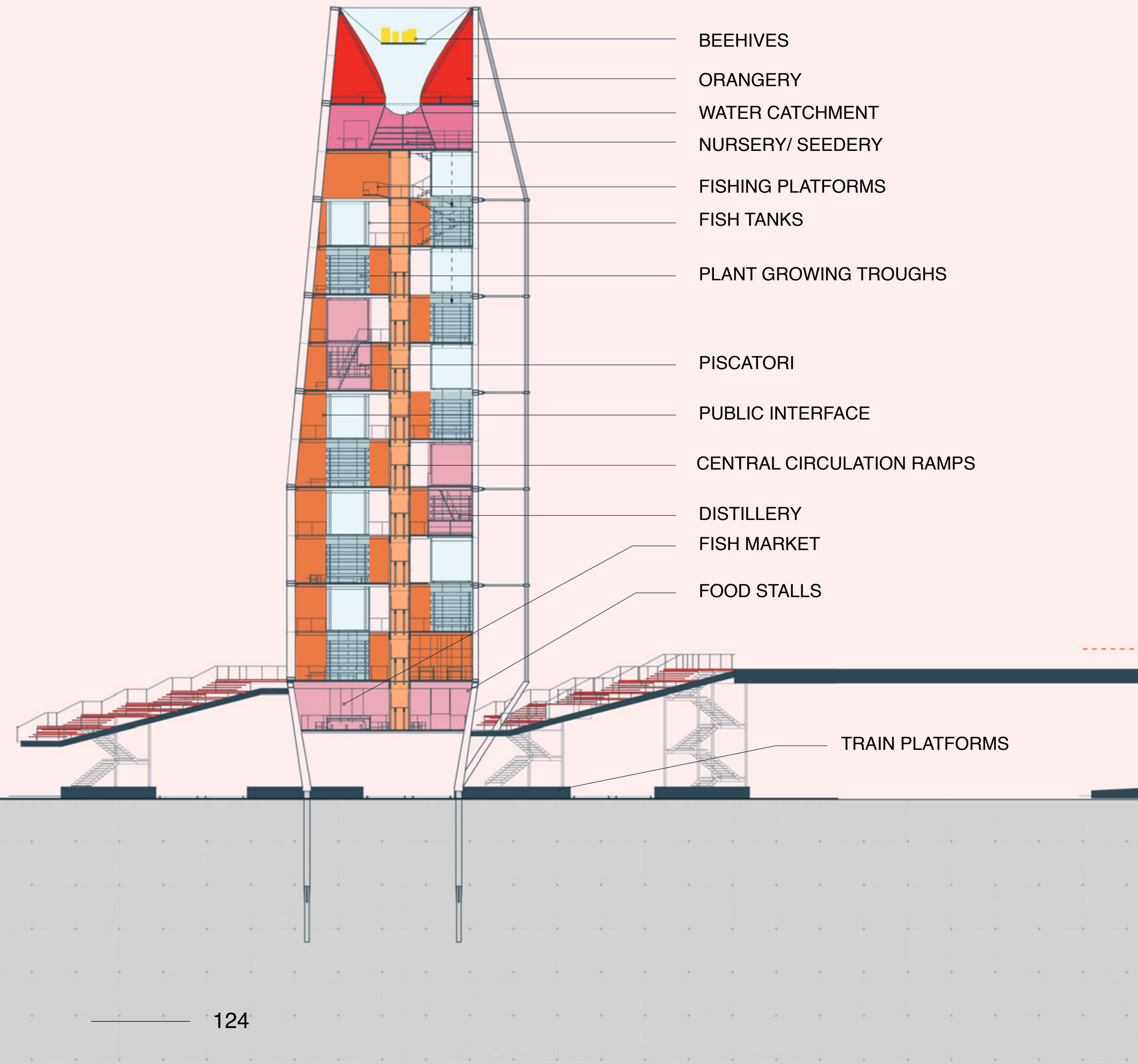


Fig 5.74. PROCESSING DIAGRAM

PROGRAM IN SECTION



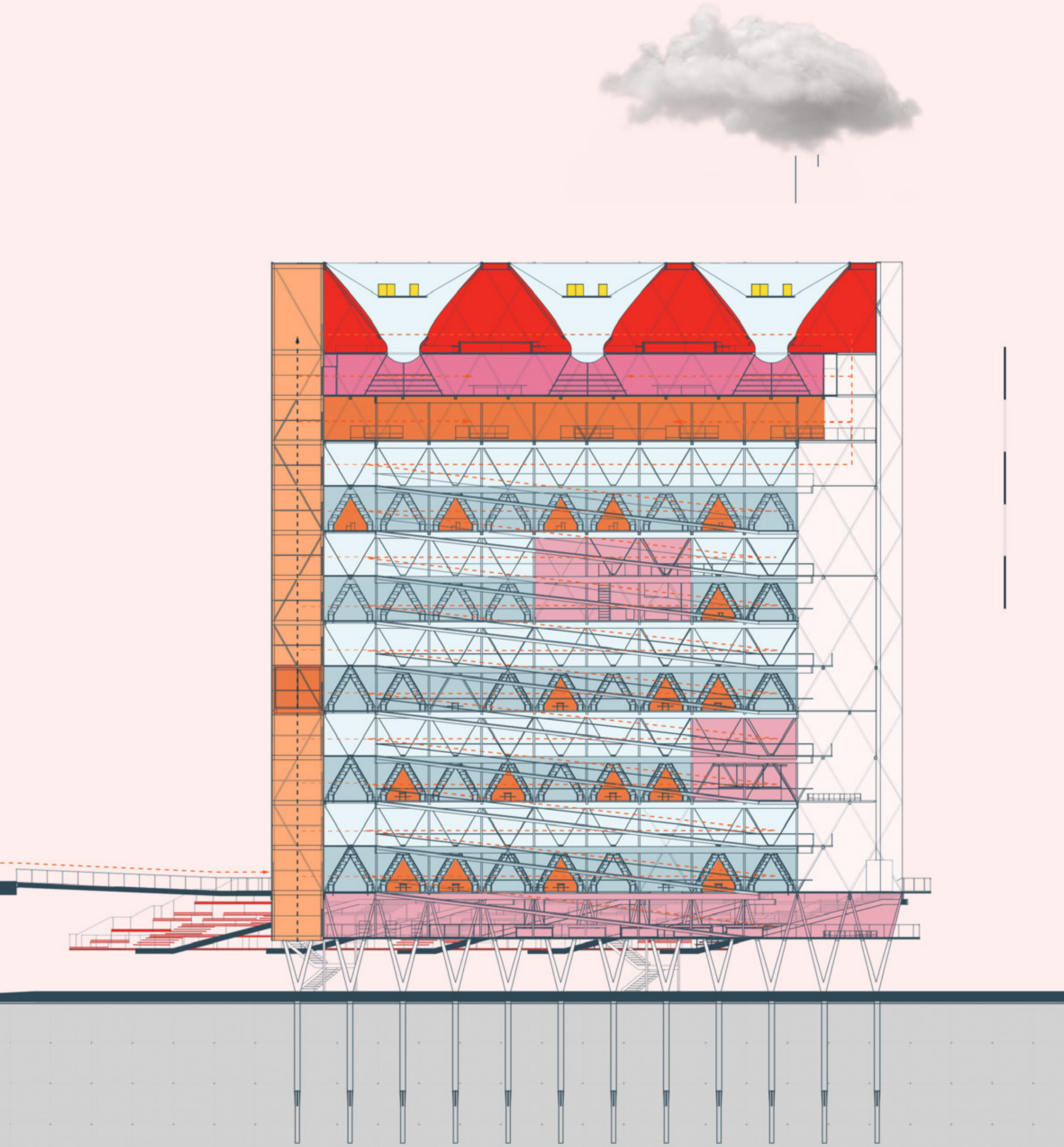


Fig 5.75. PROGRAM DIAGRAM

Fig 5.76. IMAGE SHOWING ACCESS TO THE DESIGN

EXPLORING THE PUBLIC INTERFACE

Fig 5.77. ENTERING THE STRUCTURE

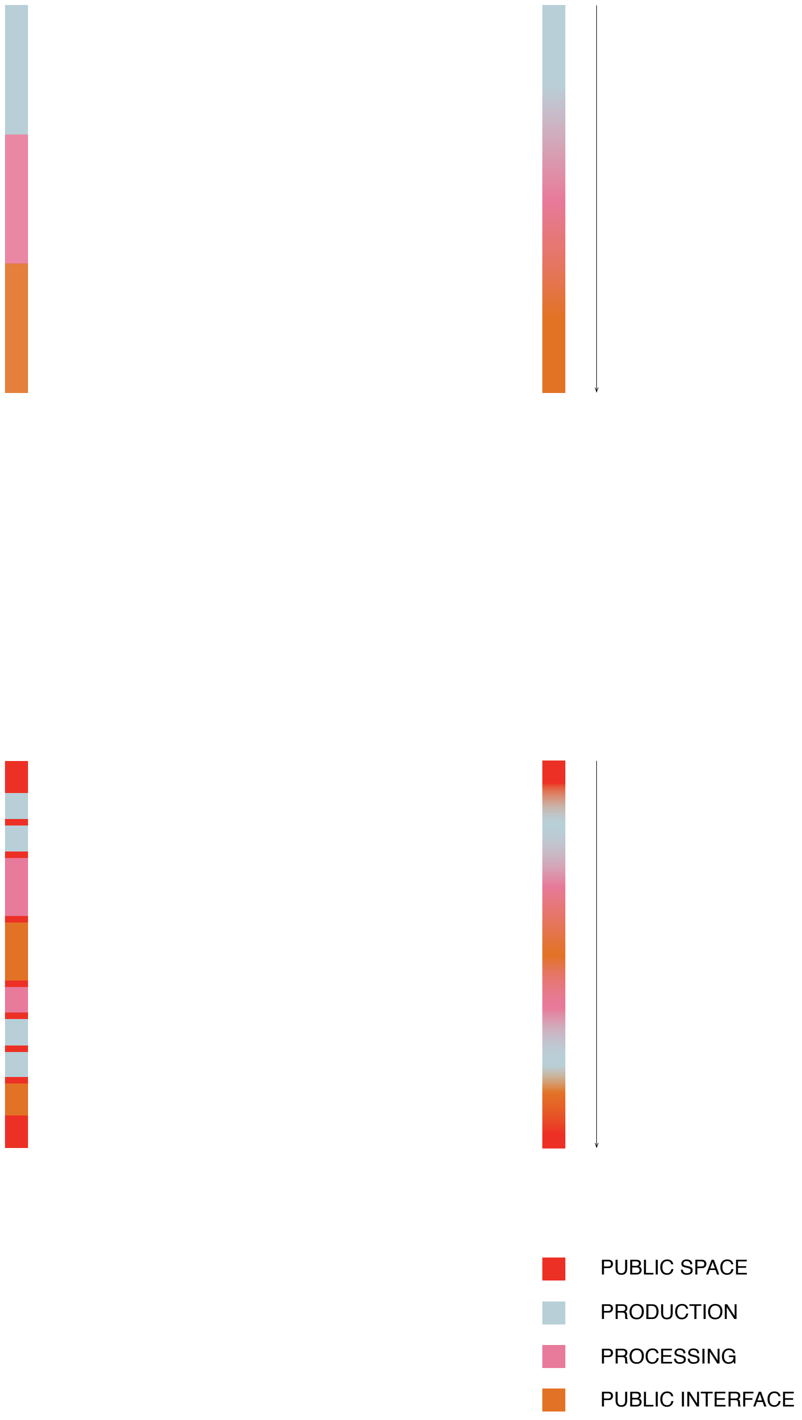


Fig 5.78. DIAGRAM ILLUSTRATING HOW THE DIFFERENT PROGRAM FUNCTIONS INTERACT

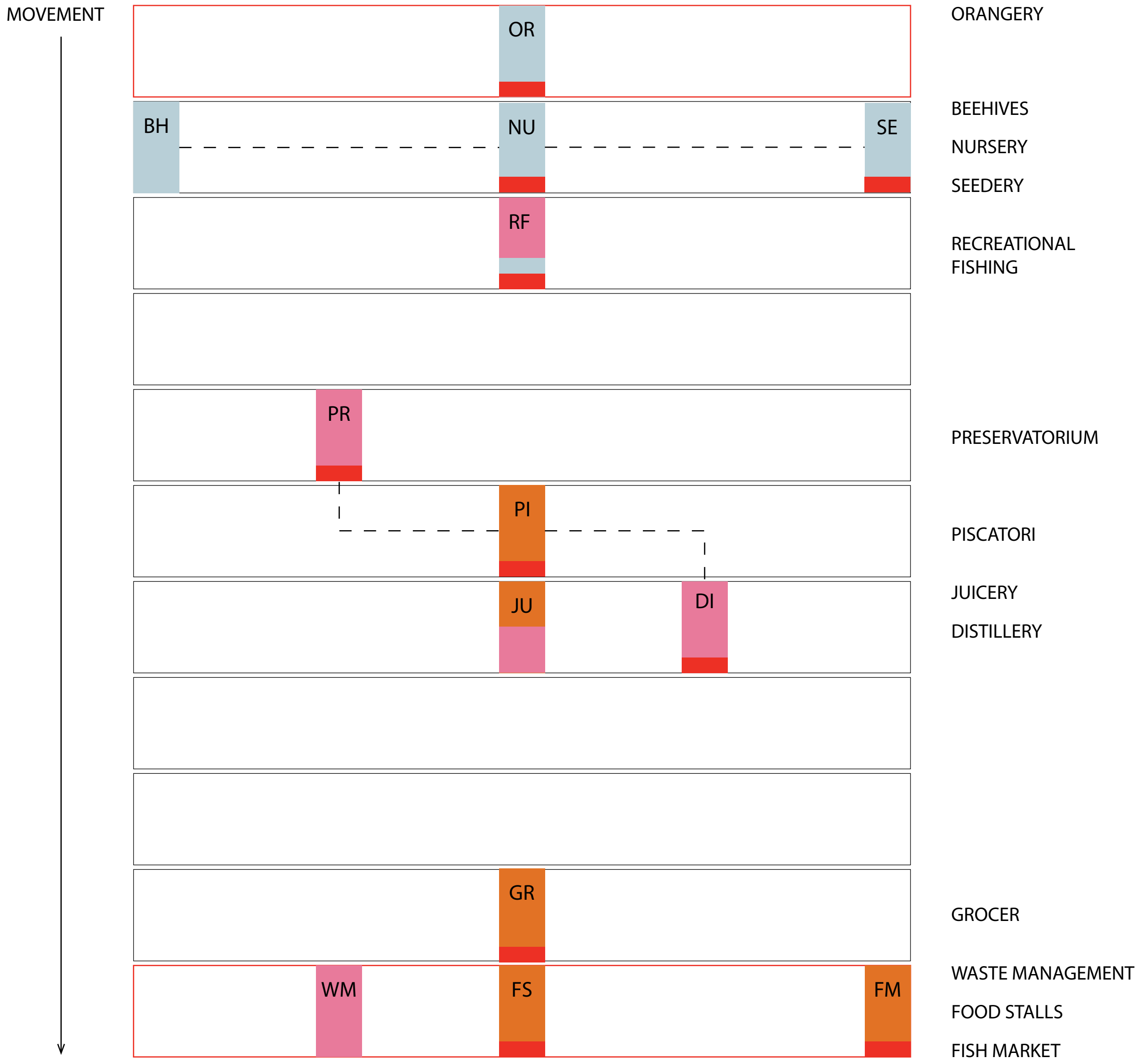


Fig 5.79. DIAGRAM ILLUSTRATING THE VARIETY OF PROGRAMS

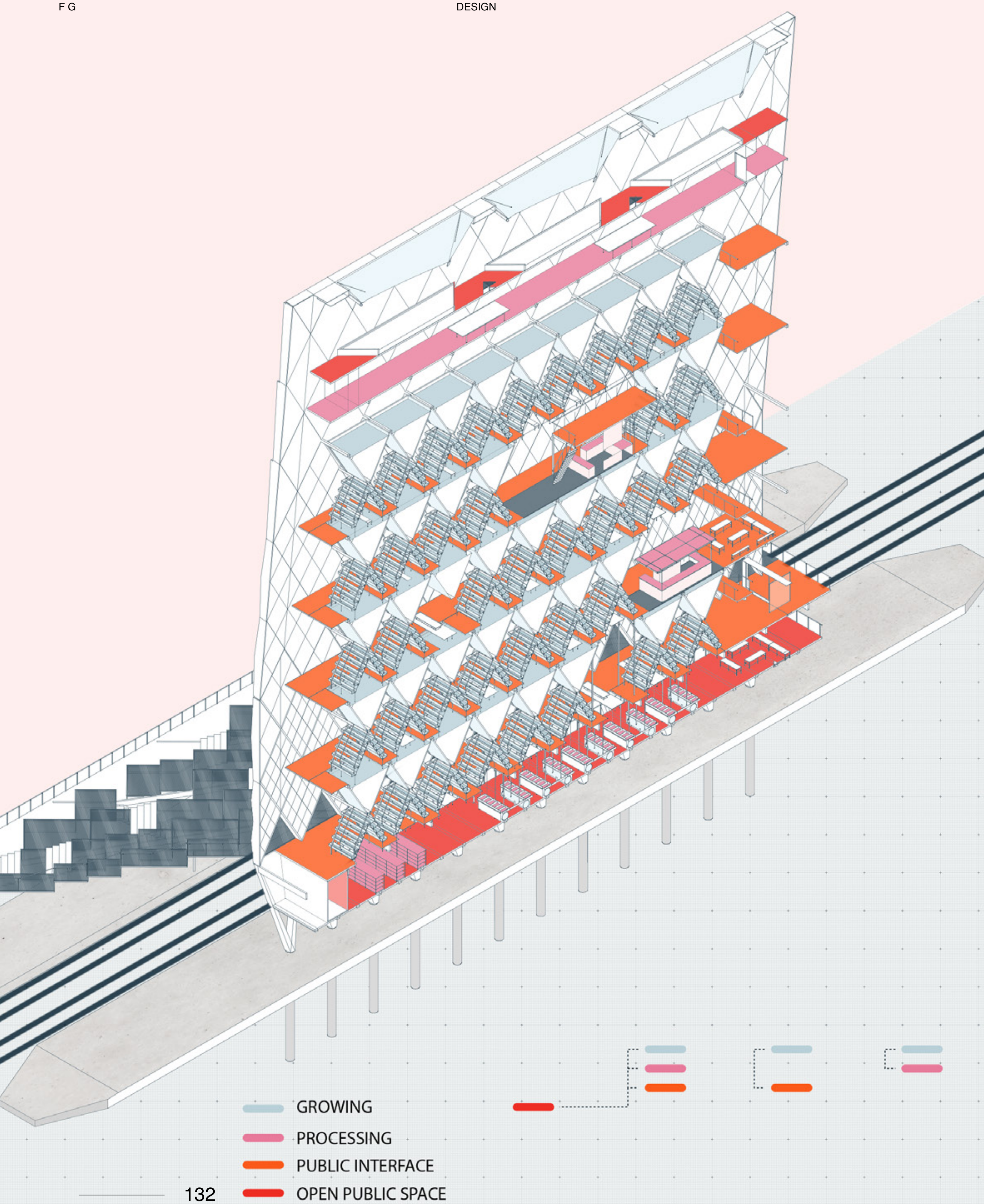

GROWING
PROCESSING
PUBLIC INTERFACE
OPEN PUBLIC SPACE

Fig 5.80. PROGRAM ISO

PROGRAM

The journey through the design begins by taking the lift to the top of the structure, which houses the orangery, this is the point at which you enter into the production system. An orangery was used to highlight the ability of the structure to support a range of plant life and its needs. Orange trees typically need warm climates in order to grow and fruit. The orangery symbolises a transition from the external to the internal, highlighting the buildings function as an active ecosystem. The public space seeks to draw people into the system, providing them with a starting point from which they navigate down through the rest of the structure.

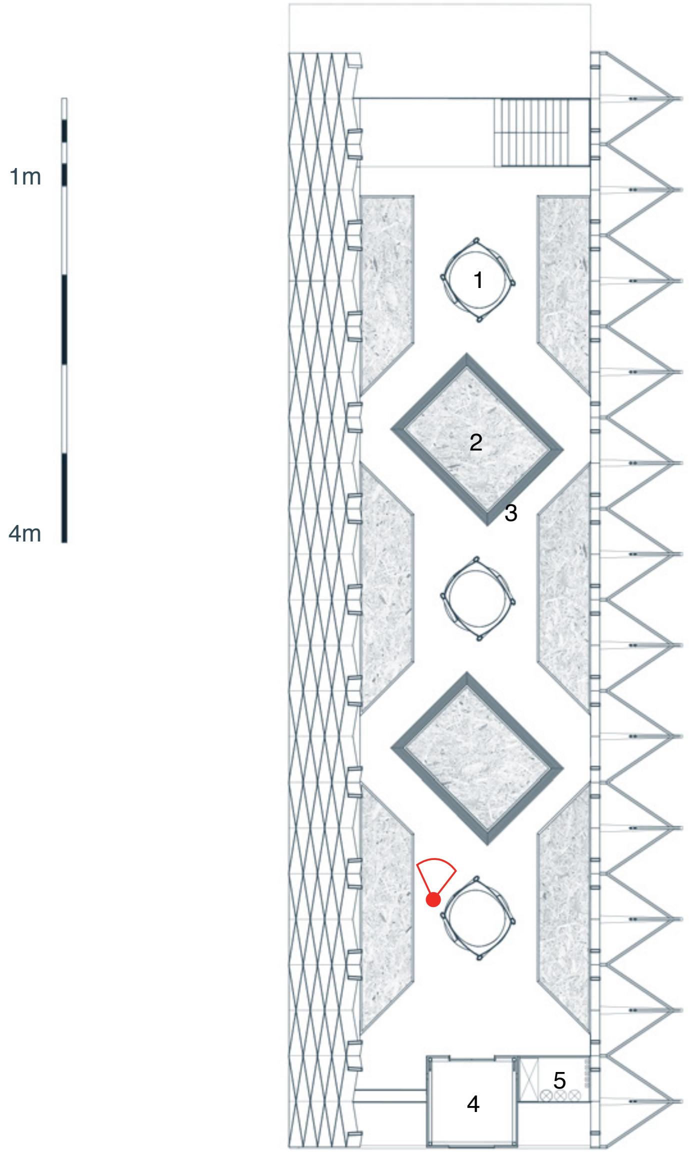
The program is laid out as a lineal journey connecting the various programs of the structure together into a navigable dialogue. The purpose of this dialogue is to emphasise the connection between the production, processing and consumption that occurs within the system. By exposing these systems, the building seeks to engage and educate those that inhabit it through passive observance. This dialogue is supported by the transparency of the building structure; it is designed to visually interconnect the various programs, offering glimpses of each space from points throughout the building. This is to encourage the inhabitants to explore the entirety of the building program.

The logical sequence of the program is based on the internal environmental conditions. The stack effect of the vertical structure creates different temperature zones that support different plants and programs. The processing and habitable areas are situated in the middle and lower portions of the building to allow occupants to dwell in a more temperate environment. Their position with in these zones is linked to the produce that is grown around them and what they require.

The growing systems act as a living breathing market place. As the occupant traverses through the system they are able to pick and choose produce straight from the plant, only picking that which is ripe and ready to consume. The produce is purchased along with any other products at the grocery store on the ground floor. This system eliminates waste as only what is ready to be consumed is picked and purchased. Anything that becomes over ripe is processed on site into value added products, or fish food to feed back into the aquaponic system.

THE ORANGERY IS THE ENTRY POINT FOR THE REST OF THE SYSTEM. IT ILLUSTRATES THE ABILITY FOR THE SYSTEM TO ACCOMODATE DIFFERENT ENVIRONMENTS

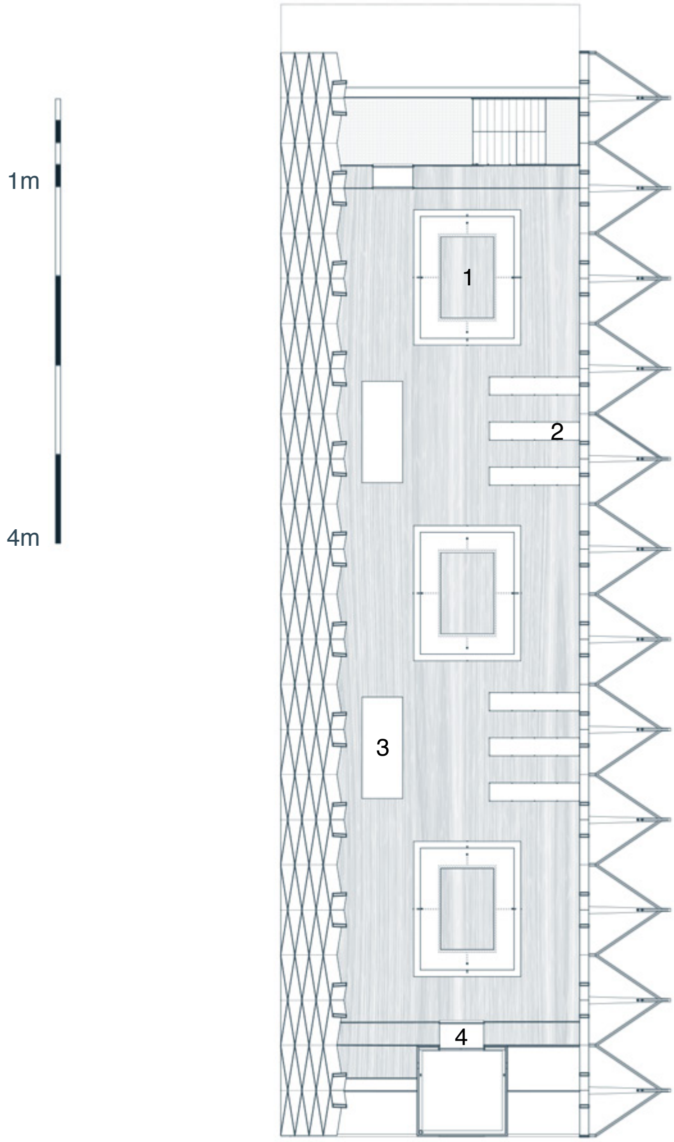
Fig 5.81. INSIDE THE ORANGERY



1 - WATER CATCHMENT
2 - PLANTERS
3 - SEATING
4 - LIFT SHAFT
5 - SERVICE SHAFT

ORANGERY PLAN

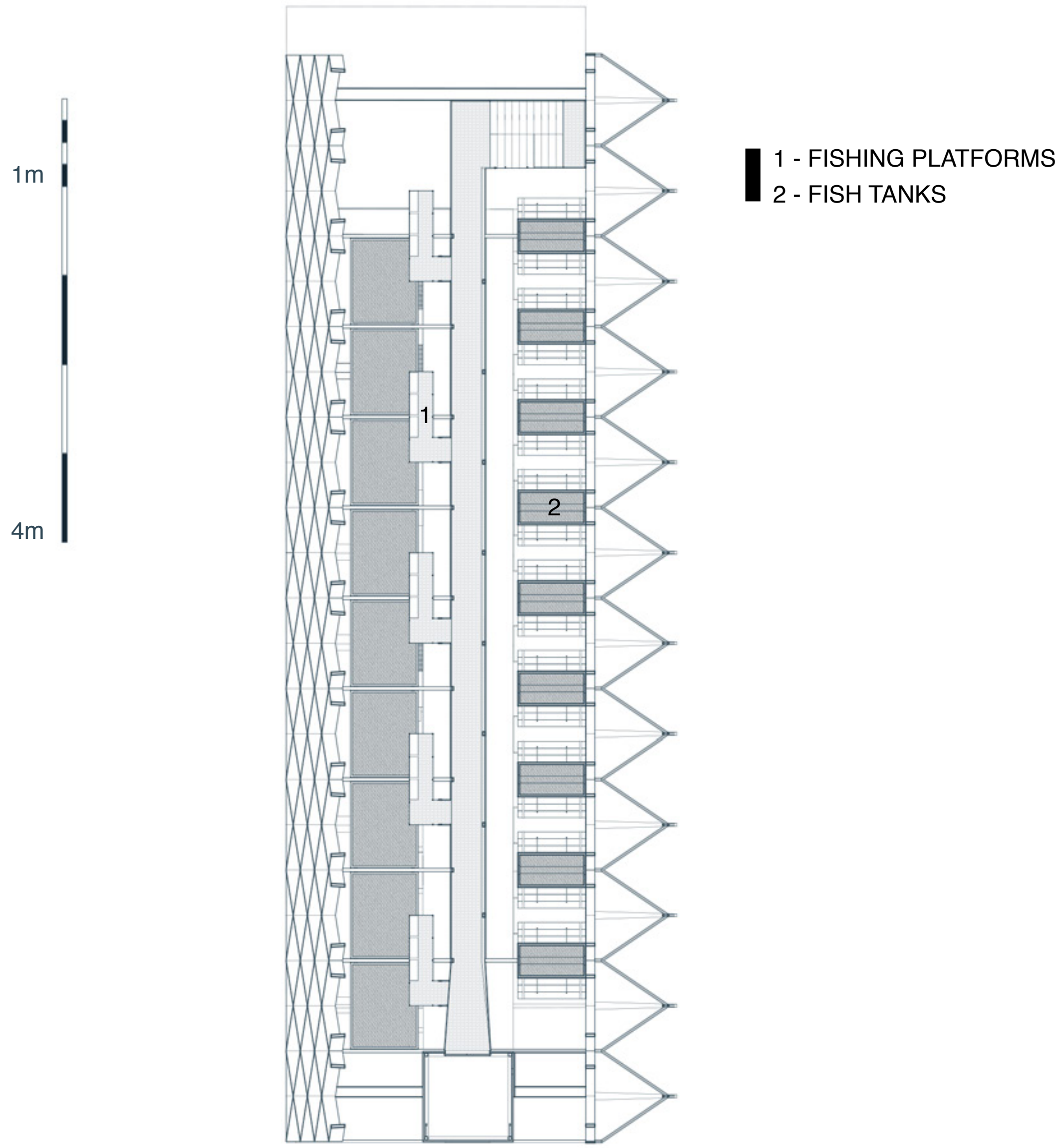
Fig 5.82. ORANGERY PLAN



1 - GERMINATION RACK
2 - SEED COOLERS
3 - SOWING TABLES
4 - AIRLOCK DOOR

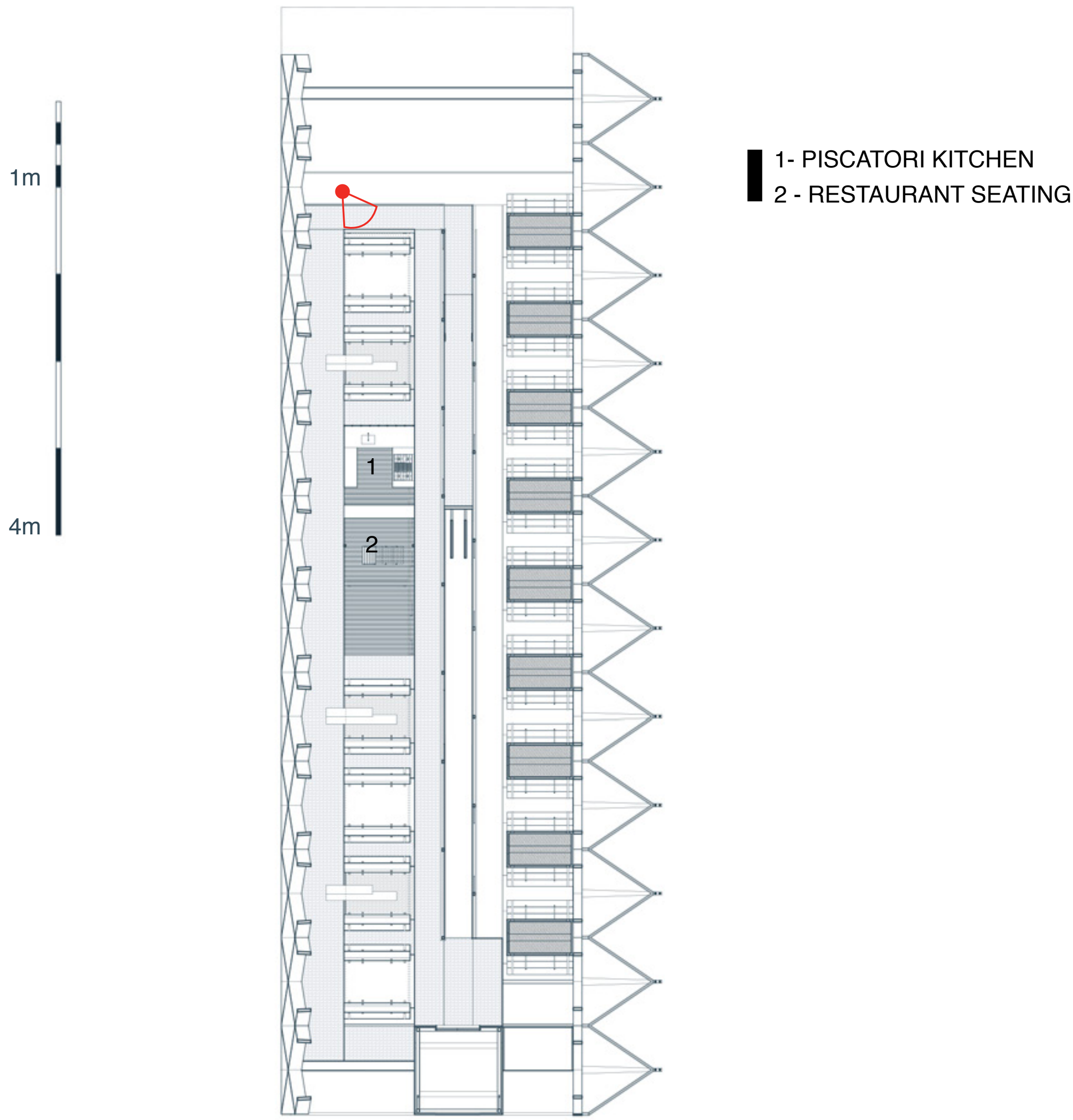
NURSERY/SEEDERY PLAN

Fig 5.83. NURSERY PLAN



FISHING PLAN

Fig 5.84. FISHING PLAN

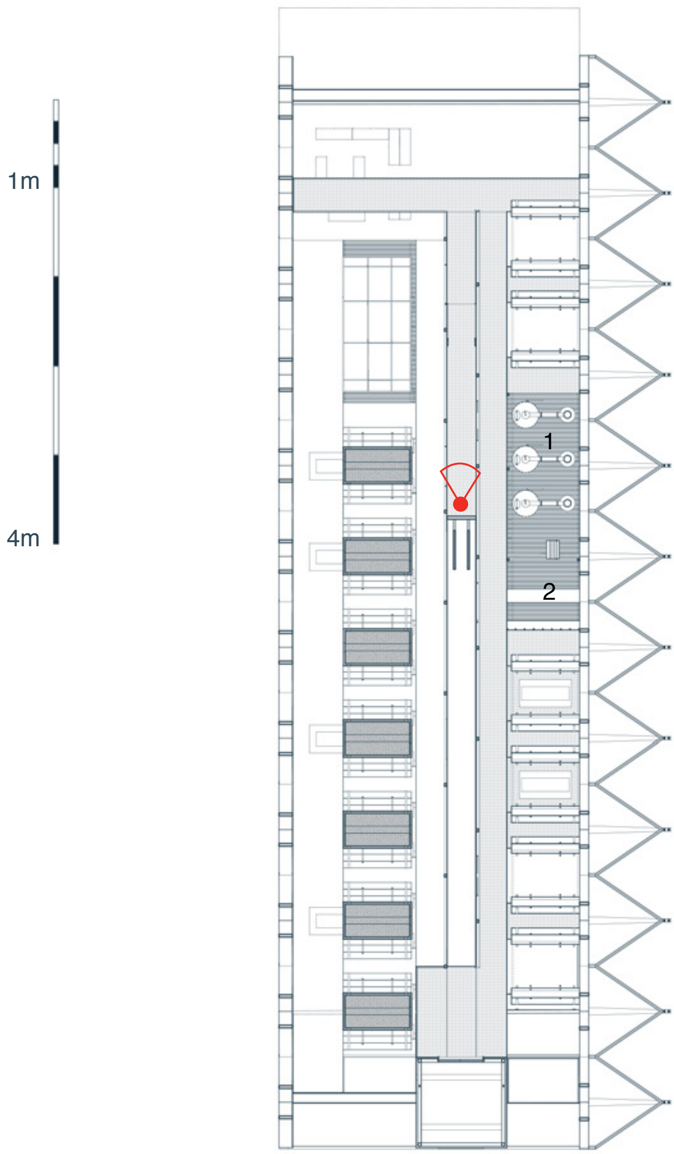


PISCATORI PLAN

Fig 5.85. PISCATORI PLAN

Fig 5.86. VIEW OF THE GROWING SYSTEMS

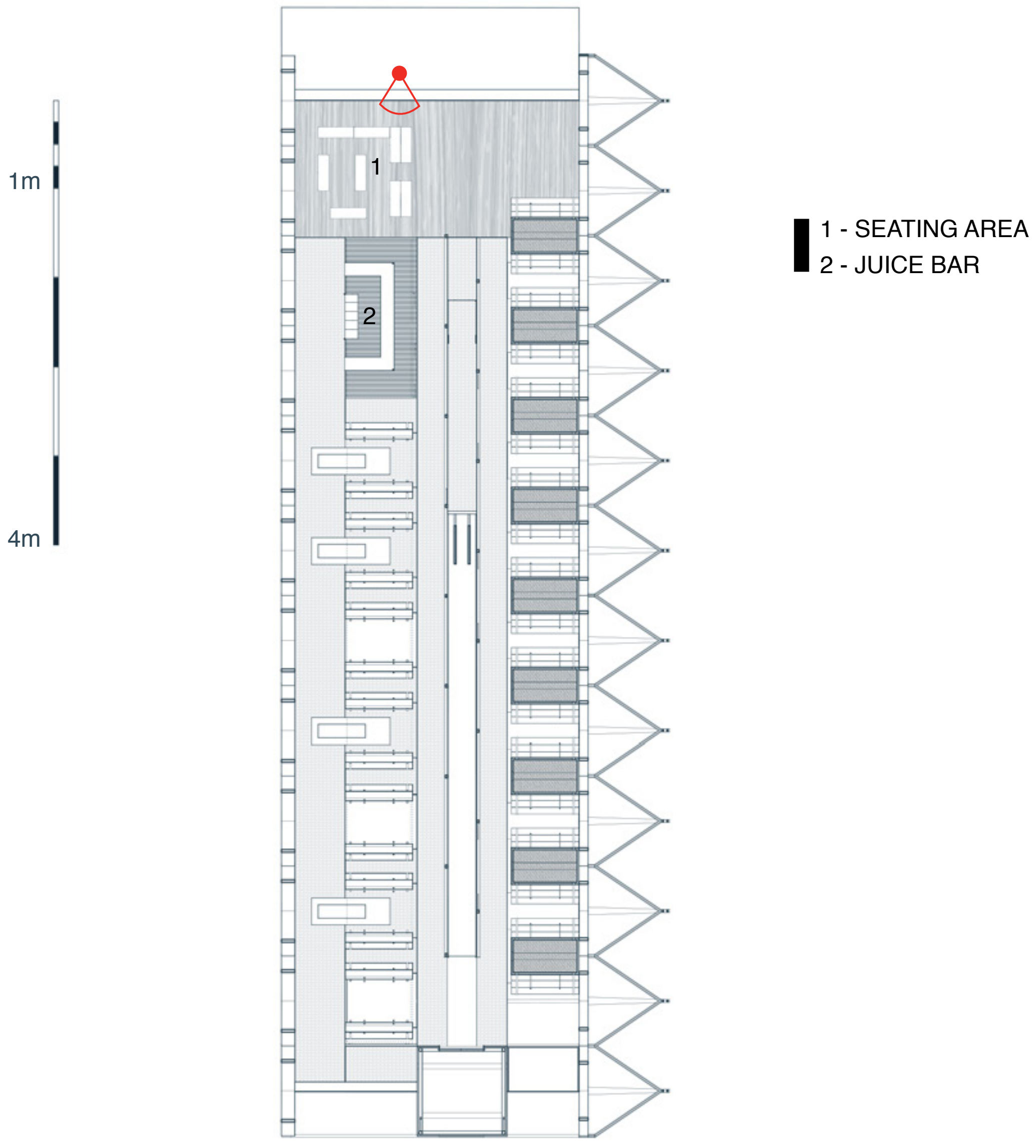
Fig 5.87. VIEW WALKING PAST
THE DISTILLERY



1 - DISTILLING TANKS
2 - DISTILLERY BAR

DISTILLERY PLAN

Fig 5.88. DISTILLERY PLAN



JUICERY PLAN

Fig 5.89. JUICERY PLAN

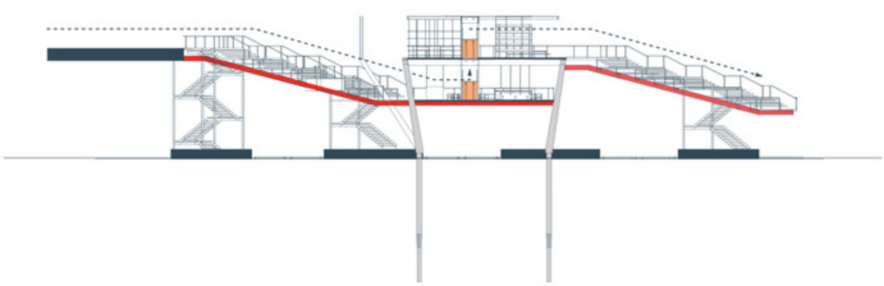
Fig 5.90. VIEW OF THE JUICERY

INTEGRATION / ACTIVATION

The tiered platforms that form the open community space that surrounds the base of the building activates the existing infrastructure that it attaches to. The previously underutilised causeway is integrated into the design, becoming an extension of the public space. The activation of the public space and causeway is aided through the food stalls and fish markets on the lower levels of the structure. These programs act as a hub of activity that invites people in throughout the day and night.

Its position as an additional route along the causeway also helps to draw activity through the space as people move from the train stations and carparks to their places of work, they are able to pass through the structure to eat, drink or purchase goods. Foot traffic that previously passed directly through the site now have the choice to interact and engage with the site and its programs.

DIAGRAM SHOWING HOW THE OPEN AIR PLATFORMS ENGAGE THE BUILDING WITH THE SURROUNDING CONTEXT.



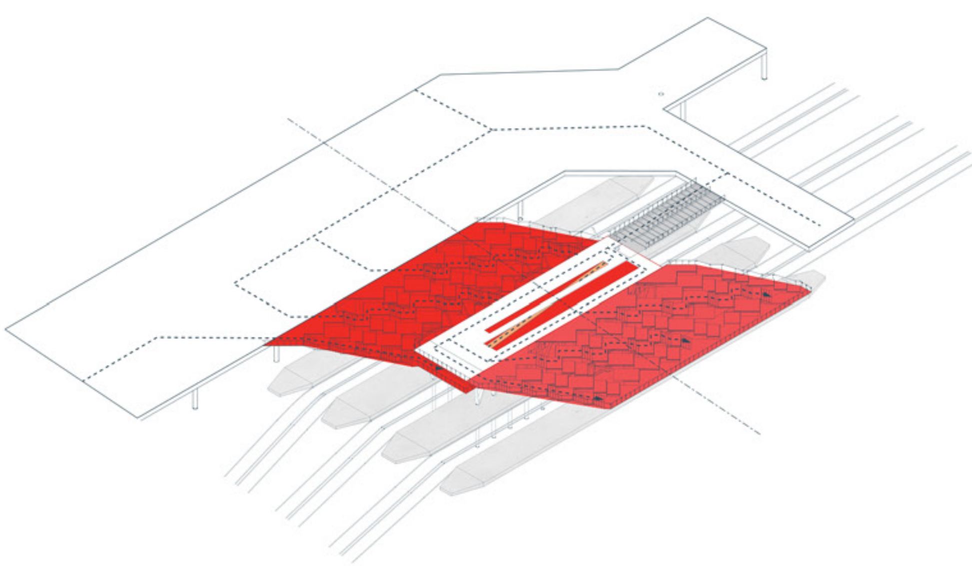
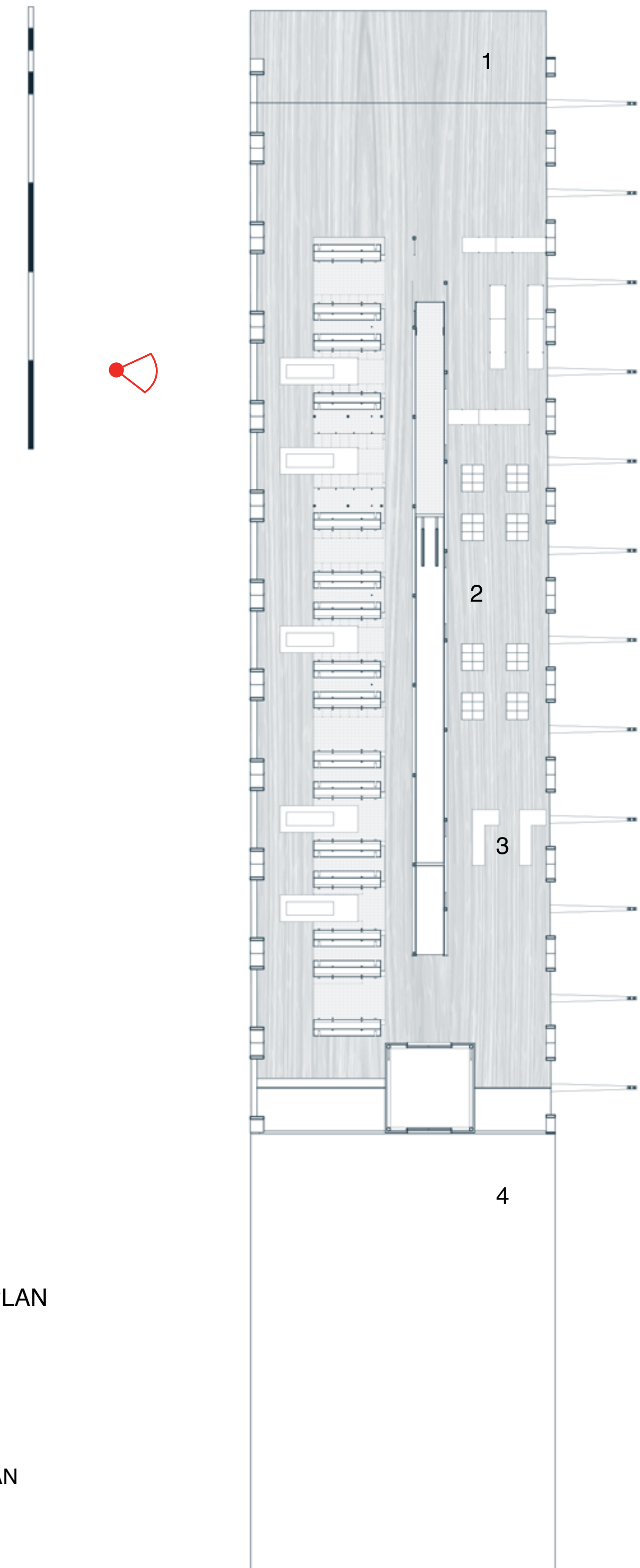


Fig 5.91. INTEGRATION SECTION AND ISOMETRIC DIAGRAM



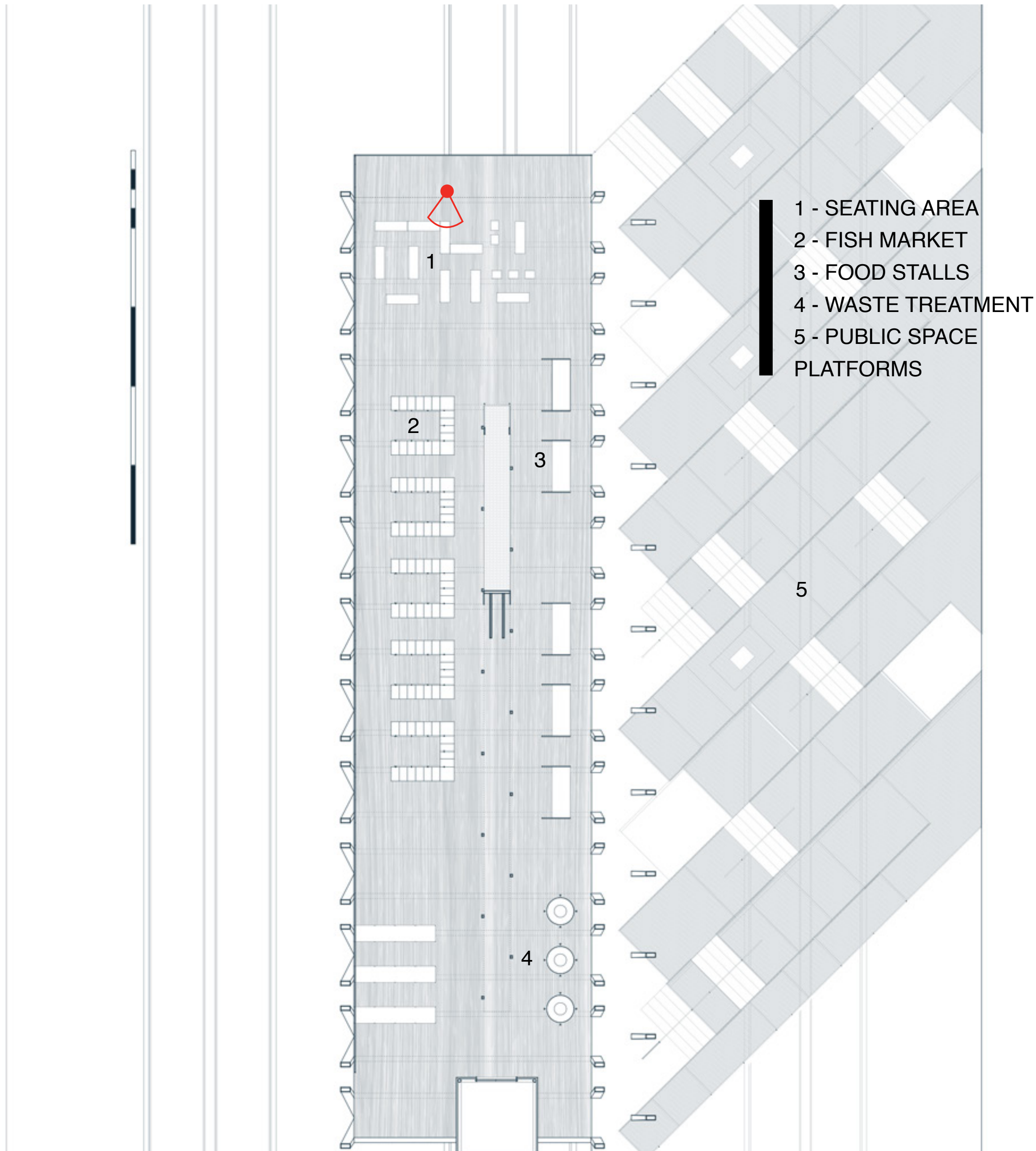
1 - VERANDAH
2 - GROCER
3 - CHECKOUT
4 - ACCESS RAMP

GROCERY PLAN

Fig 5.92. GROCERY PLAN

Fig 5.93. VIEW FROM EXTERNAL PLATFORMS

Fig 5.94. VIEW OF THE FOOD STALLS AND FISH MARKET



FOOD STALLS AND FISH MARKET

Fig 5.95. PLAN OF FOOD STALLS AND FISH MARKET

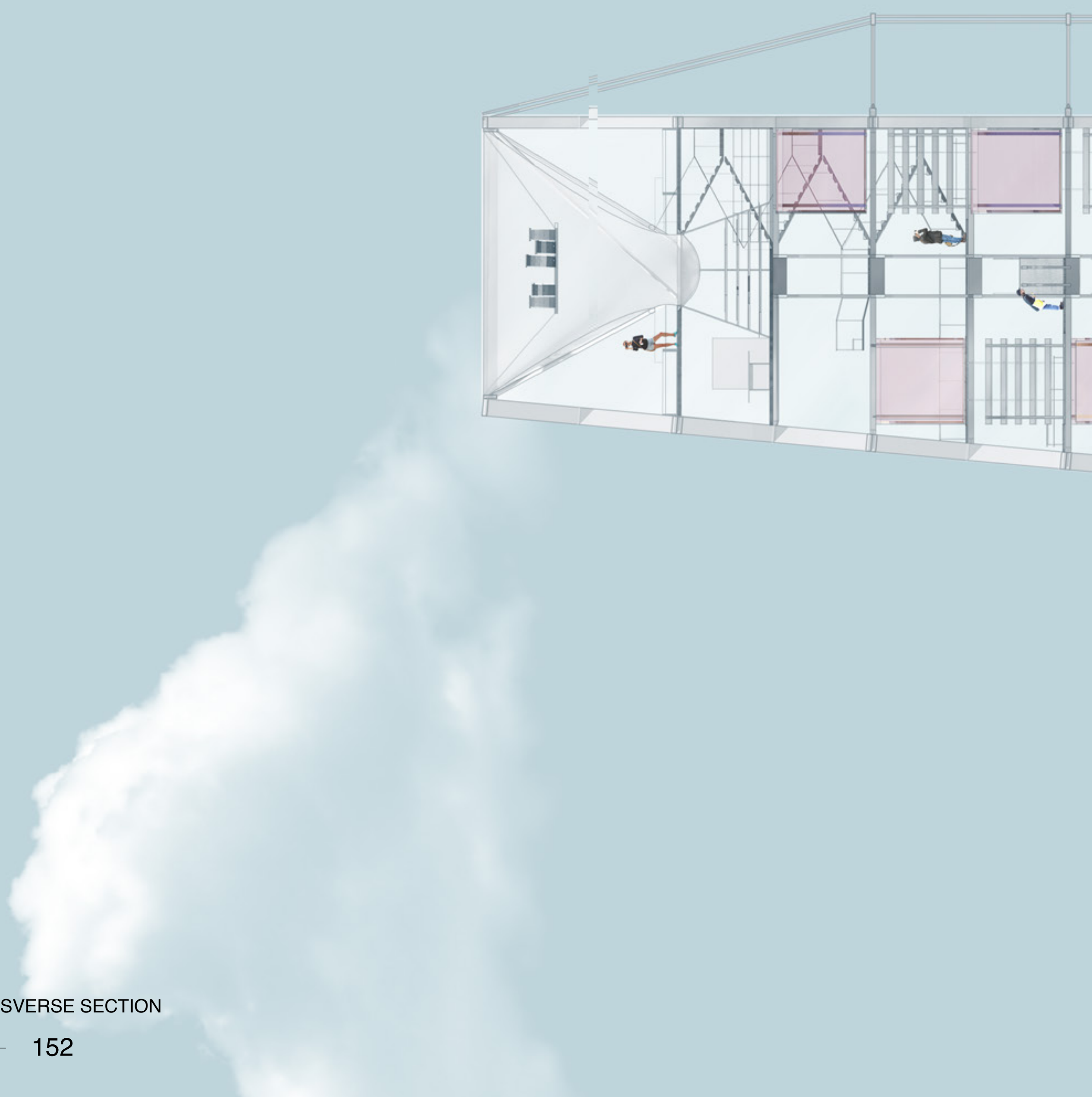
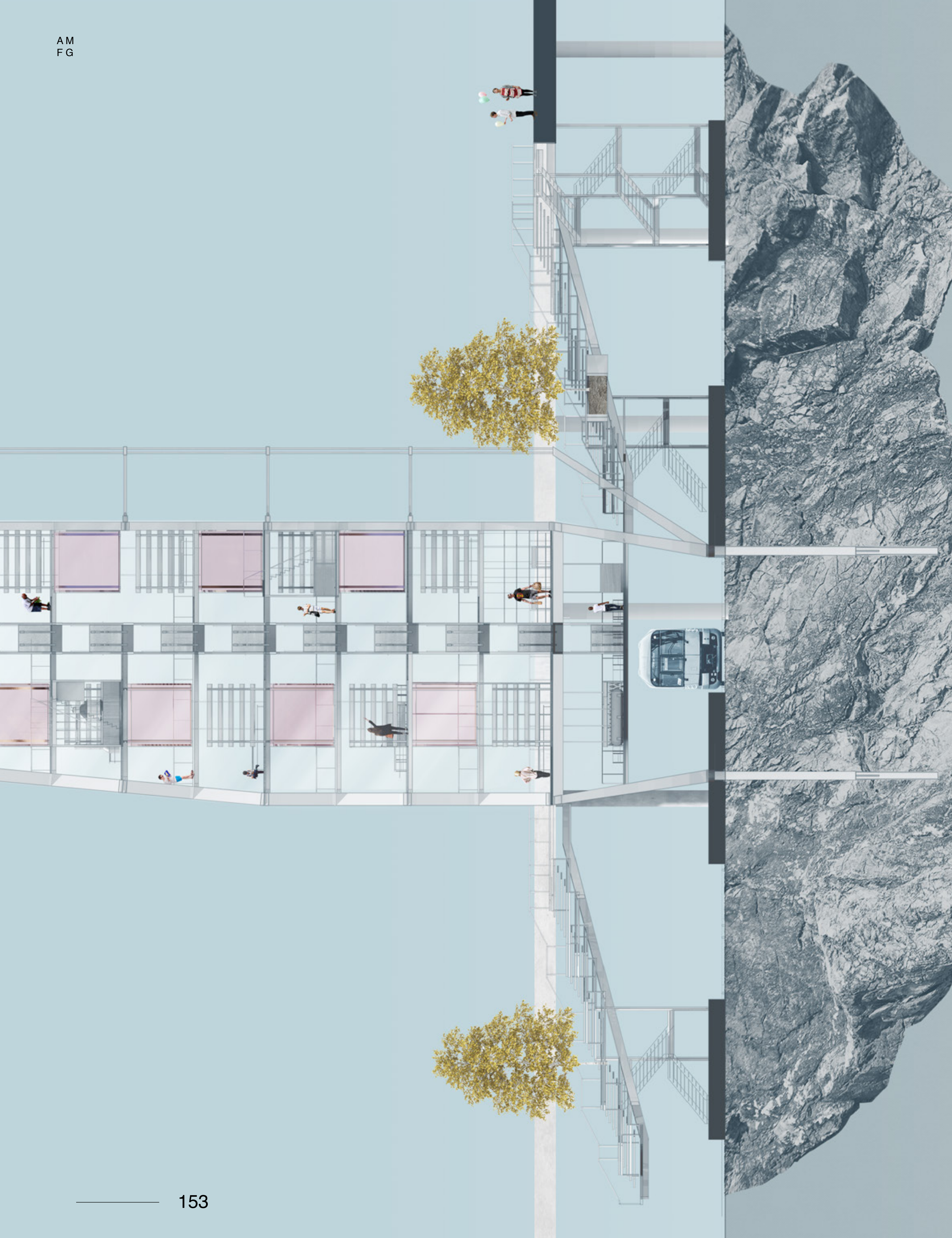


Fig 5.96. TRANSVERSE SECTION



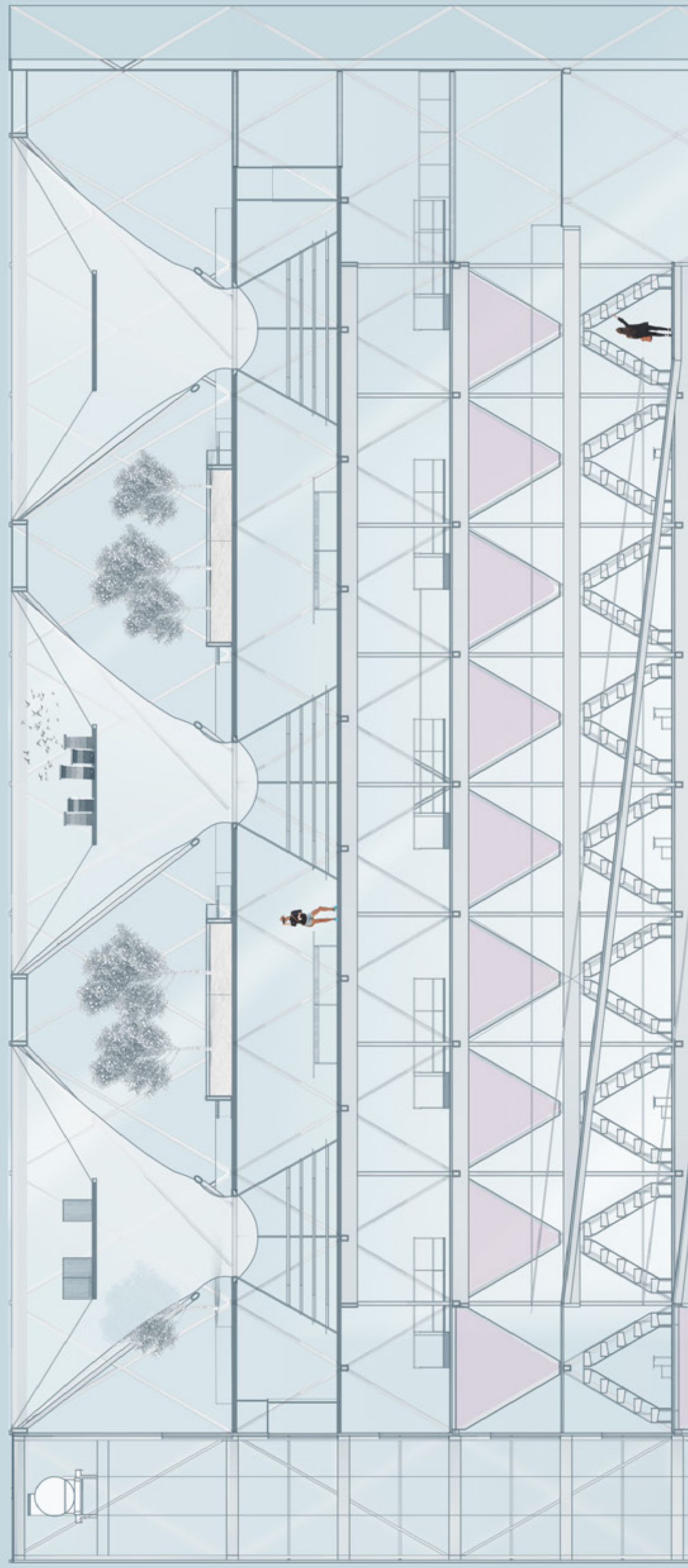
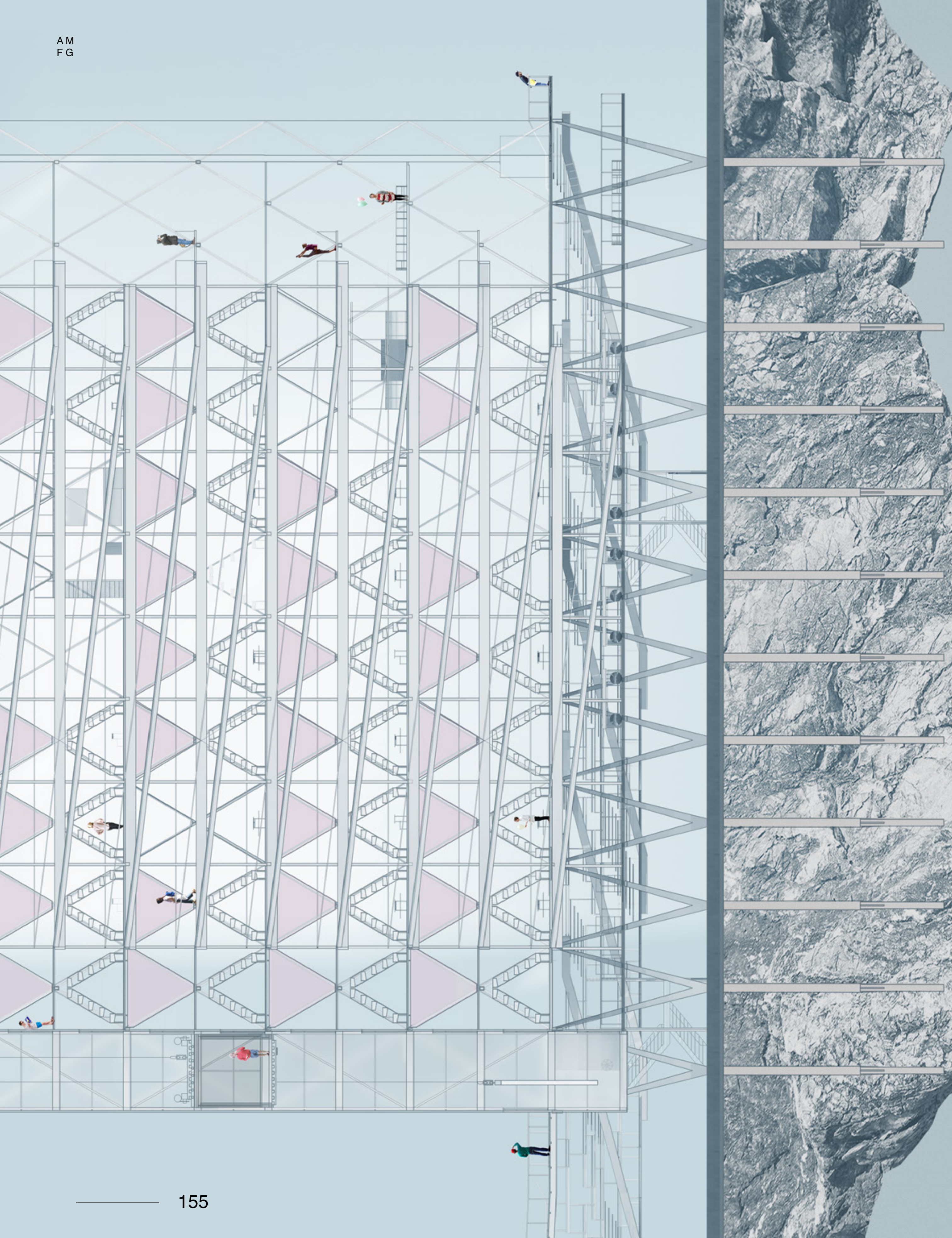


Fig 5.97. LATERAL SECTION



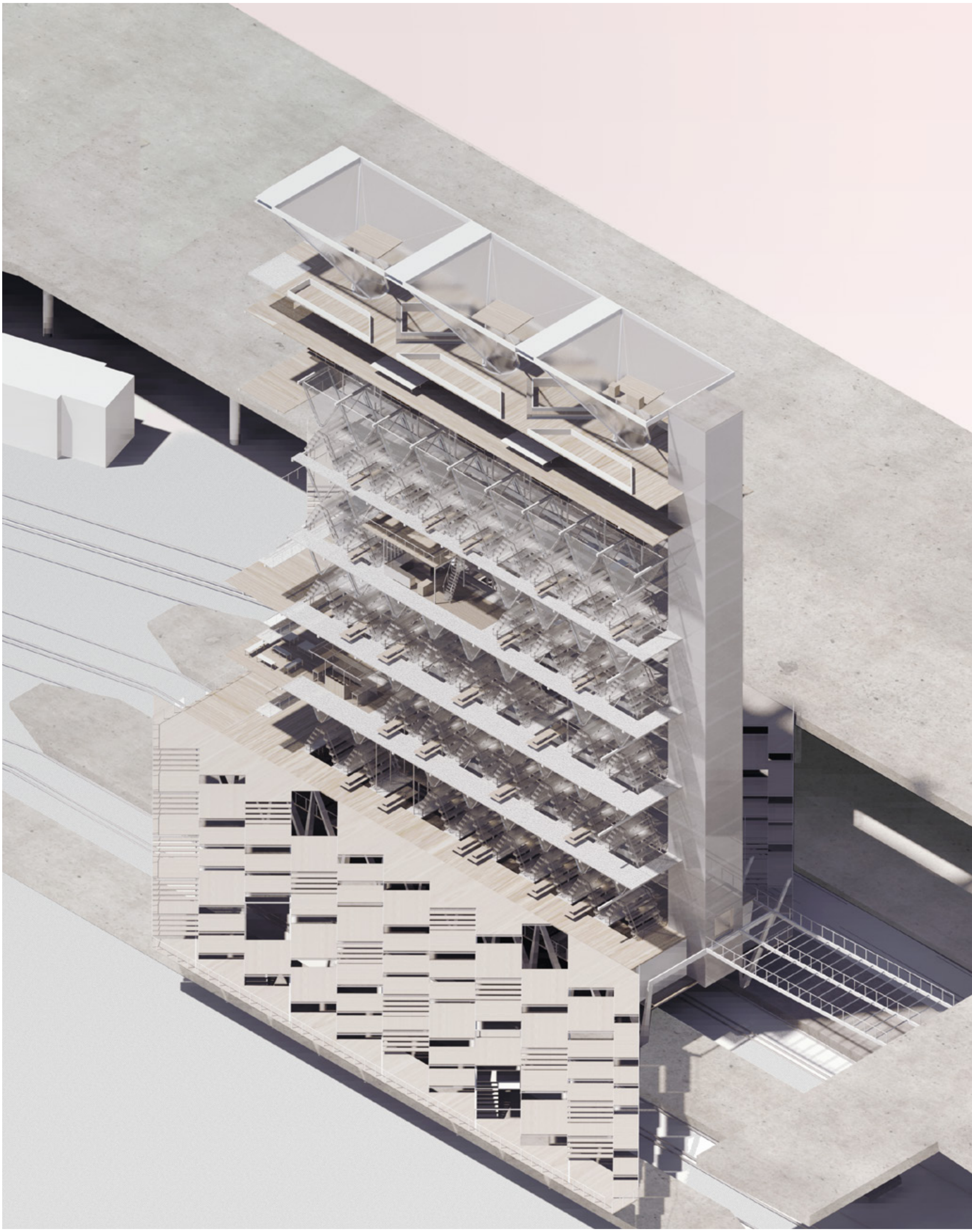


Fig 5.98. BUIDLING ISO - EAST

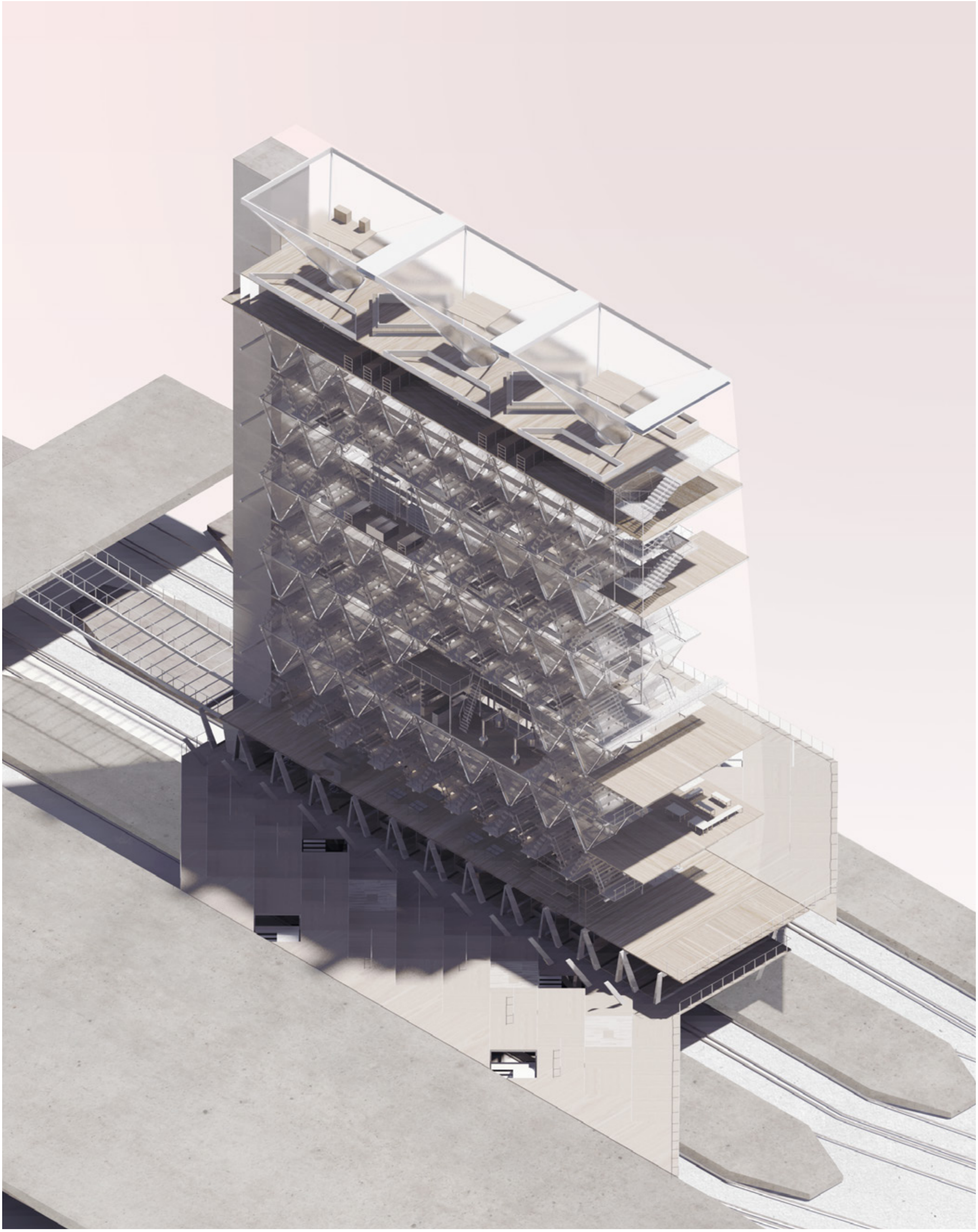


Fig 5.99. BUILDING ISO - WEST

5.6 DESIGN SUMMARY

By focusing on the objective of engagement the final design is a much more refined outcome that operates at the human scale. This scale allows it to fit more appropriately into its urban context.

The renders communicate both the external and internal qualities of the building. They provide an example of the habitable space and whimsical nature of the building that the final stage sought to explore. The refined material pallet by itself could be cold but the plants that they support soften the spaces to create a much more ambient atmosphere.

The design does not fully explore the opportunity to develop the connection with the train station. The design relies heavily on the connection with the transport network to be a successful design, but it does not explore the relationship with the platforms other than the vertical circulation.

The design could have investigated ways to support other local farmers by providing a distribution platform the consolidates many smaller operations. The opportunity to use the train line to bring produce in from areas that have less local demand could have fostered a greater sense of community input.

Fig 5.100.DESIGN FROM STREET VIEW

6. CONCLUSION

6.1 CONCLUSION

This research sought to develop an architectural framework that would enable agricultural practise to become embedded in our day to day lives by establishing itself as part of our current urban fabric. This direction of architectural exploration was conceived as a response to the research that our current industrialized framework consumes more then it produces.

The direction of the thesis was informed by selected literature reviews, these texts galvanised the idea that to create a sustainable food network would require a fundamental shift in our current system. From a large scale, monoculture, non-renewable input dependant, globalised distribution system to mosaics of sustainable, regenerative production systems that also considerably improve the productivity of small scale farmers . The aims and objectives formalised a criterion that could be referenced to determine the success of developing an architecture as a way to reconcile the current inability for cities to support productive agriculture practise.

The initial design explored ways to reimagine the current industrialized agriculture typology in order to create a new architectural identity, that could imbed into the urban fabric of Wellington. Using systems to influence the form of the design produced a pragmatic architectural response that condenses current agriculture systems into a vertically integrated structure. The design explored a mixed use program as a way of scaling the architecture. By interweaving a finer grain of program the design tested whether an intervention of this scale could become part of established urban community.

Design two further refined the concept of urban integration by developing a deployable construction system that focused on a generalised site condition. By focusing on transport infrastructure as the site context, the intervention became applicable to a broad range of urban conditions. The transparency of the intervention was used as a tool to allow the structure to fit harmoniously into its surroundings. The transparency also creates a dialect to communicate the processes within the structure.

By applying the final design intervention to a specific site in order to use the parameters to further refine how the agro-architecture framework could integrate with an existing context. It explored this idea of integration to create a public interface that enabled the occupants to engage with the growing mechanisms. This is facilitated by the buildings transparency which creates the effect of a ‘stage’ to communicate the processes that happen within the building to the outside. The final design combined the three architectural drivers, production, distribution and engagement into a refined architectural framework. Defining a set of architectural characteristics required to assist in re-localising our food production system.

The developed design documents a single intervention in a specific community, but the principle of the research is to be able to integrate these systems throughout a city, creating a local, decentralised, sustainable food production and distribution network. An intervention that contributes a tile of agricultural engagement to the much broader mosaic of urban agriculture.

6.2 BIBLIOGRAPHY

Austell, England) Eden Project (St. *Eden Project: The Guide*. Eden Project Books, 2014. Print.

Bernstein, Sylvia. *Aquaponic Gardening: A Step-By-Step Guide to Raising Vegetables and Fish Together*. Original edition. Gabriola, BC: New Society Publishers, 2011. Print.

Brain, Roslynn. *The Local Food Movement: Definitions, Benefits and Resources*. Utah State University. Web. Extension Sustainability.

Cockrall-King, Jennifer. *Food and the City: Urban Agriculture and the New Food Revolution*. Amherst, N.Y: Prometheus Books, 2012. Print.

Cox, Stan, and David Van Tassel. 'Why Planting Farms in Skyscrapers Won't Solve Our Food Problems'. *AlterNet* 2 May 2010. *AlterNet*. Web. 26 Nov. 2015.

Despommier, Dickson. 'The Vertical Essay'. *The Vertical Farm*. N.p., n.d. Web. 3 Mar. 2016.

Emmott, Stephen. Ten Billion. N.p. Film.

Hasegawa, Yuko. *Kazuyo Sejima + Ryue Nishizawa: SANAA*. First Edition edition. Milan; London: Phaidon Press, 2006. Print.

Holmgren, David. *Permaculture Principles & Pathways Beyond Sustainability*. 2nd edition. East Meon: Permanent Publications, 2011. Print.

Holmgren, David, and Bill Mollison. *Permaculture One: A Perennial Agriculture for Human Settlements*. Stanley, Tas.: International Tree Crop Institute USA, 1981. Print.

Ishii-Eiteman, Marcia. *Feeding the World, Greening the Planet*. IAASTD. Web. 24 Mar. 2016. IAASTD Fact Sheet.

Kaushik. 'The Greenhouses of Almeria | Amusing Planet'. N.p., n.d. Web. 29 Feb. 2016.

Mcintyre, Beverly et al. *Agriculture at a Crossroads - Synthesis Report*. IAASTD. Web.

‘MVRDV - MARKET HALL’. N.p., n.d. Web. 20 Mar. 2016.

‘Pasona Urban Farm by Kono Designs’. *Dezeen*. N.p., 12 Sept. 2013. Web. 13 Mar. 2016.

Pfeiffer, Dale Allen. *Eating Fossil Fuels: Oil, Food and the Coming Crisis in Agriculture*. Gabriola Island, BC: New Society Publishers, 2006. Print.

Pollan, Michael. *In Defense of Food: An Eater’s Manifesto*. 1 edition. New York: Penguin Books, 2009. Print.

Ruby, Ilka, and Andreas Ruby. *Re-Inventing Construction*. Berlin: Ruby Press, 2010. Print.

Smit, Tim. *EDEN Anniversary Edition*. The 10th Anniversary revised and updated edition edition. London: Eden Project Books, 2011. Print.

Sobek, Werner. ‘Architecture Isn’t Here to Stay’. *Re-Inventing Construction*. Ruby Press. Print.

Sorkin, Michael. ‘Big Apple, Homegrown’. *Re-Inventing Construction*. Berlin: Ruby Press. 275–285. Print.

Stang, Alanna, and Christopher Hawthorne. *The Green House: New Directions in Sustainable Architecture*. Princeton Architectural Press, 2005. Print.

Tsao, Jeff, Nate Lewis, and George Crabtree. ‘Solar FAQ’s’. Web. 2 Apr. 2015.

Wake Up Before It Is Too Late. United Nations. Print. United Nations Conference on Trade and Development.

‘Water: The Ideal Thermal Mass | BDMDialog’. N.p., n.d. Web. 21 Mar. 2016.

Weber, Max. ‘Max Weber, The Protestant Ethic and the Spirit of Capitalism’. N.p., n.d. Web. 1 Apr. 2016.

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6.3 FIGURE REFERENCES

All figures not included on this list are the authors own images. 2015 - 2016

Figure 01 - 12 December 2015. Web. http://dailyoverview.tumblr.com/

Figure 03 - 12 December 2015. Web. http://dailyoverview.tumblr.com/

Figure 04 - 12 December 2015. Web. http://dailyoverview.tumblr.com/

Figure 05 - Ellingsen, Glenn, 21 January 2016. Web. http://www.hkfarm.org/JPEGs/2.%20Home/News_Events/HK_Farm-Yau_Ma_Tei-Photograph_by_Glenn_Eugen_Ellingsen.jpg

Figure 08 - Just, Wolf, 18 February 2016.

Figure 09 - Halbe, Roland, 4 March 2015. Web. http://www.wernersobek.de/projekte/material-de/glas/r128/

Figure 10 - Keiretsu, Steve, 20 August 2015. Web. https://en.wikipedia.org/wiki/Eden_Project#/media/File:Eden_project_tropical_biome.jpg

Figure 11 - 21 April 2015. Web. http://aquaponicsalive.blogspot.co.nz/2013/04/pros-and-cons-of-different-system-types.html

Figure 15 - Ciencia, Shubert, 22 April 2015. Web. https://www.flickr.com/photos/bigberto/4753876993

Figure 24 - 12 December 2015. Web. http://dailyoverview.tumblr.com/

Figure 25 - 09 Febraury 2016. Web. http://www.mvrdv.nl/en/projects/markethall

Figure 27 - August 2016. Web. http://theweekendedition.com.au/food-drink/food-from-the-sky/

Figure 29 - Just, Wolf, 18 February 2016.

Figure 45 - Hasegawa, Yuko, 23 July 2015. Print. Kazuyo Sejima and Ryue Nishizawa, SANAA

Figure 46 - 22 August 2015. Web. http://justsomething.co/camper-looks-normal-until-its-converted/

Figure 52 - Febraury 2016. Web. http://architizer.com/projects/vejlskovgaard-an-agricultural-building-of-the-future/

Figure 53 - Febraury 2016. Web. http://www.archdaily.com/428868/in-tokyo-a-vertical-farm-inside-and-out