EMBODIED RELEVANCE

Exploring the potential of existing concrete frame structures:
The case of the Christiaan Barnard Hospital

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This dissertation is presented as part fulfilment of the degree of Master of Architecture (Professional) in the School of Architecture, Planning and Geomatics, University of Cape Town

The financial assistance of the National Research Foundation (DAAD-NRF) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at are those of the author and are not necessarily to be attributed to the DAAD-NRF.

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ACKNOWLEDGEMENTS

I would like to express my great appreciation to everyone who has supported me through my final year of the postgraduate degree.

Firstly, I would like to say thank you to the National Research Foundation (DAAD-NRF) for their financial support.

Secondly, I am grateful to the MArch (Prof) lecturers Nic Coetzer, Melinda Silverman and Matteo Fraschini and particularly Kevin Fellingham, my studio supervisor, for their words of wisdom and inspiration, constructive criticism and guidance throughout the year.

I would also like to show my appreciation to the other members of staff within the faculty at UCT that have mentored me and guided me during my academic journey.

In addition I would like to thank the following parties for their assistance:

- the Christiaan Barnard Hospital and its staff for their time, numerous site tours, generous assistance and help in the collection of data.
- the practitioners Paul Carew and Georgina Campbell from *PJCarew Consultants*, Henry Fagan from *Henry Fagan and Partners*, Gavin Golden from *SMEC Engineering*, Herman Mynhardt from *Sigma QS* and Henning Rasmuss from *Paragon Architects* for their invaluable advice.

Lastly, my special thanks are extended to my family and friends for their continuous moral support, love and encouragement throughout.

ABSTRACT

Our cities to a great part consist of a large amount of already built fabric and this dissertation shall address this as an area of concern, encouraging the transformation of existing buildings, rather than building anew. Furthermore, the dissertation focuses on the universal issue of 1960's concrete frame buildings and investigates the potential for their continued re-use rather than demolition. This falls within the current discourse around the negative impact of the built environment and its contribution to climate change, and forms the backbone of the intended research.

While progress has been made towards achieving urban sustainability in practical and conceptual terms, cities are still unsustainable. Buildings have a large negative impact on the environment in terms of the natural resources and energy that they consume, as well as the CO2 emitted throughout their lifespan. For environmental, architectural and economic reasons this dissertation investigates the applicability and process for the transformation and/or rehabilitation of existing buildings - to retain the existing embodied energy, while also focusing on adapting buildings to become more energy efficient.

It is difficult to develop a fixed set of rules for retrofitting or rehabilitating existing buildings as they are all unique by definition. However, the general idea of retaining the embodied energy and actively engaging with the existing should be apparent throughout, encouraging environmental consciousness and bringing new life and purpose to the building. In the case of the Christiaan Barnard Hospital, this was done through retaining the bulk of the existing concrete frame (86%), while enhancing the internal quality of the building through the incorporation of light wells and various cuts and punctures throughout. While increasing occupancy wellbeing, this also allows for a comfortable interior climate through passive means and will improve the energy efficiency of the building, which is coupled with the energy savings from retaining the concrete frame. Additionally, a lightweight modular steel frame structure with movable mesh screens was incorporated into the building's façade to provide a fresh new look and allow for an interplay between the old and the new, while providing natural light, ventilation and shading. The functional changes in the building also allow for the reintegration of the building into the Cape Town CBD as a building that will now contribute to its surroundings. Thus, the design explores and strives to serve as a precedent for a methodology for sustainable building refurbishment.

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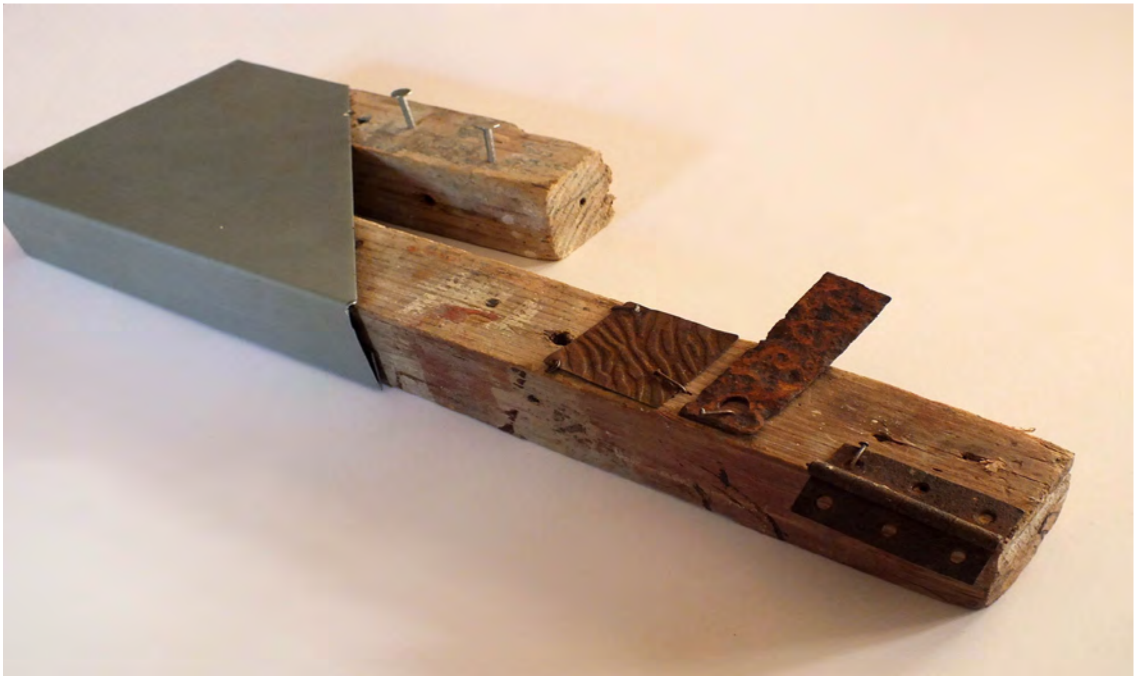
REPORT STRUCTURE

The report documents the dissertation in three parts – from the theoretical underpinnings, to the city scale and the resultant architectural application of a set of ideas.

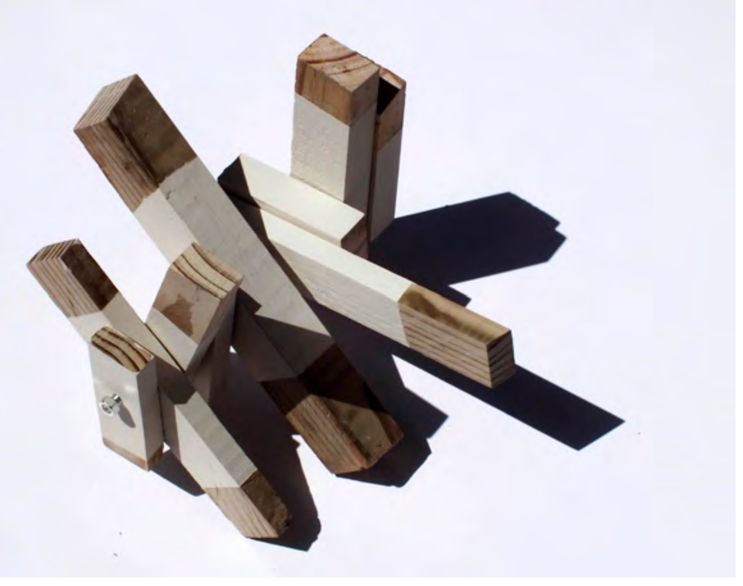
Part 1 deals with the broad theoretical and research area of the dissertation, namely the negative environmental effect of the current building sector. The potential for sustainable building refurbishment is investigated, which aims to recapture the embodied energy of a building, as well as improve the energy performance of existing structures, lessening their negative environmental impact.

Part 2 introduces and investigates the retrofitting of existing buildings, specifically existing concrete frame structures. This is an area of concern in relation to the current changing nature of the Cape Town inner city.

Part 3 explores strategies for the specific site – the current Christiaan Barnard Hospital – evolving an architectural response that aims to introduce new life and value to the building. Through the engagement with the site, the specific pragmatics and challenges of the existing, as well as the application of a set of ideas, the building begins to change from what it was to what it could be.

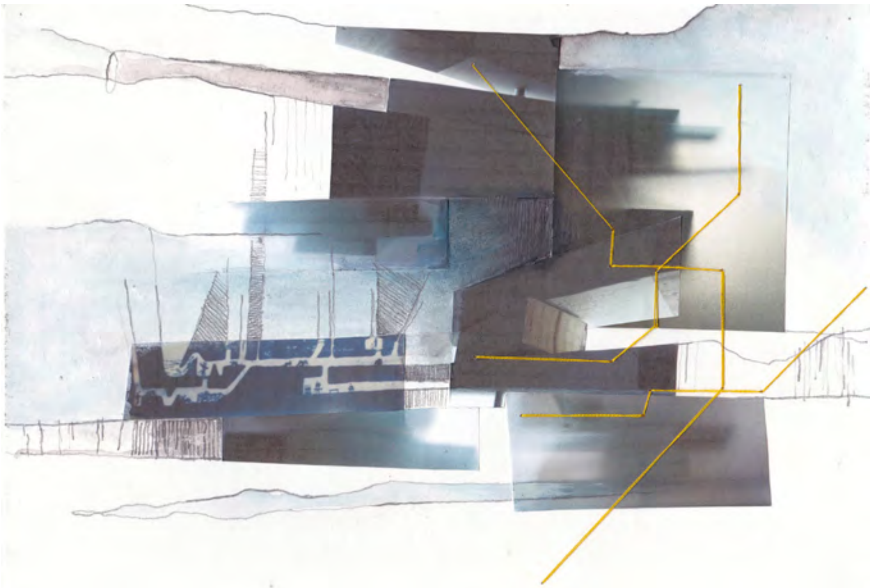


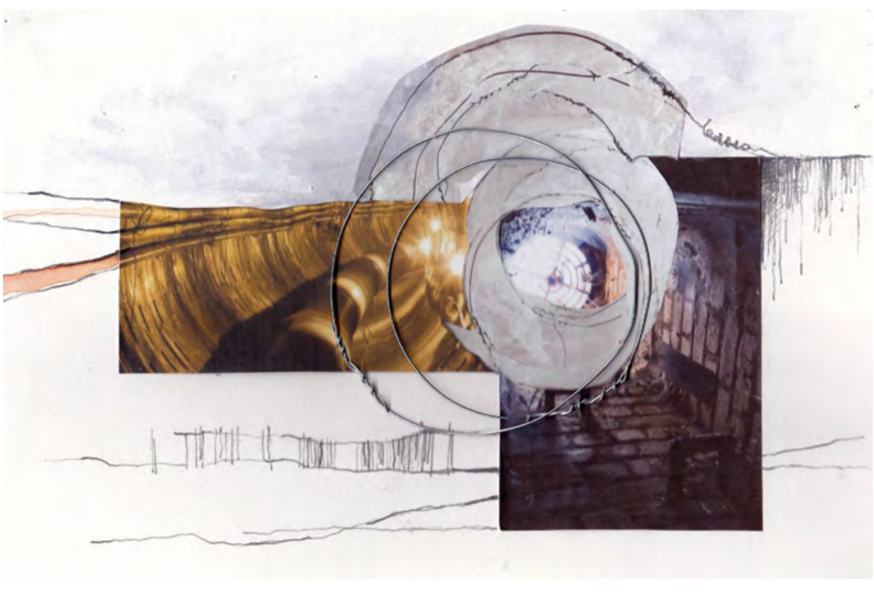
This artefact, created at the beginning of the year, explores the broad ideas of restorative re-use and the re-purposing of a structure. The tectonic intersection between old and new is addressed – recognising the richness and value of the old, as well as the excitement of the new.



For the second task, an artefact was created in response to the word opposite – resulting in a light, loose, flexible and whimsical object rather than the static, jagged and durable and sturdy initial artefact.

In the third artefact the same initial pieces of wood were deconstructed and reconstructed in an opposite approach of how to work with the 'existing'.

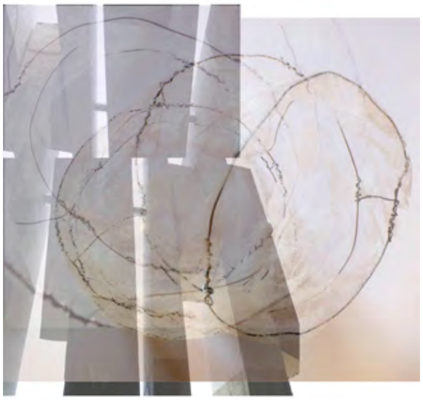




The collages, created in response to the given word “tunneling”, explored ideas relating to archaeology and the excavation of hidden layers.

The produced images represent a modern interpretation of Borromini's design process, which can be linked back to ideas of excavating and carving a building out of a solid. The detailed assembly and use of tectonic is then ultimately the result of the created space.

The explorations lay the path for the broader theme of the dissertation inquiry.



INTRODUCTION

The dissertation emerged from an interest in working with the existing built fabric of the city. This interest is linked to a set of real world issues currently faced within the building industry, affecting the way in which to approach working with the context of the existing built fabric. These include the current negative environmental effect of the building industry contributing largely to climate change, in both the construction and operational phase of a building. As a form of addressing the abovementioned issues, ideas around environmentally conscious retrofitting of existing buildings were established. The environmental impact of the current building industry, in correlation with a personal joy of working within an existing fabric and old buildings, would thus be combined, addressing both the technical and experiential matter.

As our cities consist of a large amount of already built stock, sustainable design approaches are increasingly addressing this area of concern (be it for preservation, sustainability and cost-effective reasons), encouraging the retrofitting of existing buildings, rather than building anew. The dissertation addresses the growing need of working with existing buildings, to improve their environmental performance and resilience, reduce their energy consumption and adapt them to both current and future climate changes.

The Christiaan Barnard Hospital, in Cape Town, was selected as the site for the design intervention, as the building falls within the category of generic 1960's office buildings, addressing a general methodology for renovation, yet a site specific solution. Additionally the building's future is currently unknown making it a highly appropriate and relevant site/issue. The primary focus of the dissertation is to address and investigate the potential of retaining the existing concrete frame structure and creating a feasible design that adds environmental, yet also architectural and cultural value through maintaining a sense of character and continuity within the city. Thus, the existing building is the design generator and not seen as an obstacle but rather a foundation for continued action.

The dissertation explores the paradigm for energy-conscious renovation, as well as challenges society's views on the current negative path of the building industry and on the merits and potential of the transformation and refurbishment of concrete frame structure.

Figure 1: Collage of two grafitti murals combining the issue of global warming (graffiti by Banksy) and the negative effect of the building sector ("We're eating the earth" by unknown artist)

MAKING THE EXISTING RELEVANT

theoretical underpinnings

"According to the Centre for Low Carbon Futures, 70 percent of the buildings that will exist in 2050 have already been built. As material resources become increasingly scarce and sustainability policies even more stringent, the coming generation of architects will become more and more involved in the transformation and refurbishment of an already built environment."

- The Architecture Review, October 2013

Buildings have a large negative impact on the environment, in terms of the natural resources and energy they consume, as well as the CO2 emitted throughout their lifespan. While progress has been made towards achieving urban sustainability in practical and conceptual terms, cities are still unsustainable and are described by Gasson (2007) as using 75% of all resources and producing 75% of all waste.

As our cities to a great part consist of an already built fabric, there exists a growing need to work with current buildings to improve their environmental performance, reduce their energy consumption and adapt them to both current and future climate changes. This section investigates the potential for sustainable building refurbishments in a global discourse, which aims to recapture the embodied energy of a building, as well as improve the energy performance of existing structures. This particularly considers the importance of embodied energy within the realm of discussion as an increasingly important field, which should be given greater recognition within the South Africa discourse.

The Current Negative Impact of the Building Sector

The building sector is the largest contributor to climate change, with direct and indirect processes causing detrimental effects on the environment throughout the lifespan of a building. It is estimated that the lifecycle of the building sector (construction, operation and decommissioning) consumes approximately

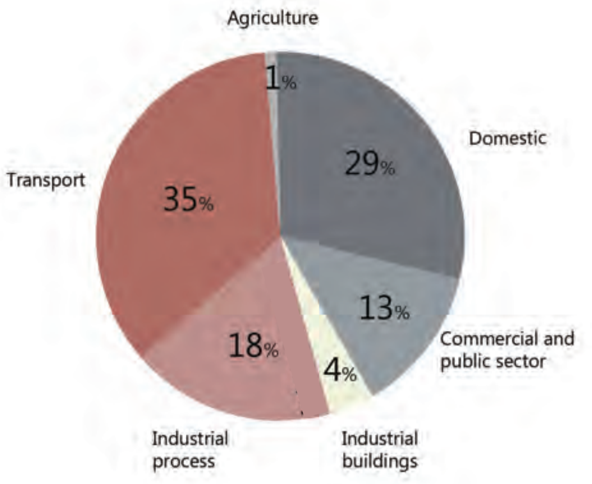


Figure 2: Total UK energy consumption by sector in 2002

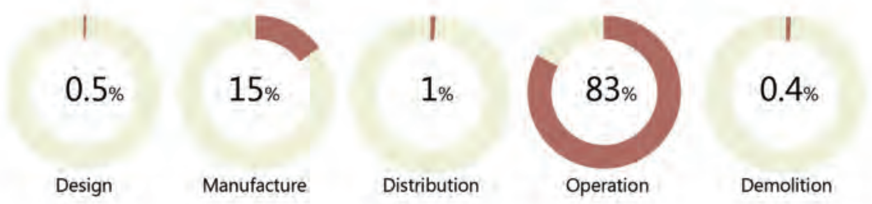


Figure 3: Phases of a building and their overall contribution to the carbon emission of the UK

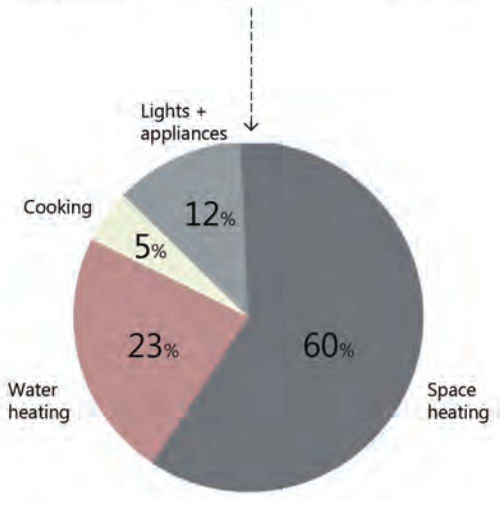


Figure 4: Breakdown of the carbon emissions from buildings in the UK in 2002

16% of global fresh water resources, 30-40% of global energy, produces 23-40% of the world's greenhouse gas emissions and accounts for half of the raw materials extracted from the earth (du Plessis, 2002). Furthermore, international construction and demolition waste produces 20-30% of greenhouse gas emissions and 40-50% of the waste in landfills (du Plessis, 2002).

Relative to the available figures for Europe and particularly for the UK (since extensive studies and comprehensive information is available for this region), shown in Figure 2, the available statistics in South Africa do not present such a severe environmental impact of the building sector. In South Africa, the building sector accounts for approximately 23% of greenhouse gas emissions, of which 5% is used for the production of major building materials (Milford, 2009). Additionally, South African demolition waste amounts to about 20%, compared to 40-50% in Europe. However, this figure is likely an underestimate since a proportion of landfill waste is illegally dumped, and even a small percentage is recycled and reused.

The building sector 'only' accounts for 31% of the total annual electricity consumption in South Africa (Milford, 2009), compared to 66% in the UK. However, South Africa faces energy supply problems and even at these low levels, the demand for energy outweighs the supply. Consequently, a reduction in the energy consumption of the building sector is required to lessen the demand for electricity and assist in preventing continued load-shedding in South Africa.

The above mentioned statistics from Europe, specifically the UK, as well as South Africa, all demonstrate that cities are currently unsustainable. The building sector is a high energy consumption industry from start to finish that accounts for a large proportion of global environmental deterioration. The energy requirements of the building sector include the extraction, processing and transporting of raw materials, construction and operation of buildings and finally their decommissioning and demolition. All of these processes have negative effects on the environment on a local and global scale. However, these can be simplified into two main CO2 contributors by considering the construction and the operation phases within a building's lifecycle.

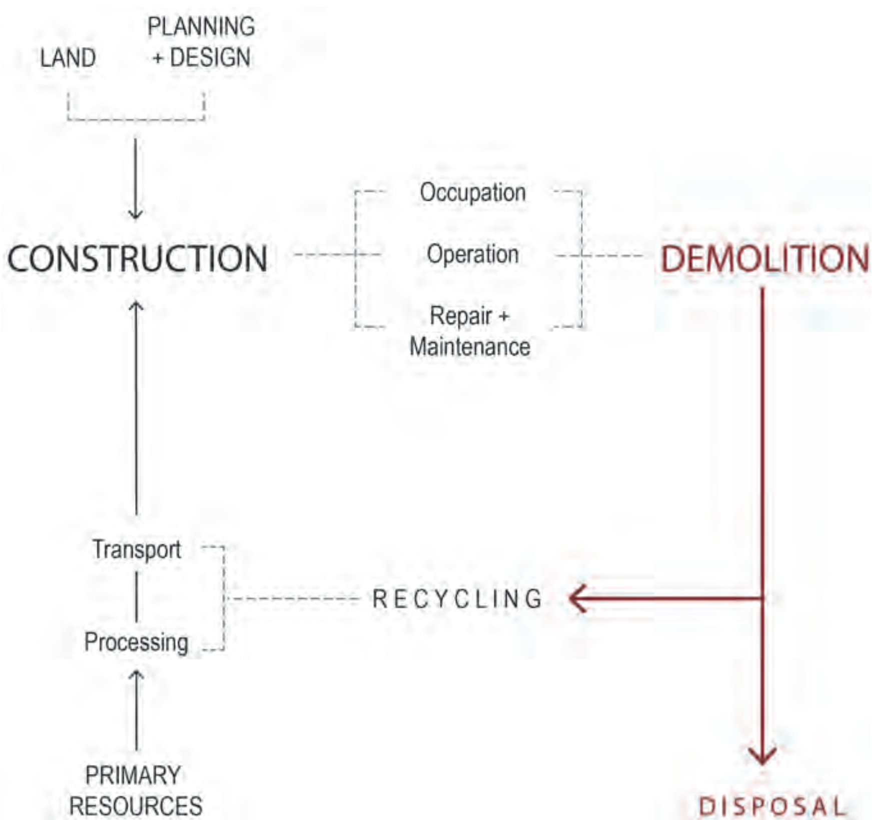


Figure 5:
The construction cycle

Figure 5 shows the construction cycle and its various stages. In the current building cycle, buildings are constructed and then demolished for various reasons when they no longer 'work'. Their demolition waste is dumped in landfills or perhaps small parts recycled to be used in the construction of new buildings to replace them. As the industry has an obligation from an environmental perspective to reduce its use of natural resources, a case for the recycling of materials or even whole buildings is made; rather than for their demolition. As cities consist of a large amount of already built stock, in addition to the current negative impacts caused by the building sector, begs the need for the retrofitting of existing buildings, rather than building anew. Thus the optimal sustainable solution for an existing structure is to re-use it, in particular where a large amount of embodied energy can be retained (Georgopoulos and Minson, 2014). In addition, according to Gonzalo (2006) about 75% of existing buildings require retrofitting to optimise energy savings, further establishing retrofitting as a viable option to facilitate a decrease in the environmental impact of the current built stock and building sector.

Working With Existing Structures

In conjunction to building's CO2 emissions, the closely related energy usage of a building displays further reasons for working with and improving upon the negative environmental effect of buildings, specifically existing structures. Similarly this aspect can be divided into two sections – 'energy content' and 'energy-in-use'. The energy content, otherwise known as embodied energy, is the energy consumed in producing the building; while, the energy-in-use is the energy needed in operating the building throughout its lifespan (Connaughton, 1992). A Lifecycle Costing Approach (LCA) (a tool and calculation method requiring intensive data) takes into account both of these sections when considering the feasibility and environmental impact of a building. The LCA reveals that 80-90% of the energy used during a conventional building's lifecycle is consumed during its in-use phase (European Concrete Platform, 2009). The drastic increase in greenhouse gas emissions, shown in Figure 7, is in part due to the increased heating and cooling within buildings in the 20th century. As a result, the embodied energy has historically been considered insignificant and emphasis was placed on lowering the operational energy of a building, namely heating, cooling, lighting

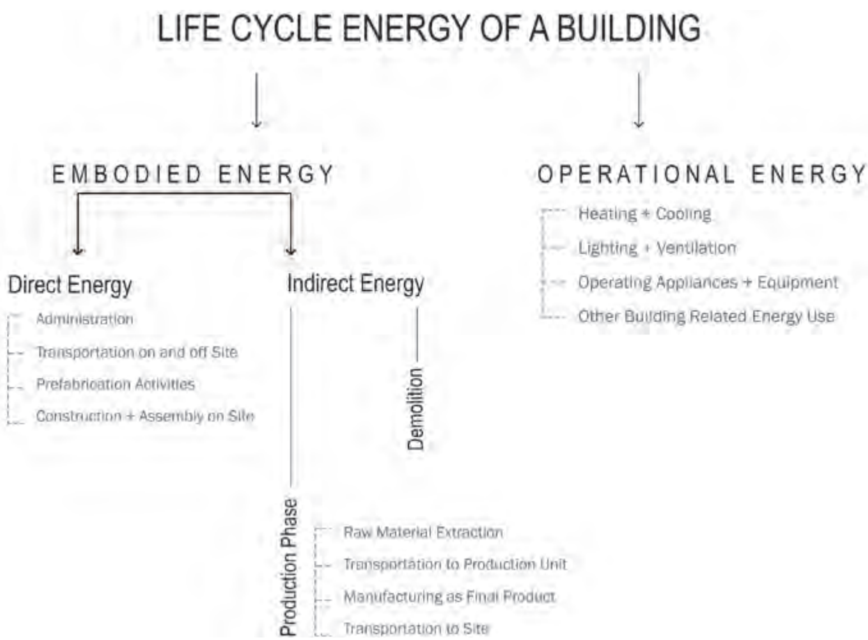


Figure 6: The lifecycle energy of a building

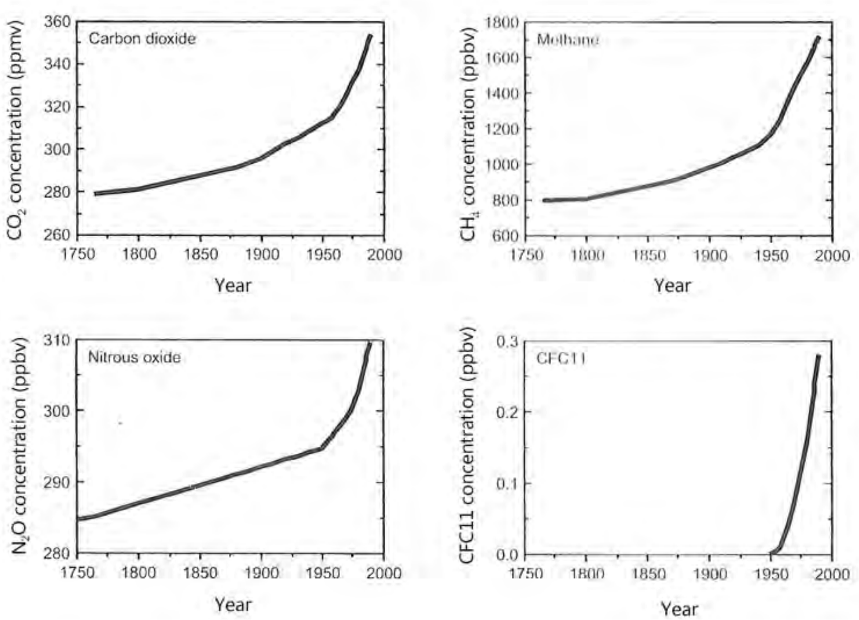


Figure 7: Various factors, including the arrival of the motor car and the increase in heating and cooling of buildings, resulted in the rapid increase of greenhouse gasses into the global atmosphere in the middle of the 20th century

and ventilation (Dixit et al., 2012). New buildings are therefore generally built with significantly higher thermal and sustainable design standards, as well as with new technologies and environmentally friendlier household appliances (as seen in Figure 8) and, as a result, consume relatively low amounts of energy.

However, only a small portion of the total building stock consists of new buildings. In the UK alone, new buildings account for less than 1% of the housing stock a year (DCLG, 2013). Furthermore a report by the National Trust for Historic Preservation established that constructing new energy-efficient buildings often does not save as much energy as renovating old ones (Laskow, 2012). As there are an even greater number of aged or unused buildings in need of maintenance, sustainable building refurbishment is a growing industry (Birkeland, 2002). The majority of these buildings were constructed when energy was freely available and energy standards were low or non-existent. They are however still likely to be in use for many years, highlighting the need to appropriately refurbish aged buildings for current and future use, as well as to improve their standards of energy use, especially when facing current and future effects of global warming, so as to continue to function under extreme conditions and optimise building resilience.

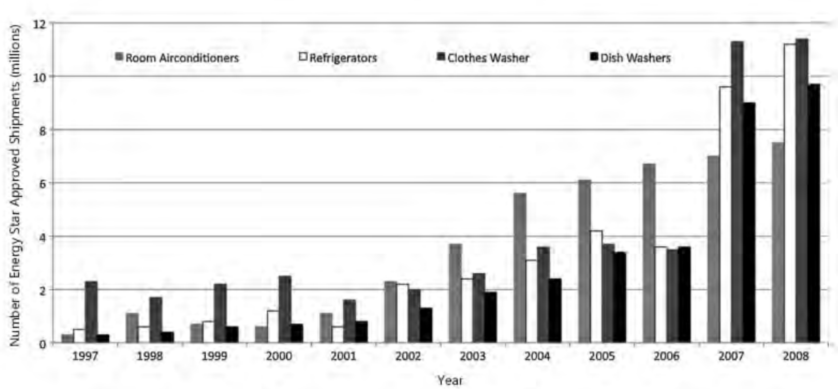


Figure 8: The number of Energy Star approved appliances keeps growing

Current Building Trends in Relation to Climate Change

Since 1850 mean temperatures have risen by about 0.6°C (Figure 9) and the world is now warmer than at any time during the last 1000 years (PGWC, 2005). Recently, at the beginning of March 2015, temperatures in Cape Town reached a 100 year high of 42°C, proving that these concerns are no longer issues of the future, but a current reality. Due to the environmental crisis and rising temperatures, not only in South Africa, but the rest of the world, there is a need to find new ways of understanding the relationship between humanity and nature.

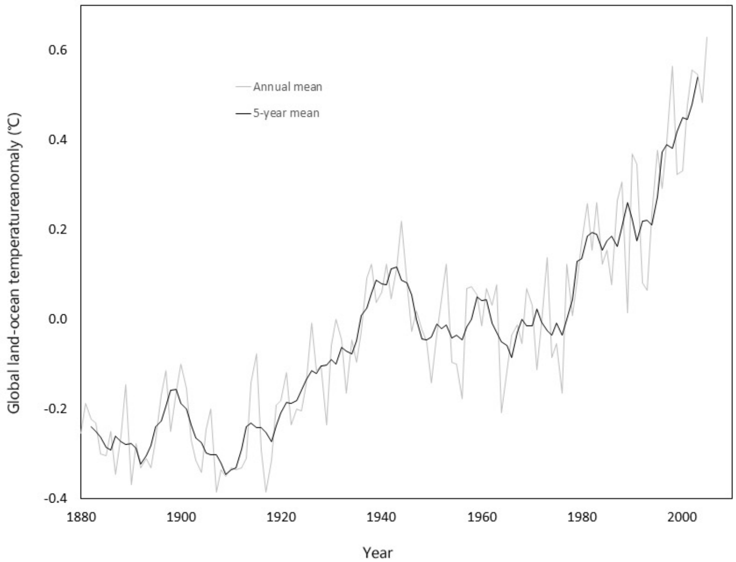


Figure 9: Global temperatures have increased over the past 100 years, with a drastic increase since the 1970's

Much of the operational energy usage of a building is aimed to increase human comfort in one way or another. Human thermal comfort is not only an important factor of user satisfaction, but it also influences the amount of energy used. This enhances the importance for informed design decisions based on a greater understanding of human thermal comfort within a building. Yet as cities grow further in ways that are no longer dictated by the climate, natural resources for creating human comfort are forgotten. Achieving a relationship between form and the city, as well as buildings and the climate, for energy needs, as previously intuitively achieved by vernacular architecture, is no longer made use of (Bothma, 2010). Thus, the comfortable interior climatic environments now achieved in modern buildings by heating, cooling and lighting are consuming large amounts of non-renewable energy, resulting in the emission of CO2 gasses and the advancement of climate change.

The new SANS1400XA regulations, introduced in 2013, aim at achieving a fundamental change in the building industry, especially in regard to reducing the need for energy. These standards are however still in their infancy and fail to address many aspects of our local and natural context, as they are based on international sustainability examples, where emphasis is placed on providing airtight, mechanically operated buildings, with little relation to the exterior environment. These standards, along with modern design principles of closed building envelopes, should be interrogated in terms of their appropriateness in the South African context. Unfortunately, economic trends inspire international aspirations. Yet among the reasons for their inappropriateness is the issue of technology, cost, feasibility and most importantly the varying South African climate. In addition, in the northern hemisphere, in coming years, due to global warming, the need to cool a building will likely increase, while heating loads will decrease (Keeler and Burke, 2009). Thus, as temperatures experienced in the northern hemisphere slowly tend towards those experienced in the southern hemisphere, attention should be given to ways of building and lessons learnt in the south, rather than the north, as these are relevant and have something to offer future European design models.

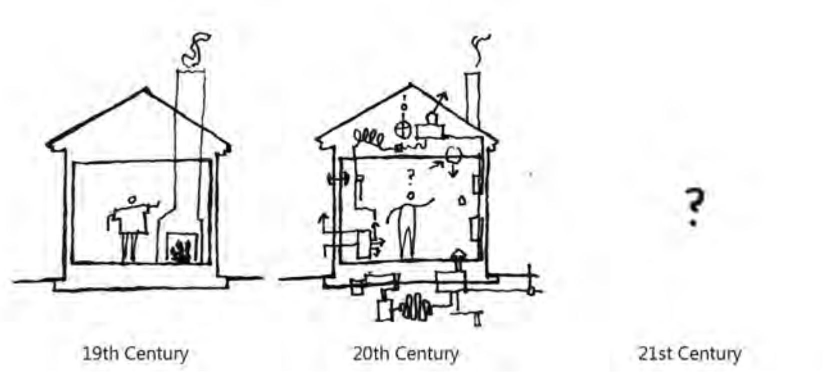


Figure 10: Moving towards sustainability

Within contemporary South African architecture, some architects draw into question the newly introduced building codes and rather advocate a climate responsive design. In particular the place-specific architecture of Gabriel Fagan serves as a precedent. His work, inspired by the Cape Dutch Vernacular, is reinterpreted in a modern, regionalist way to suit contemporary lifestyles (Joubert, 2004). In his domestic house die Es, transformations of the vernacular typically include the use of cross ventilation, movable louvres or shutters to protect from the direct summer sun (Figures 12-19). Thermal mass is also of importance within his designs, incorporating the use of 400mm thick brick walls, concrete floor slabs and quarry tiles to absorb and reradiate the sun's heat (Buchanan, 2005). Together with the 260mm first floor slab an enormous heat sink is created, storing the afternoon sun's heat (Buchanan, 2005).

Contrary to current environmental building standards and the passive house principle of airtightness, the windows within die Es are anything but airtight. Acceptable internal climatic conditions are thus achieved through natural sources, highlighting a reappraisal of traditional methods employed in hot climates for two millennia or more (Smith, 2001). Gabriel Fagan strongly believes in the importance of interacting with one's external environment and his architecture deviates from modern architecture in its consideration and response to climate and place, combining richness of experience, form and environment (Buchanan, 2005). This dissertation aims to similarly integrate these ideas into the retrofitting of existing buildings, incorporating a context based 21st century vernacular within the design to once again achieve a direct relationship between man and nature. These concepts will lead to better environmental efficiency which will complement the environmental benefits already achieved from retaining an existing building.

Figure 11: Change in context requires a re-interpretation of vernacular passive strategies to achieve a comfortable living environment in all seasons

Figure 12: East facing windows protected by adjustable sliding screens in die Es

Figure 13: The west façade faces the sea with large glazing and sliding shutters

Figure 14: Large west facing windows and 400mm thick brick walls

Figure 15: A semi-enclosed outdoor courtyard space protects against strong Camps Bay winds

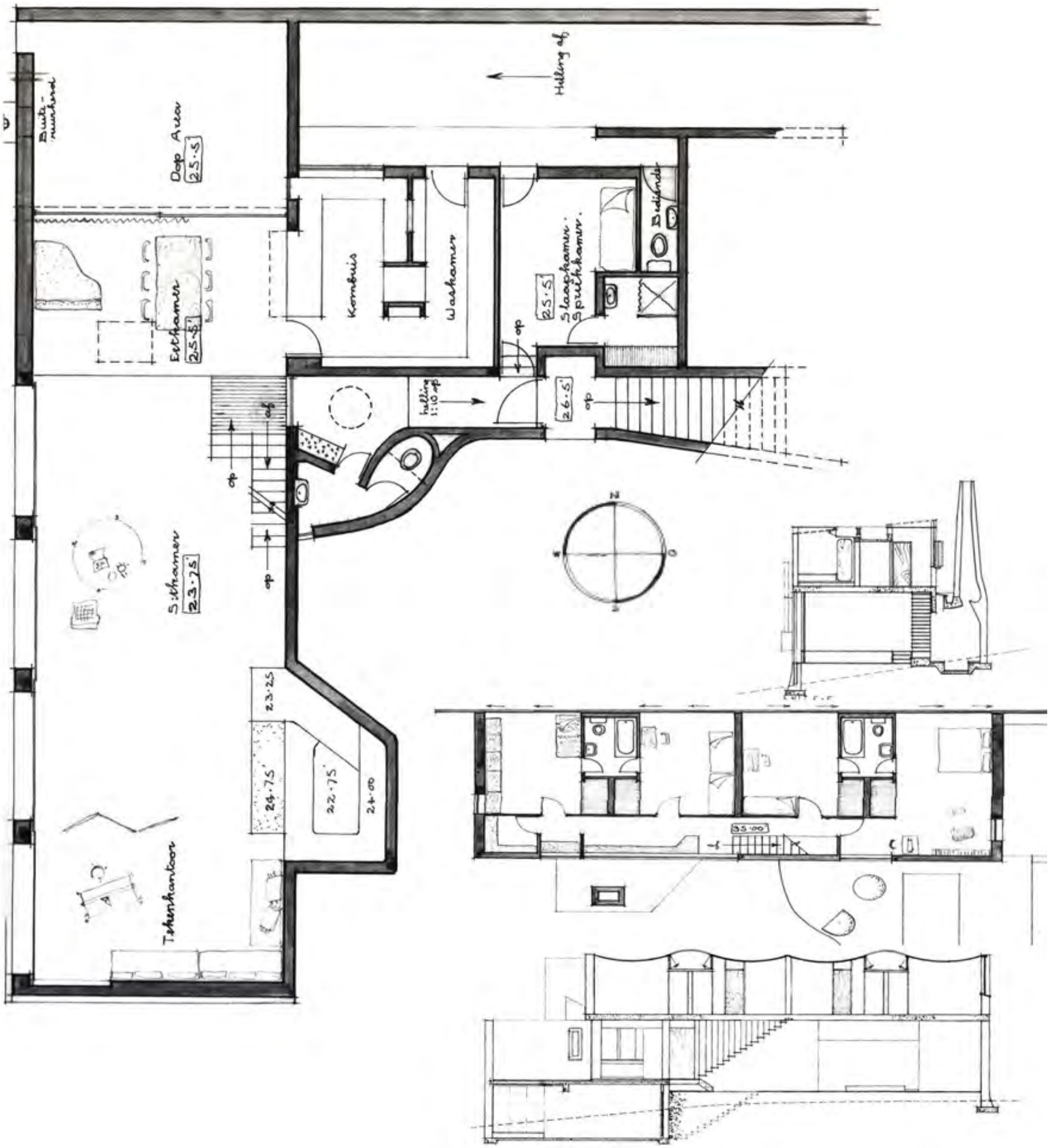


Figure 16: Plans and sections: The building is located along a north-south axis to turn its back on the wind and maximise the sea view

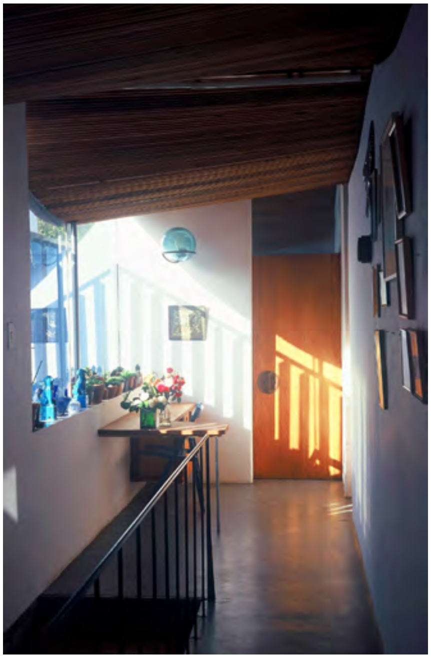


Figure 17: The internal fireplace warms up the open plan room and is the true centre of the house in winter, as indicated by its name Die Es or the Hearth.

Figure 18: The passage to the bedroom is naturally lit

Figure 19: Thick external load bearing brick walls along with the tiled floor and a thick first floor concrete slab create a heat sink. Daylighting and natural ventilation enhance the lovely open plan environment

Yet, when addressing the total energy consumption of a building, the operational energy usage of a building is only one aspect. As more buildings are constructed to become increasingly energy efficient (by various means including new technologies, environmentally friendlier household appliances, etc.), the importance of carbon emission and energy usage has shifted from the operational emissions to the manufacturing of materials, transport, and their eventual demolition and disposal (RICS, 2012). As a result, the focus of sustainable development and the basis for this dissertation is the refurbishment of buildings to achieve the necessary reductions in carbon emissions and energy usage. This addresses both the building's in-use phase (with a focus on passive environmental means), as well as the importance of the existing embodied energy.

The Significance of Embodied Energy

The concept of the embodied energy of a building encompasses the environmental impact caused during the construction of a building and the production and manufacture of its materials. This includes the energy required to produce the materials used, the CO_2 emissions resulting from the manufacturing process, the impact on the local environment due to the extraction of the materials, transportation of the materials, as well as the pollution resulting at the end of the materials useful lifespan (Roaf, Fuentes and Thomas, 2003).

The measurements of various building materials and factors that increase the embodied energy of a building are of importance when selecting materials in the initial stages of a project. However, there are other influencing factors when addressing the embodied energy of existing structures. The longer the life span of a building, the lower the impact of the initial energy consumption is and the pollution caused during the manufacture of its materials. Existing buildings already contain a large amount of embodied energy, energy consumed during the building's construction and lifespan. This embodied energy is wasted when buildings start to decay or are demolished (with additional considerable energy and natural resources required to replace it), arguing for their refurbishment and continued use when possible.

The importance of a building's embodied energy is slowly achieving greater recognition around the globe in light of sustainable practices and, in particular, the need to reduce CO_2 emissions. The UK has embraced these ideas around sustainability which are being incorporated within design processes such as the Elizabeth II Court in Winchester (Figures 20 & 21) and the Angle Centre in London (Figures 22-26). In both case studies, the existing building was no longer serving its intended function sufficiently and required alterations, additions or even possible demolition. The outcome of these buildings was decided while considering the embodied energy of the concrete structural frame, resulting in their reuse for financial and environmental reasons.

In the South African context and mentality, in comparison to the UK, the benefits of embodied energy are unlikely a determining or influential factor when considering the re-use of a structure. Instead, the focus is rather on reducing the cost of a project and saving time. The embodied energy is often only considered when wanting to achieve a Green Star rating (as one scores points for recycling existing structures). However, the construction time can be reduced by retaining an existing frame and can save up to 35% of the total cost in a South African context (H Rasmuss 2015, pers. comm., 28 April). Furthermore, high interest rates in South Africa worsen the costs associated with an extended construction time, compared to countries with low interest rates, such as Europe. In addition, the actual cost of a concrete building amounts to 12-15% of the total building project cost (H Rasmuss 2015, pers. comm., 28 April), presenting further reasons for the practice to be recognised for the value it can add - economically, architecturally, culturally and environmentally.

Figure 20: The original 1960's façade of the Elizabeth II Court

Figure 21: The remodelled Elizabeth II Court responds to the surrounding context

Figure 22: The existing open air central courtyard of the Angel Centre in London

Figure 23: Much of the existing concrete frame was retained

Figure 24: The new façade adds a modern look to the Angel Building. An additional floor can be seen slightly set back from the rest, consisting of a white façade

Figure 25 & 26: The thermal mass and control of internal environment has contributed to the 'Excellent' BREEAM (assessment method for sustainable buildings) rating of the Angel Centre

Figure 27: Collage of buildings in Cape Town depicting the layering within the city

LOCAL DISCUSSION

the urban | identifying a site

This section engages with the changing nature and character of the Cape Town CBD city fabric, as a precursor in arriving at a specific area of concern and identification of a site within the broad topic of sustainable building refurbishment.

Continuity of Change

As a wider area of study the Cape Town CBD was chosen as the most appropriate area of investigation, as it is home to a range of building types and styles, with buildings of different ages layered together forming a rich and complex urban fabric. However, the city is constantly in a state of transformation – ever changing and constantly adjusting to economic, political and social influences. Its evolution is embedded within the urban fabric of the city, as its buildings are shaped and reshaped due to the changes in use in and around them.

Changes in cultural values, technology, money and fashion are various forces that influence a building’s lifecycle. However, since the introduction of the 60 year preservation rule, the life of our city has been forcibly altered. Younger, not so well protected, buildings are targeted before older vacant or derelict ones. The recently demolished Tulip Hotel within the CBD is such an example (Figure 29). A part of the city has been eradicated, a void has been left in the urban fabric and the cohesion of the city disregarded. Rather than advocating for a building’s demolition and replacing it when it no longer ‘works’, this dissertation argues for a stronger and more meaningful engagement with our already built environment.

An appropriate site needed to be established within the CBD that fulfilled the criteria for a typical demolish and replace project. First, the identification of heritage graded buildings was useful in eliminating a large category of buildings within the city. This category consists of buildings usually older than 60 years of age or of some heritage significance that are already somewhat protected and at the same time would be difficult to alter. In addition, these older buildings are presumably well-built, with low embodied energy and in need of low energy

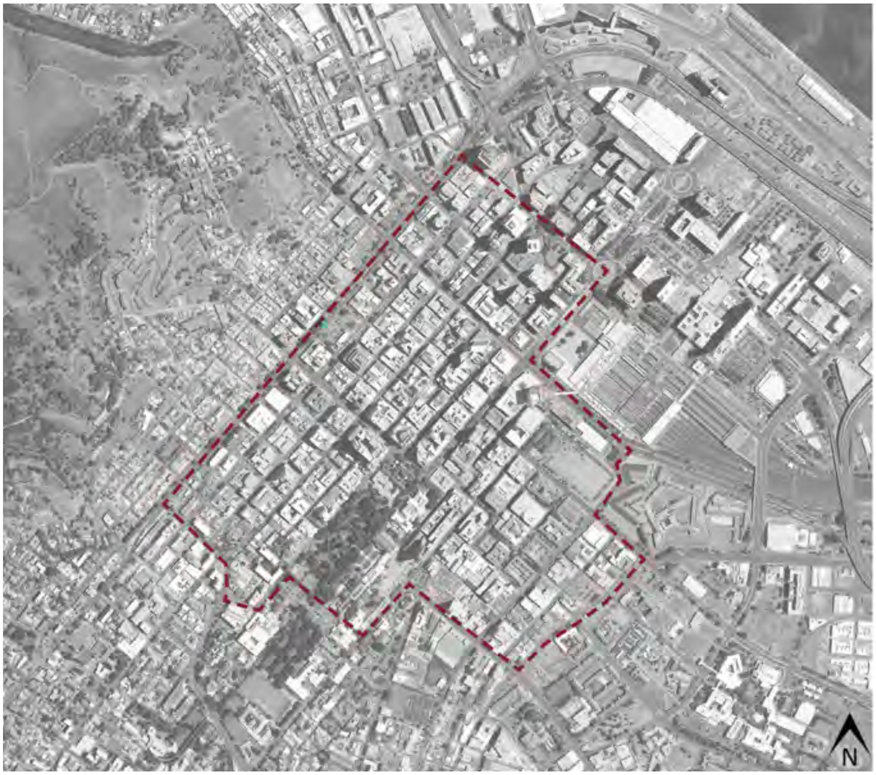


Figure 28: Field of study – Cape Town CBD

Figure 29: The recently demolished Tulip Hotel rubble. A new hotel shall be erected in its place.

Figure 30: Mapping exercise of concrete frame buildings built before 1978 without a heritage grading

use vs. buildings that were built when energy was freely available and energy standards were low or non-existent. Rather than focusing on older well-built buildings, as well as current ones built according to environmental performance regulations, buildings built in a time in-between were sought after (which were also likely to be in use for many years to come). The dissertation focuses on this area of inquiry; the potential and possibilities of the ordinary. Rather than to demolish them, these mundane buildings have the potential to be transformed, their meaning and impact on their surrounding altered, as well as the way in which they are regarded by the city and its inhabitants.

The survey undertaken during 1977 and 1978 by John Rennie recorded in "The Buildings of the Central Cape" assisted in narrowing down the list of potential sites even further. Among the buildings that appeared within the survey a substantial number of concrete frame structure were recorded. The field of inquiry was thus narrowed down, as concrete frame structures were identified as the predominant structural system used in the mid-20th century (Figure 30). The listed buildings would in addition serve as a starting point as they would have been built in the sought after time period when environmental and energy conscious design was not yet a key focus. The buildings in question are not only amongst the least energy efficient buildings within our city, but also a current and future area of concern.

Concrete Frame Structures

Concrete is typically an environmentally unfriendly material – contributing largely to the greenhouse gas emissions primarily due to the manufacturing process of cement. However, concrete structures are usually designed for an extended service life of 50-100 years, which needs to be taken into consideration. Other building materials may initially be more environmentally friendly; however, over the full lifecycle of a building a concrete structure has the potential to recover its initial environmental shortfall. A long service life of concrete structures is therefore highly desirable from a sustainable perspective, as well as from an ecological, environmental and cultural point of view.

Building material	Density kg/m3	Thermal conductivity W/mK	Specific heat capacity J/kgK	Effective thermal mass
Timber	500	0.13	1600	Low
Steel	7800	50	450	Low
Lightweight aggregate blocks	1400	0.57	1000	Medium-high
Precast and in-situ concrete	2300	1.75	1000	High
Bricks and dense blocks	1750	0.77	1000	High
Sandstone	2300	1.80	1000	High

Figure 31: Thermal properties of common building materials

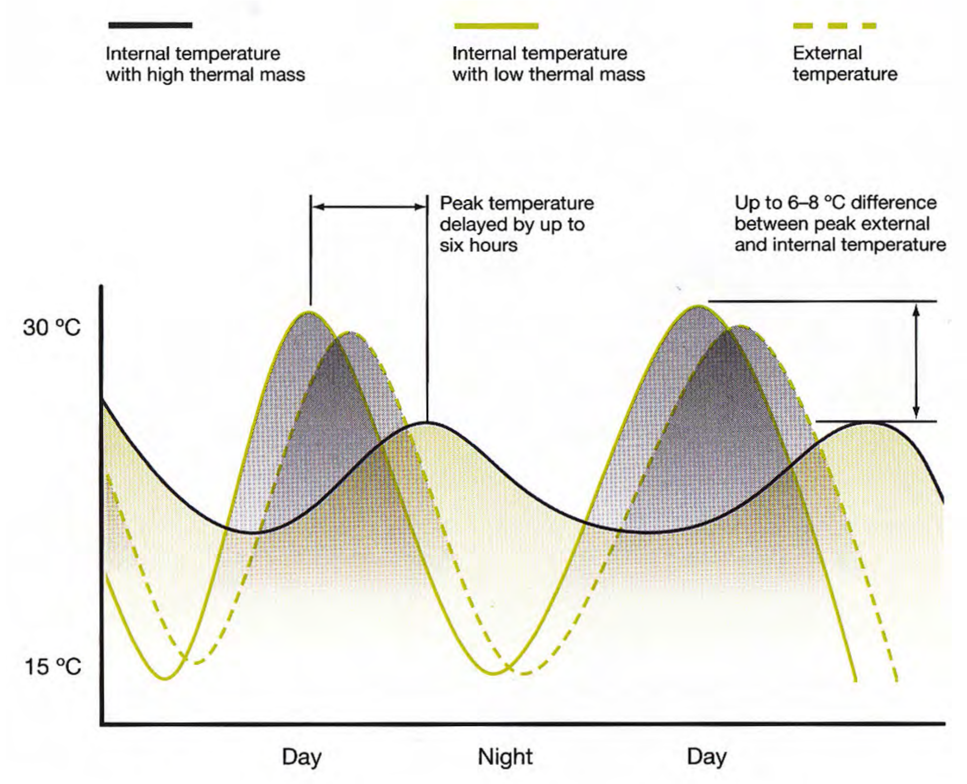


Figure 32: Stabilising effect of thermal mass on internal temperatures

A further enhancing quality of concrete is its high thermal mass. This property helps to maintain a good temperature within a building, while reducing the need for mechanical heating or cooling. Although brick and concrete initially have 1.25 tons more embodied CO2 than timber, it was estimated that they would emit 15 tons less CO2 in heating and cooling over a 60 year period (Forty, 2013). This energy saving has been attributed to the increase in thermal mass (shown in Figure 31) and will have a significant impact on the operating energy of a building (Cole and Kernan, 1996). Concrete frame structures are therefore at an advantage and their benefits will become more dominant as temperatures rise and warmer climatic conditions appear worldwide.

Exposed concrete is particularly helpful in hot climates as it absorbs internal heat gains during the day (Bennett, 2010). In conjunction with solar shading, concrete's thermal mass can keep the internal temperature 6-8°C below peak external temperatures (Georgopoulos and Minson, 2014). The stabilising effect of thermal mass on interior temperatures can be seen in Figure 32. Any structural element (walls, floors or frame) can contribute to thermal mass provided the surface is exposed; with exposed concrete soffits in particular acting as effective storage heaters (Figure 34) (Forty, 2013). In existing buildings, removing wall, ceiling and floor coverings can unlock the thermal mass potential of the slab (Bennett, 2010). If appropriately used, the material properties of concrete can help reduce CO2 emissions in the long run and save running costs of a building.

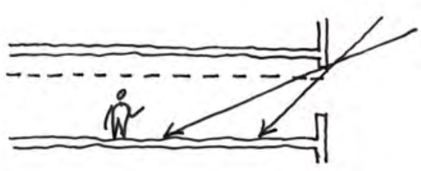


Figure 33: The removal of a dropped ceiling extends the floor to ceiling height and allows more light to enter the building

Figure 34: Exposure of the underside of the concrete floor slab allows the floor to absorb internal heat gains

Figure 35: Park Hill in Sheffield was a council housing estate built between 1958-1961 and designed by architects Ivor Smith and Jack Lynn. The building is made up of a series of interconnected blocks constructed using concrete frames

Figure 36: After the buildings decay, due to various factors, it is being renovated by developpers Urban Splash. The building is being stripped back to its concrete framework and a new facade is being added

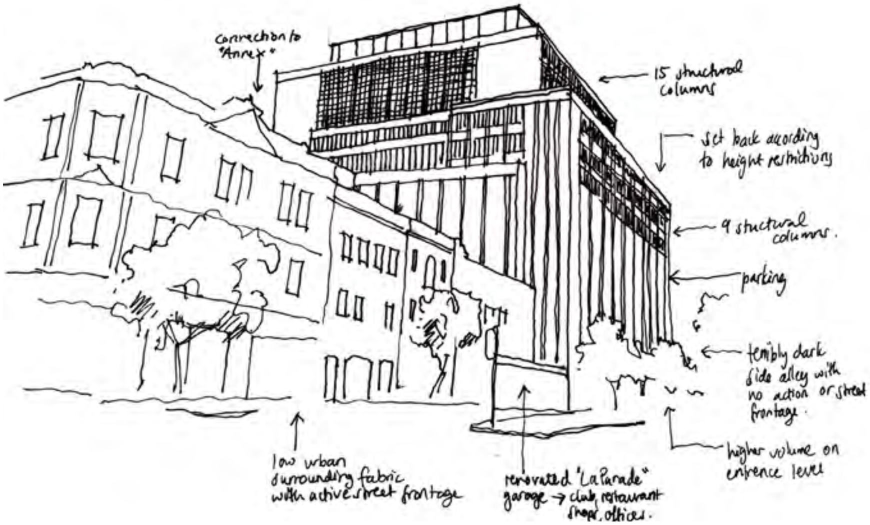


Figure 37: The Christiaan Barnard Hospital occupies a whole city block amongst an otherwise richly layered urban fabric

Figure 38: The Christiaan Barnard Hospital within the Cape Town CBD -context

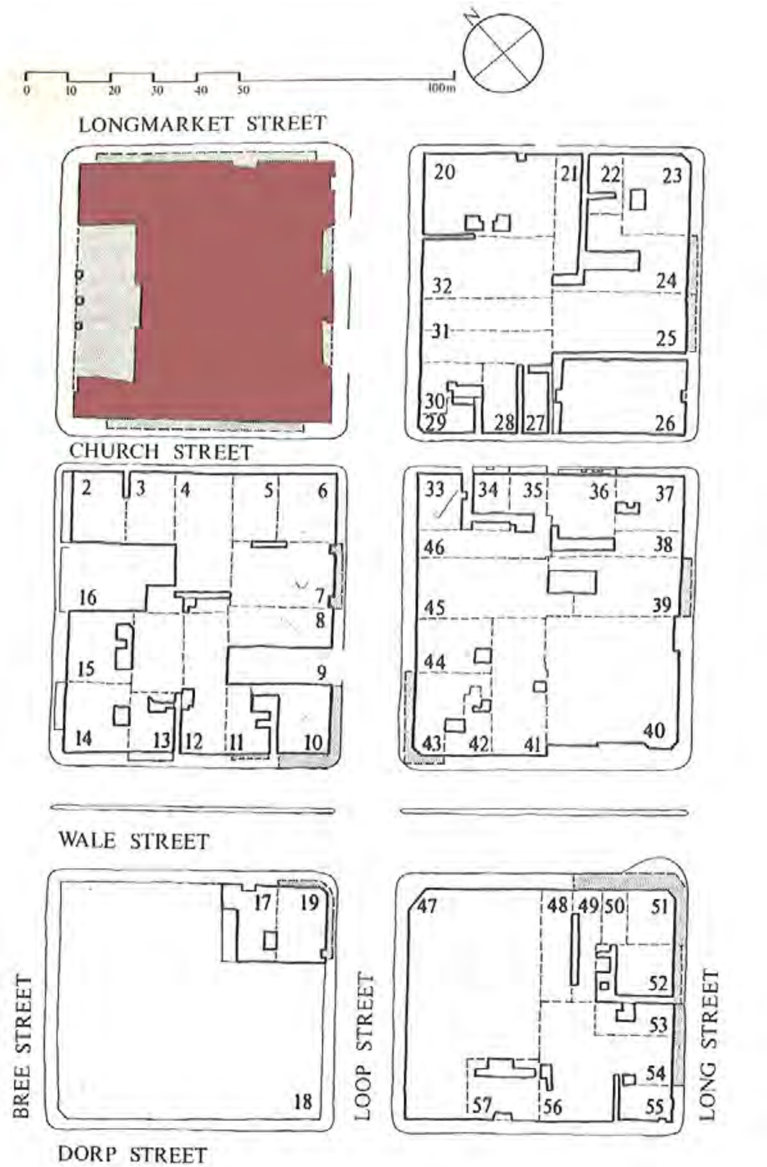
The Christiaan Barnard Hospital

A series of exercises and site visits were undertaken to locate an appropriate concrete frame building within the CBD in which to show the potential and excitement of working with an existing structure. A site that stood out was the Christiaan Barnard Hospital – a building with an uncertain future that takes up a whole city block. It is commonly regarded as an eye-sore in the city, on an otherwise rapidly developing street. The current tenants plan to relocate to a custom designed hospital building, as the existing building no longer serves its intended function sufficiently and would otherwise require extensive investment, additions and alterations. The new hospital is currently under construction in the Foreshore area, expected to open its doors in October 2016. No plans have yet been made for the existing hospital building, although the owners are looking to sell it and let the new owners decide upon its future. Feasibility studies of the potential to either re-use/re-purpose or whether to demolish the building and start again are currently underway.

While investigating the history of the building, the discovery was made that the current building is not a purpose-built hospital. The approximate date of its construction is estimated in the year 1969. According to John Ronnie's "The Buildings of the Central Cape", it was initially a parking block with offices for "City Engineers" on the floors above. The current hospital, then previously known as City Park, opened its doors in 1984. The necessary alteration apparently took place over a short period of time, with dry wall partitions within the otherwise repetitive frame allowing for the new and very specific uses to be accommodated.

Although the essential components of the building, namely the load bearing concrete structural system, remained the same during the retrofitting, alterations and additions were carried out, including:

- Two service lifts were added and placed into an existing light well, dividing it into two
- Several more toilets and service ducts were added throughout
- Large portions of the balconies on the 9th and 10th floor were enclosed and now make up part of the hospital floors



Bree Street, Longmarket Street, Loop Street and Church Street
CITY PARK (City Engineer's offices and parking block)

erven: 2105, 2106, 2107, 2108, 2109, 2110
2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123
prop. ref: WB 21B 21
inspected: December 1977

Multi-storey concrete framed modern city block. Facebrick, aluminium etc. Lift 1969

Figure 39: Recorded information by John Rennie in "The Buildings of the Central Cape"

- Various drywall arrangements have been utilised and altered over the years to accommodate the changing needs of the hospital

The building is an example of a generic office building – the ground floor is dominated by vehicle access, followed by seven floors of parking and a further seven floors above, originally designed as office space. These top seven floors have since been occupied by the hospital. Its scale and typology (generic and particular at the same time) as well as its uncertain future, render it a suitable and relevant site choice. The previous alterations to this robust building and structural system suggest that the building could and should be expected to change further for its usefulness and continued lifespan to be sustained.

According to Steward Brand, a building is conceived out of several layers of building components; namely its shell or structure, services, scenery and set. However, the structure typically remains as the dominant building component despite radical changes in use (Brand, 1995). As a result, the condition of the structure is pivotal and would require structural assessment. This is a concern with all existing buildings and consequently, the condition of the existing concrete structure of the Christiaan Barnard Hospital would need to be properly assessed. As concrete is a very durable construction material however, it should typically not have any problems achieving its design life of about 50 years. The structural integrity of the building can usually be extended even further without much effort, unless the concrete quality or cover to rebar was poor (H Mynhardt 2015, pers. comm., 08 October). According to Herman Mynhardt, a quantity surveyor from SigmaQS, even if the hospital's design life is now nearing the threshold of 50 years, it is still more economically feasible to rehabilitate deteriorating structural elements than to demolish them and rebuild. As such, the Christiaan Barnard Hospital building is a suitable candidate for a rehabilitation project for economic, environmental and aesthetic purposes.

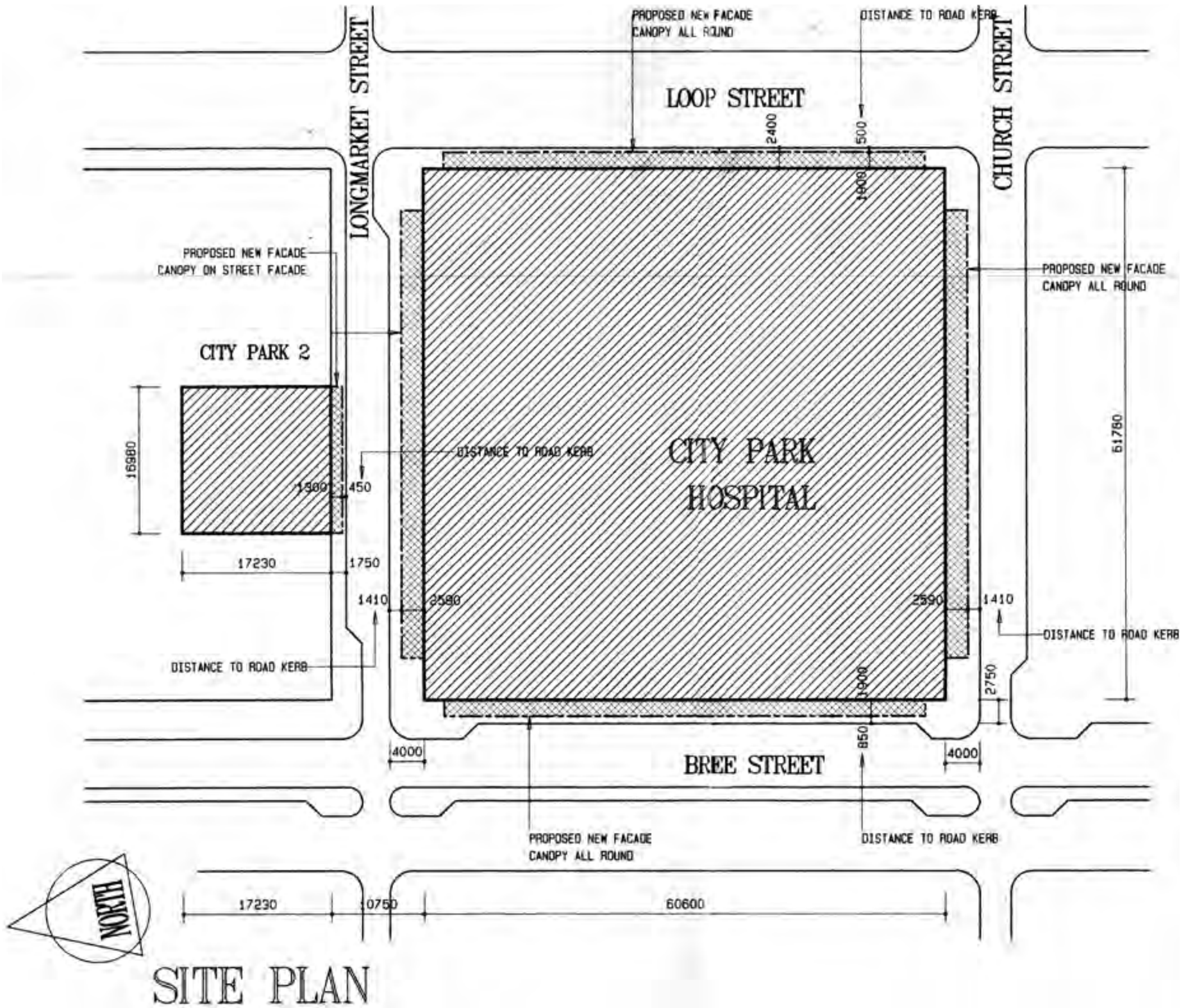


Figure 40: Site plan drawn in 1998 by the architectural firm Brink Stokes Marais & Moolman

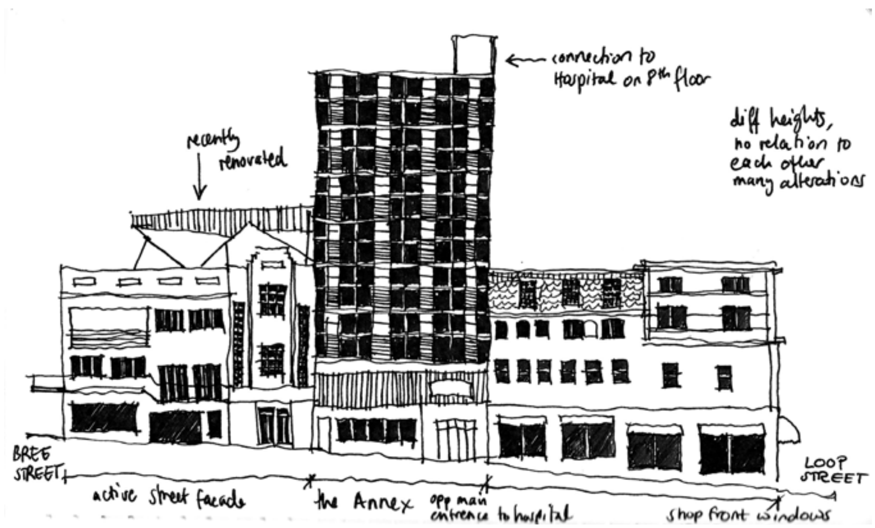
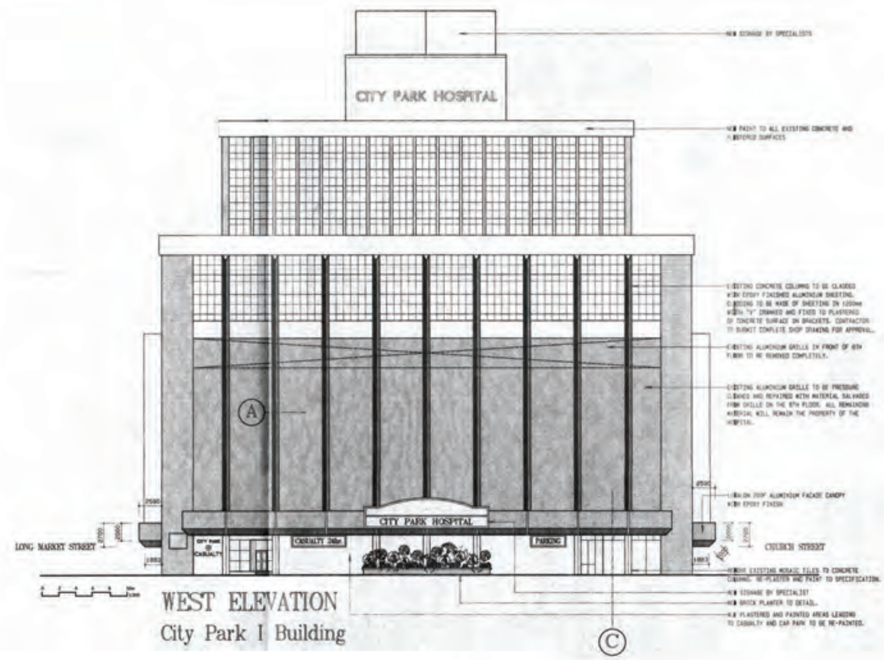


Figure 41 & 42: Sketch of surrounding buildings
(a) Church Street elevation
(b) Longmarket Street elevation



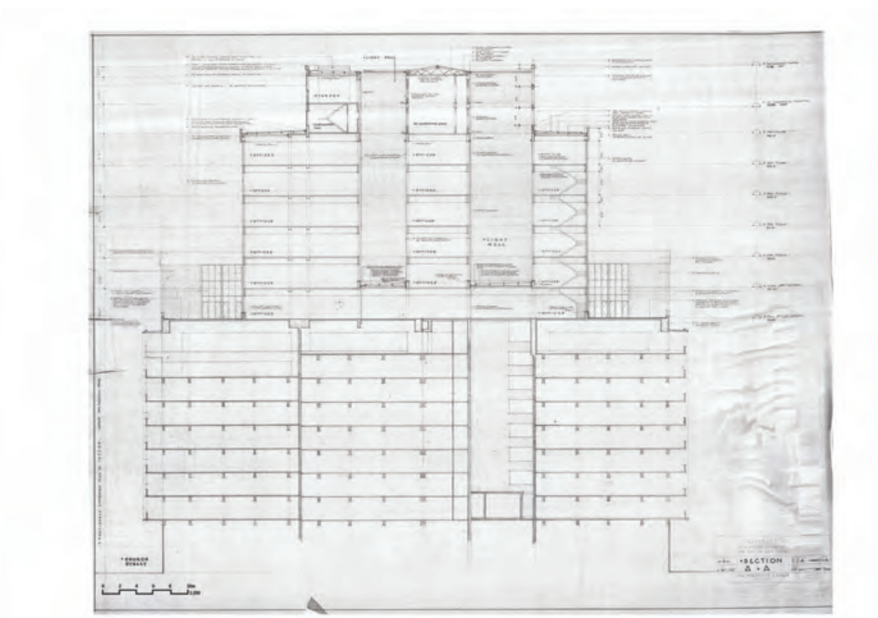
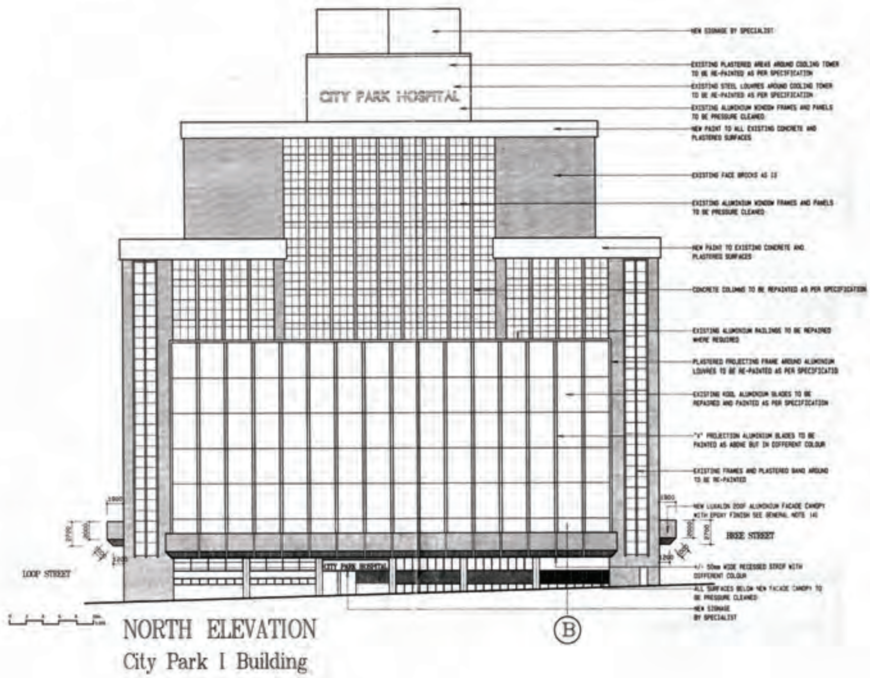


Figure 43: West elevation on Bree Street drawn in 1998 by the architectural firm Brink Stokes Marais & Moolman

Figure 44: Original section through Church and Longmarket Street showing two existing lightwells, drawn in 1968



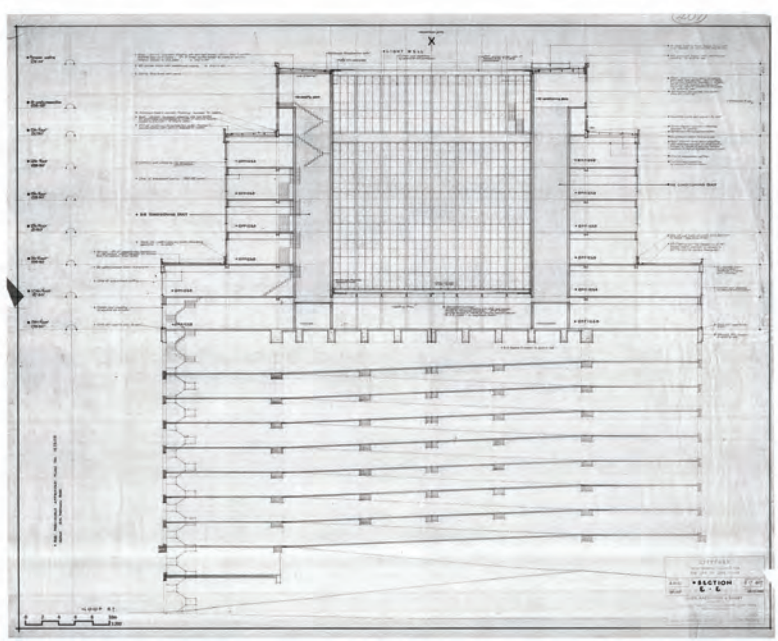
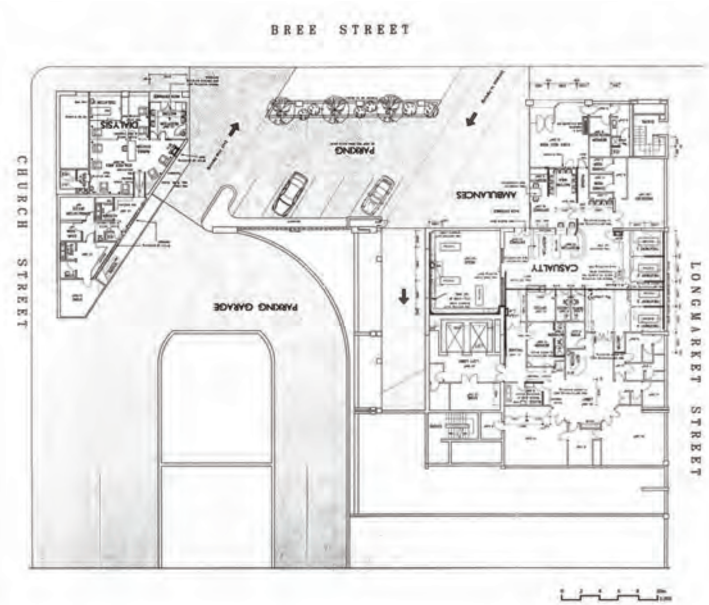


Figure 45: North elevation on Longmarket Street drawn in 1998 by the architectural firm Brink Stokes Marais & Moolman

Figure 46: Original section through Bree and Loop Street showing the parking area and one lightwell, drawn in 1968



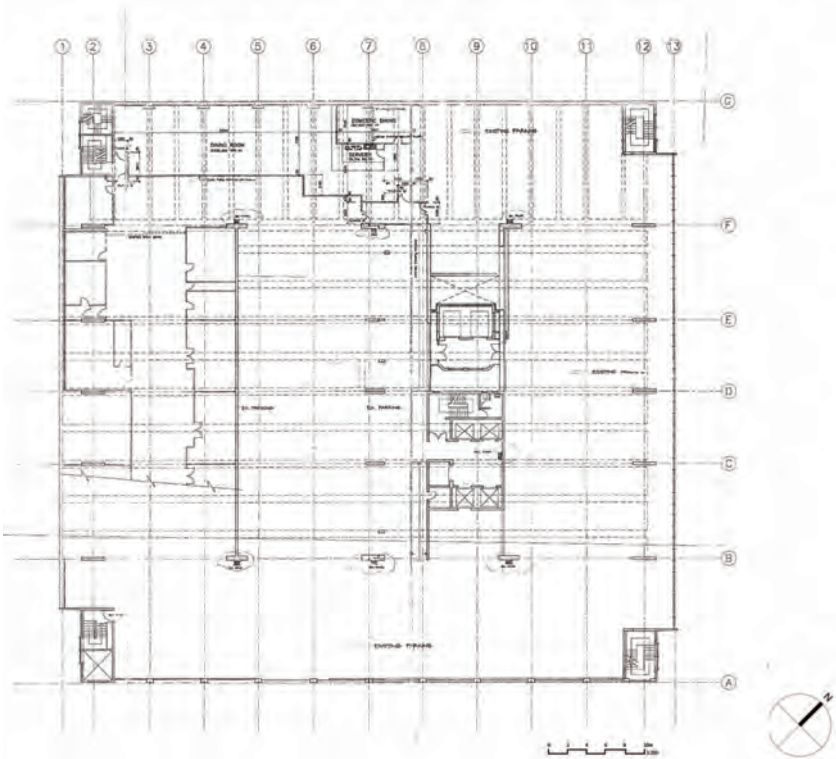


Figure 47: Existing ground floor plan

Figure 48: Existing parking layout – floors 2-7

Figure 49: Existing layout – floors 8-10

Figure 50: Existing floor layout of the set back floors 11-14

Figure 51: The hospital building within the Cape Town skyline

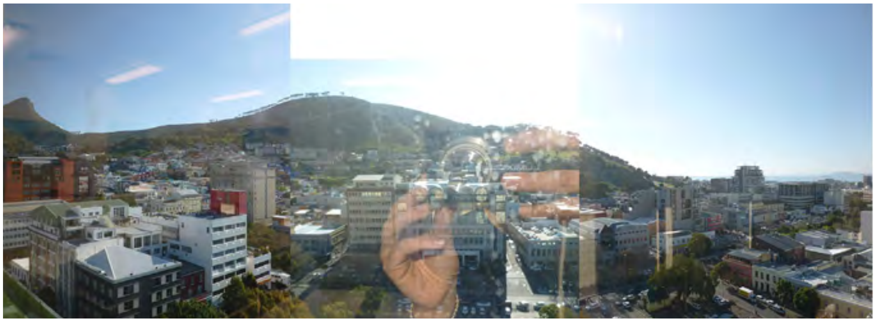


Figure 52: View towards Lions Head and Signall Hill from the 14th floor of the Christiaan Barnard Hospital

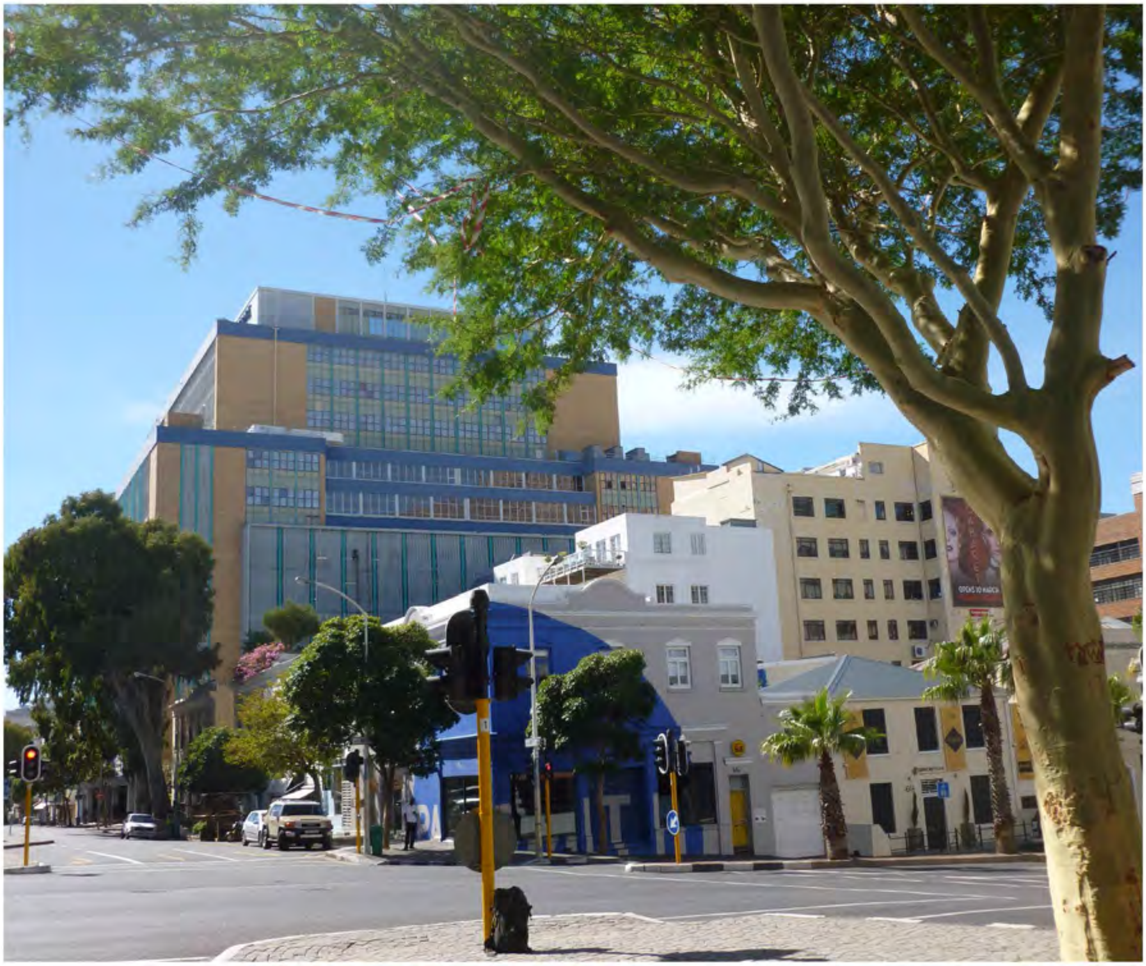


Figure 53: View along Bree Street towards the harbour

Figure 54: View along Loop Street towards the harbour

Figure 55: Ground floor with entrance on Bree and Loop Street

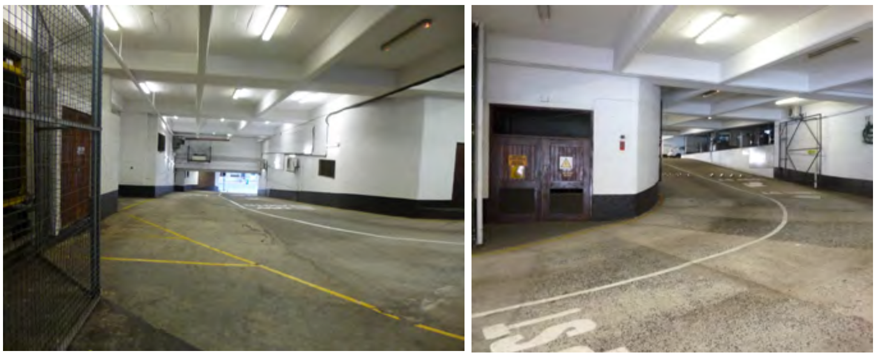


Figure 56: Vehicle ramps floors LG -1

Figure 57: Parking garage floors 2-7

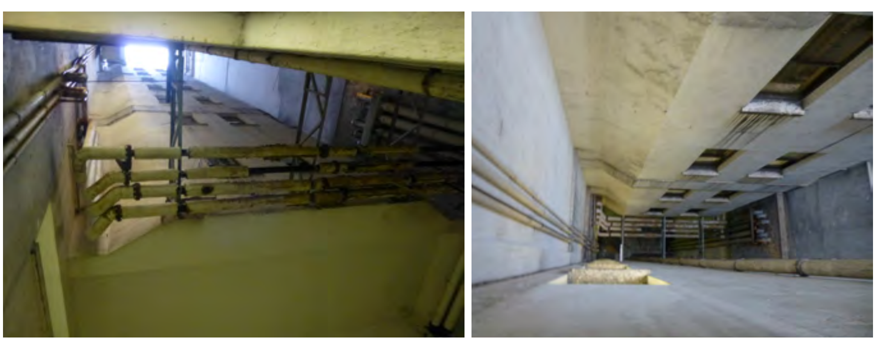


Figure 58: The main light well is halved in two due to the later inserted goods lift

Figure 59: The second light well is not made use of

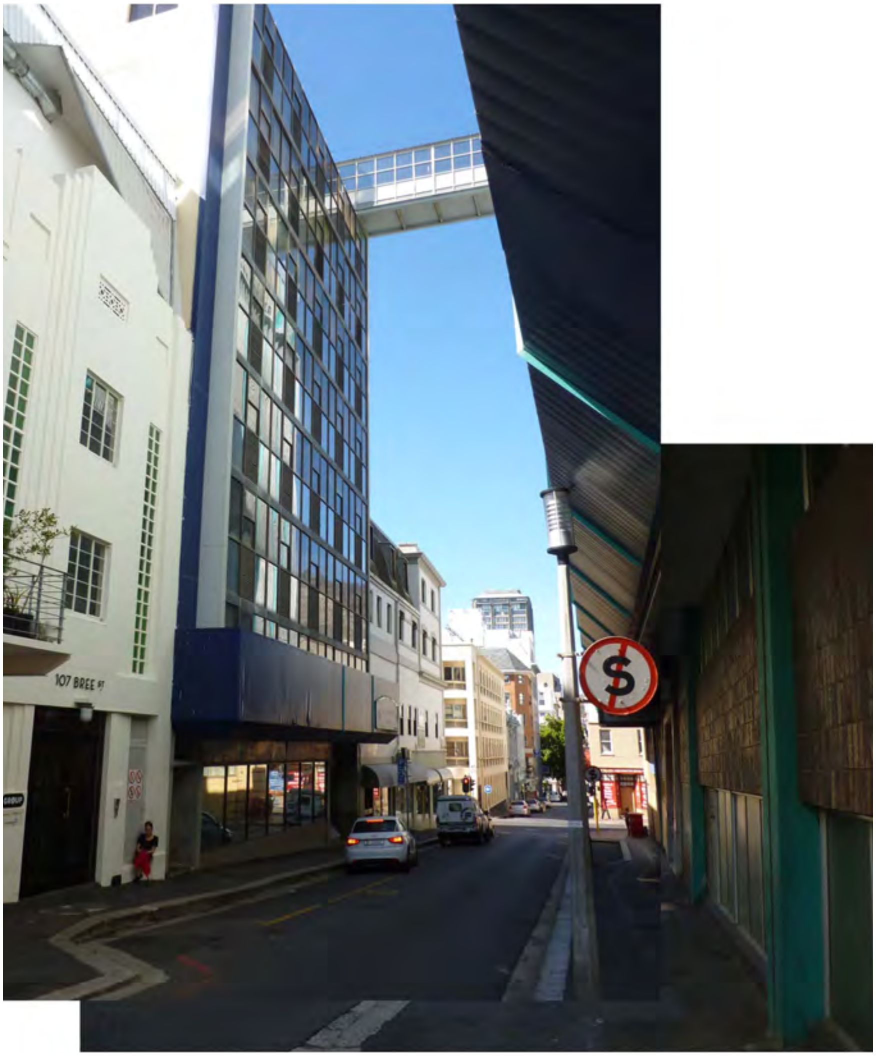


Figure 60: Longmarket Street frontage is unpenetrable and does nothing to enhance its surroundings but rather detracts from them

Figure 61: Unwelcoming street frontage on all four sides of the building

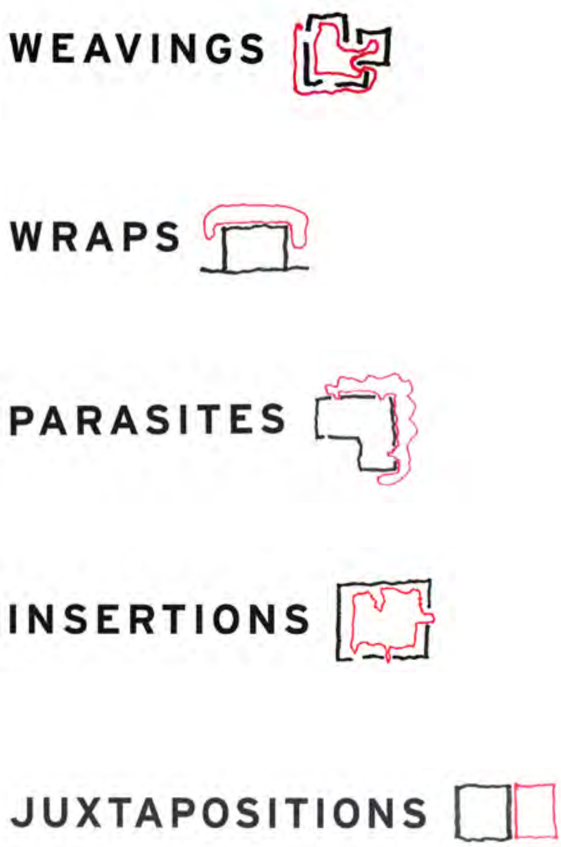


Figure 62: Strategies for restorative reuse as defined by Francoise Bollock in "Old Buildings New Forms"

EVOLVING A METHODOLOGY

Interventions for a responsible and sensitive design operation

Various and very different approaches can be taken when dealing with an existing building. Strategies involve either meticulously restoring the existing structure, or bringing it into the realm of the modern through interventions, either invasive or of a gentler nature. The stance taken in this dissertation is one of improving upon the current reality, rather than replacing or mimicking it. In doing so the existing structure is not regarded as a ruin or a distant object, but as a component of the present, with the new design weaving itself in-between the old.

Although this thesis topic addresses global concerns, the proposed design rather focuses on an architectural solution to a specific site, instead of general strategies for concrete frame buildings. As every building brings with it its own set of challenges, constraints, bulk and site conditions, individual responses are required; thus allowing for innovation. The transformation aims to arrive at a design operation of relevance that communicates both the previous and continued life of the structure, the environmental benefits of the adaption and the positive architecture created for the inhabitants when incorporating the surrounding climate within the design. Alterations are only undertaken to progressively change the space from what it was to what it could be – through minimum impact achieving maximum results. This project is therefore not of a radical nature or an attempt to create an icon in the city, but rather to exhibit the benefits of climate responsive architecture to generate spaces in which its occupants feel comfortable.

Figure 63: Collage depicting sought after internal qualities of the atrium

Architectural Response

The theoretical underpinnings serve as the basis for the design, with the general idea being to retain the embodied energy and actively engaging with the existing, as well as encouraging environmental consciousness and bringing new life and purpose to the building.

In the case of the Christiaan Barnard Hospital, this was done through retaining the bulk of the existing concrete frame (86%), while enhancing the internal quality of the building through the incorporation of light wells and various cuts and punctures throughout. While increasing occupancy wellbeing, this also allows for a comfortable interior climate through passive means; thereby improving the energy efficiency of the building. The functional changes in the building also allow for the reintegration of the building into the Cape Town CBD as a building that will now contribute to its surroundings – illustrating the potential of a buildings re-use and positive transformation.

The subsections to follow look to acknowledge and unpack the physical restraints and opportunities which influenced the points of entry and the design process, showing them not as limitations but rather as interesting challenges and unique opportunities explored. These 'limitations' include the existing structure, services and parking, while other influential factors are also explored. Combining these parameters with the existing structure develops an additional richness, giving rise to a layered more intricate end product compared to tearing a building down and starting afresh. The environmental, economic and social benefits of this rehabilitation are discussed further and hopefully serve as a precedent for a methodology for future sustainable building refurbishments.

Transformation

Urban Response

The Christiaan Barnard Hospital forms part of a desirable neighbourhood and is surrounded by an increasingly active street life, yet it does little to nothing to contribute to it. Amongst the otherwise palimpsest fragmented urban fabric, the existing building negatively sets itself apart from its surroundings due to its large bulk of occupying an entire city block. Consequently, the side streets on either end are cast in shadow for most of day. In addition, the hospital lacks a positive and engaging street response, resulting in dead spaces on all four sides of the building amongst an otherwise bustling part of the CBD – identifying another key aspect for improvement of the existing building. This is primarily due to the ground floor being occupied and utilised for car accessibility (Figure 64), which has resulted in the building appearing shut off and unfriendly to pedestrians.

On an urban scale, a greater connection and engagement with the surrounding context was sought. One of the first design moves involved the rethinking of the ground plane. In redirecting the car movement, inverting the car ramps into pedestrian spaces, as seen in Figure 65, and pulling the side-walks into the building, the ground plane can actively contribute to and enhance its surroundings. The design proposal allows for a greater interaction with Bree Street – currently an increasingly popular and active pedestrian street. The current pedestrian entrance off Longmarket Street will be kept as a more private entrance. This reinforces the street as a pedestrian street – historically being the longest pedestrian street connecting Green Market Square to Bo-Kaap.

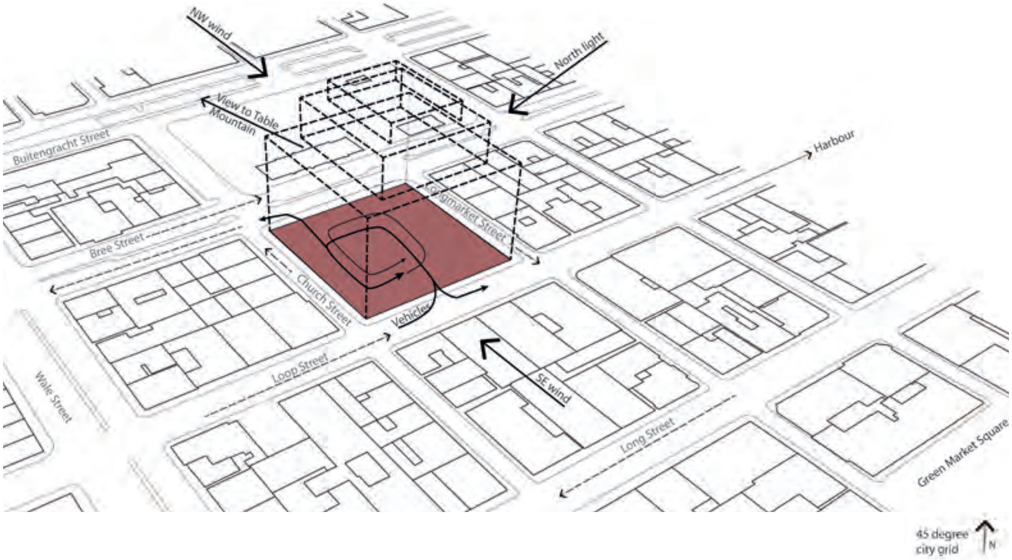


Figure 64:
Urban context

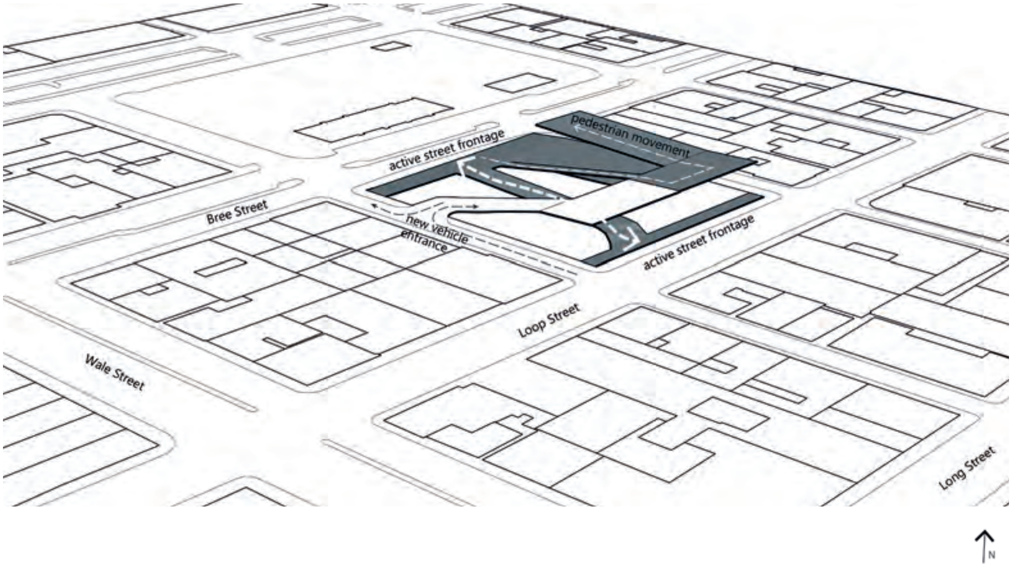


Figure 65:
Initial urban responses

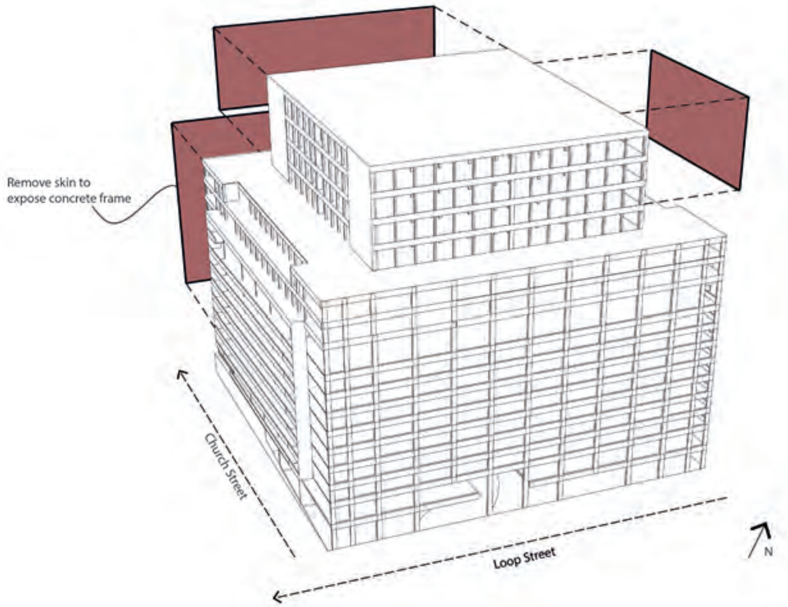


Figure 66: The existing concrete frame structure is exposed

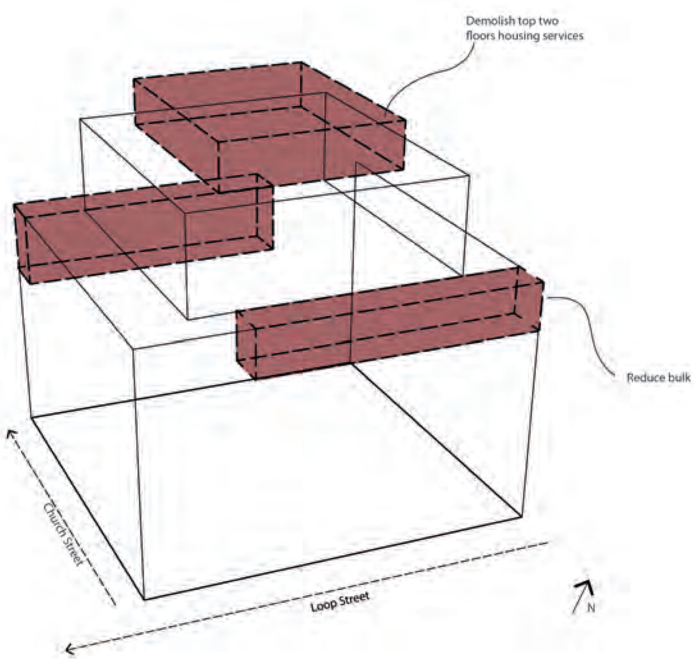


Figure 67: The top two floors are demolished and some of the sides are cut back to reduce the bulk of the building

Structure

In some cases the height clearance within a building might be unsuitable for the requirements of the proposed future use, yet this is not the case in the Christiaan Barnard Hospital building. With a generous floor to ceiling height in the hospital (previously office floors), as well as the parking levels, easy conversion of the building in question is possible. The decision was thus taken to strip the building to reveal the original structural concrete frame, which provided the starting point of the new design and defined the remodelling possibilities.

According to Georgopoulos and Minso (2014), due to concrete's robustness, durability and the redundancy of the frame structure, concrete frame buildings can be stripped to their core and easily re-used. However, it is important to keep the column grid and shear walls to ensure the building's stability is not compromised (King, 2013). Thus, interference and alterations within the frame occur strategically and minimally to improve upon the internal conditions and better respond to the surrounding urban fabric.

The least amount of unnecessary disruption to the structural frame was sought after, as the structure of a building is the largest component of initial embodied energy. By retaining the initial embodied energy, the required energy of the new design is reduced, which also decreases the carbon footprint of the building. Yet the design aimed at drastically enhancing the amount of natural light and ventilation achieved within the interior. Thus, in an attempt to modify the interior environment, as well as to reduce the scale of the building within its context, the frame was cut and punctured in places and the top two levels, housing services, were demolished, as seen in Figure 67. The punctures are strategically placed and thus minimal, resulting in about 86% of the existing concrete frame and slabs being retained, reducing the amount of rubble going to landfills and advocating its re-use for financial as well as environmental reasons.

The adaptions to the frame considered the orientation of the site, the surrounding built context, climatic drivers and enhancing of views. These intricately placed cuts set up a disturbance, generating a complex interior landscape consisting of varying conditions and interesting spaces.

Light well

Two existing light wells are currently not taken advantage of within the collectively deep floor-plates (seen in Figure 68). Subsequently, much of the building's interior does not have access to natural light. In addition, all windows are tinted and glued shut for privacy and security reasons – further separating the occupants from their exterior environment. The service lifts (inserted into the main light well in about 1984) were removed from the light wells in the pursuit of re-incorporating the light wells into the design. This will allow for the channelling of light, linking of programs and enhancement of both vertical and horizontal views. This light well, already puncturing most of the building, was extended further to the ground level and acts as a vertical social connector. The second light well organises a more private realm and swells in places to become more generous.

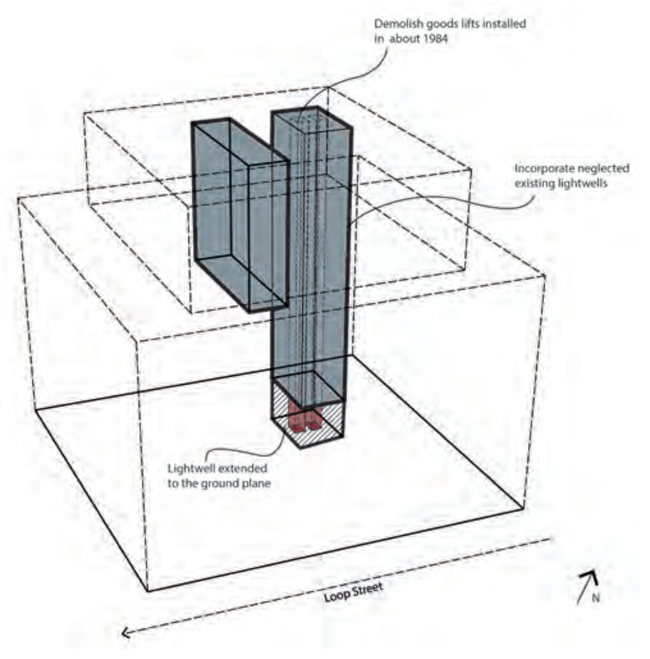


Figure 68: The two existing light wells are reincorporated within the design

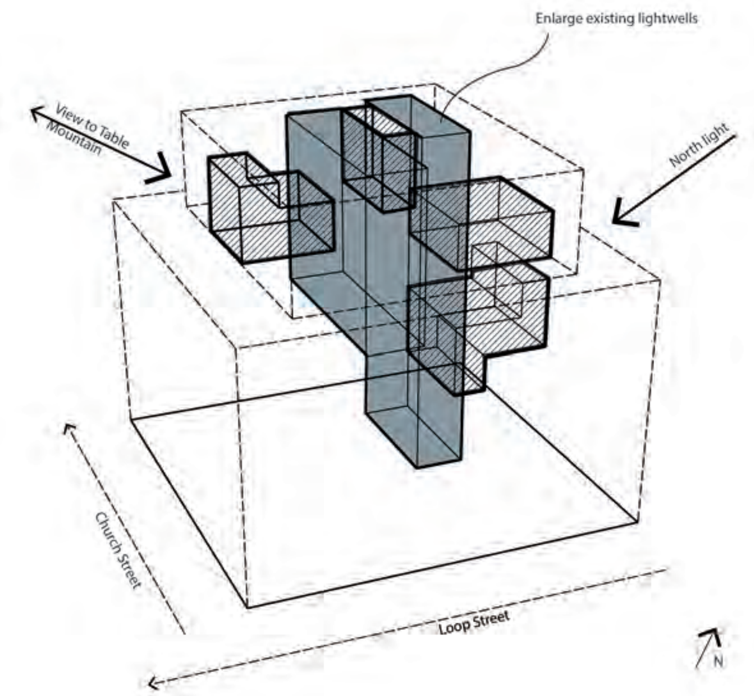


Figure 69: The light wells are extended, as well as swell and become one in places to achieve a continuous space

With the addition of further cuts and punctures into the structural frame, natural light is able to penetrate further into the deep floor plate from various sources. The continuous space achieved (Figure 69) is then combined with people and service risers, circulation and social spaces, which allows the naturally-lit central public realm to function as the heart of the building. The continuous central public space simultaneously assists with the technical function of passive cooling, ventilating and heating the building as much as possible. These effective yet simple place responsive regional strategies, simultaneously have the potential to significantly reduce the energy consumption of the building, as well as to receive renewed attention within the design.

Program

Within the design exploration, functions such as structure, light, circulation and energy are treated as the drivers, with the program organising itself around them according to their distribution. This dissertation as such developed a masterplan for the building, with the program of the building and the environmental concerns centred on the existing light wells.

In this process, the ground planes are given over to pedestrian movement, and further opportunities are taken to create public areas at various additional levels within the building – making use of the existing unutilised setbacks and rooftop spaces (Figure 72). The idea of a public realm within the upper floors of the building is reinforced with a campus typology over three floors, offering a variety of flexible working spaces, incorporating public and private amenities.

According to Rob McGaffin, a town planner and land economist lecturing at the University of Cape Town, the commercial market is currently unbelievably flat (R McGaffin 2015, pers. comm., 29 July). The question posed was thus, what space is in demand within the inner CBD. The answer to this question is residential accommodation. Yet, as the market constantly changes and fluctuates, these spaces would need to be flexible enough to accommodate future possible needs of office space – which is clearly possible from the adaptability of the concrete frame.

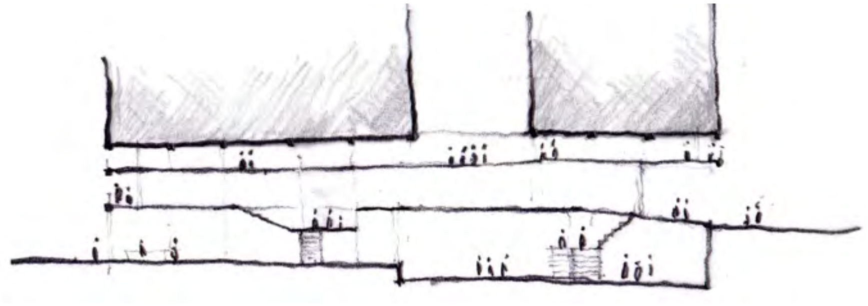


Figure 70: Public access extended across the ground plane and upwards

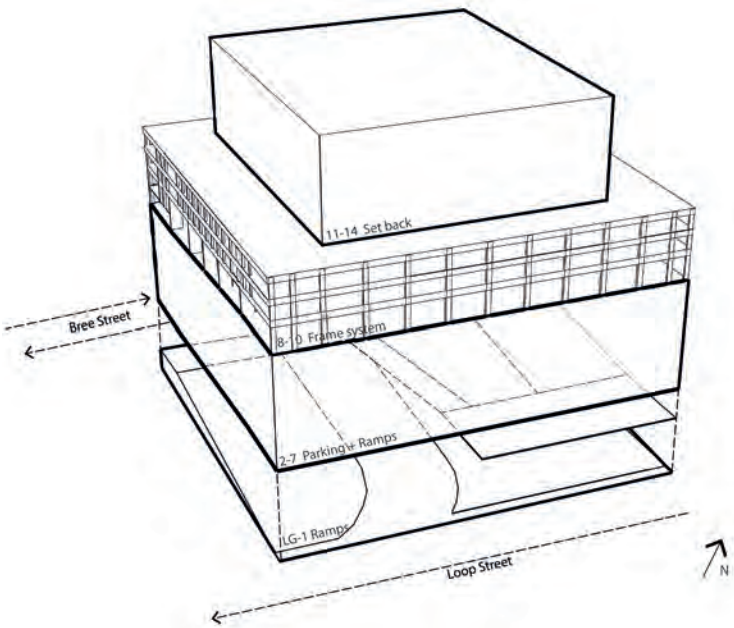


Figure 71: The conditions of the structural frame require individual responses

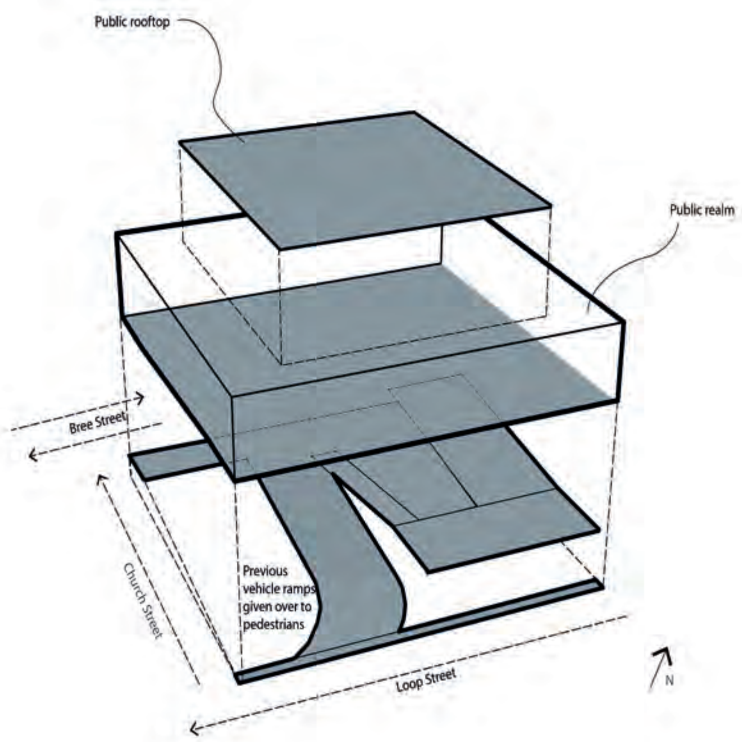


Figure 72: Further public realms are incoporated within the design

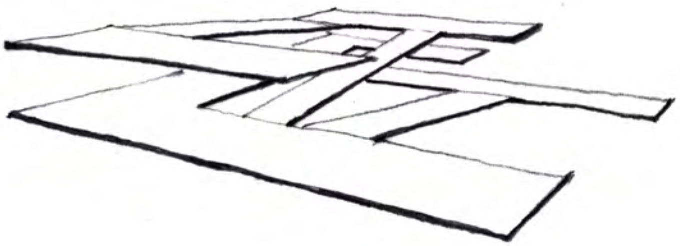
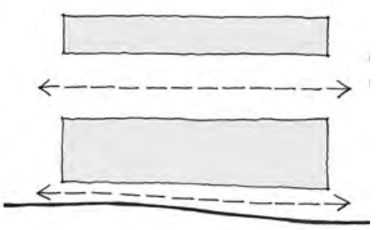


Figure 73 & 74: Car ramps on the first few floors are given over to pedestrians



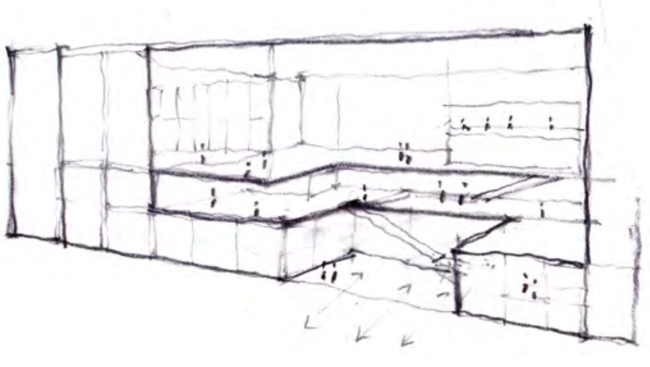


Figure 75 & 76: Within the upper public realm large civic openings are punctured into the frame and visual permeability is enhanced

Figure 77: Model exploration of permeability, beauty of exposed columns and potential light quality achieved through opening up the building

Parking

The seven levels of existing parking are of great economic value to the hospital. They are used by permanent hospital staff and hospital visitors, with about half of the bays rented to people working in the area (for a substantial amount). In terms of the economic value of the parking, as well as the need for parking within the inner CBD, the decision was made to keep most of the parking, yet investigate whether it would be possible to reduce this and make use of the space in other ways.

As engineers normally over-design building structures, parking areas are generally designed for an imposed load of 5.0 kN/m2, while office spaces, as well as residential activities, require 3.0 kN/m2. As a result, the parking area can seamlessly be converted into office or residential space without worrying about the structural integrity of the concrete frame. As such, from a structural point of view, as well as due to the adequate floor to ceiling heights, a portion of the parking area shall be given over and occupied by an alternative use, namely residential. This conversion results in the feat of an active street frontage on three sides of the building within the first 7 floors, as seen in Figure 81.

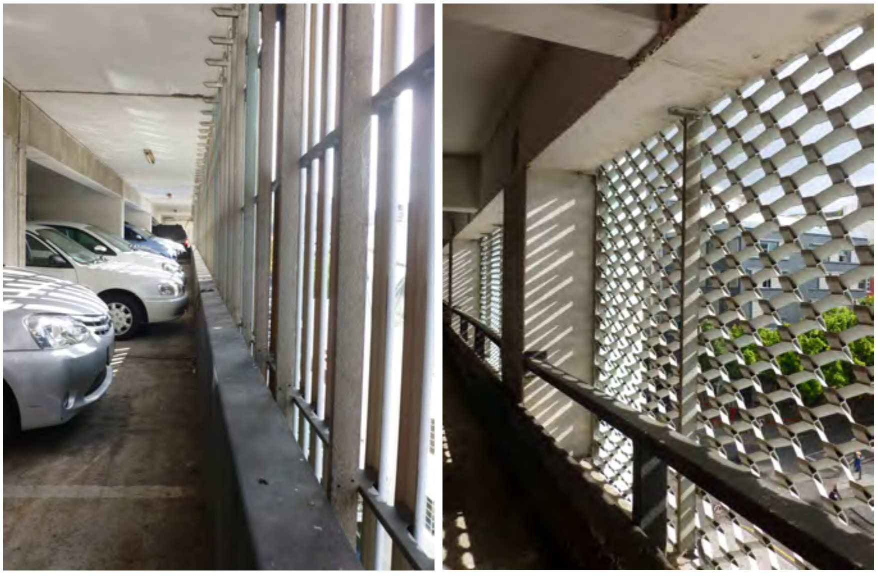
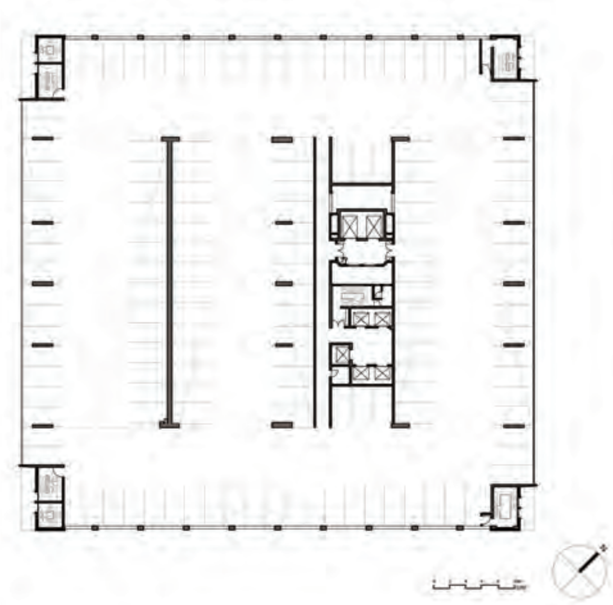


Figure 78: Images of the existing downstand conditions and screening used in the parking floors



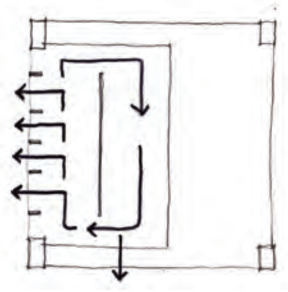


Figure 79: The existing parking layout

Figure 80: A CO2 sensor and shunt fans shall be installed to naturally ventilate the parking area as much as possible

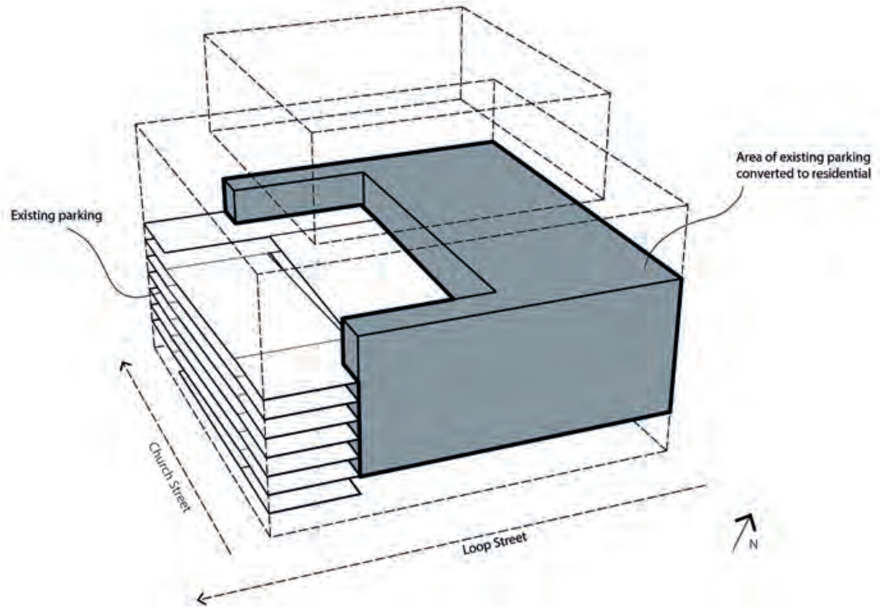


Figure 81: The proposed new strategy allows for three sides of the floor plate to be given over to other uses

Circulation

The existing fire escapes and central lift core were interrogated in terms of the new use of the building. As various private and public levels exist, a clear circulation strategy needed to be developed. With the prediction that the building's use would perhaps keep changing, the circulation needed to be flexible enough for the floor plate to be owned by one or various parties. Two circulation cores have thus been established – the existing central lift core as well as a new core on the opposite side of the building. The two fire escapes (on the southern side of the building) are kept in their same location, while the other two (currently situated on the northern ends) are moved slightly inwards to free up the corners for other use (Figure 84). Within the atrium space, newly introduced walkways were offset from the grid, as irregularity reinforces and creates a somewhat Piranesian space to enhance social interaction within this new central circulation 'atrium' space.

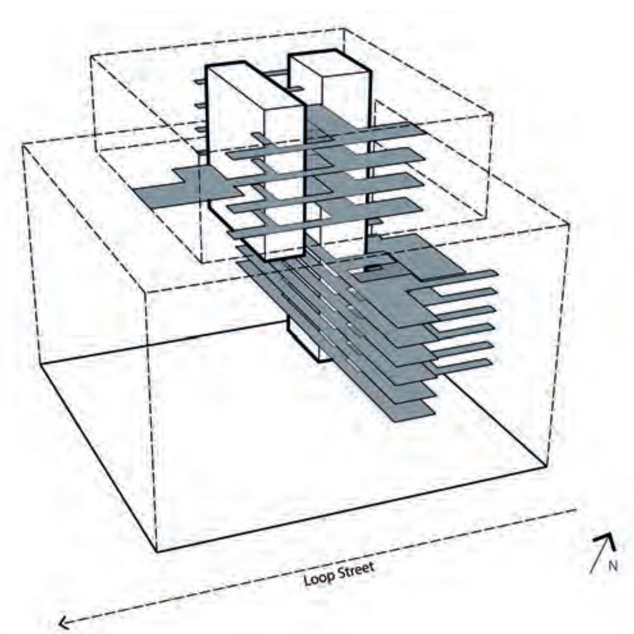


Figure 82: The circulation wraps itself in and around the light wells

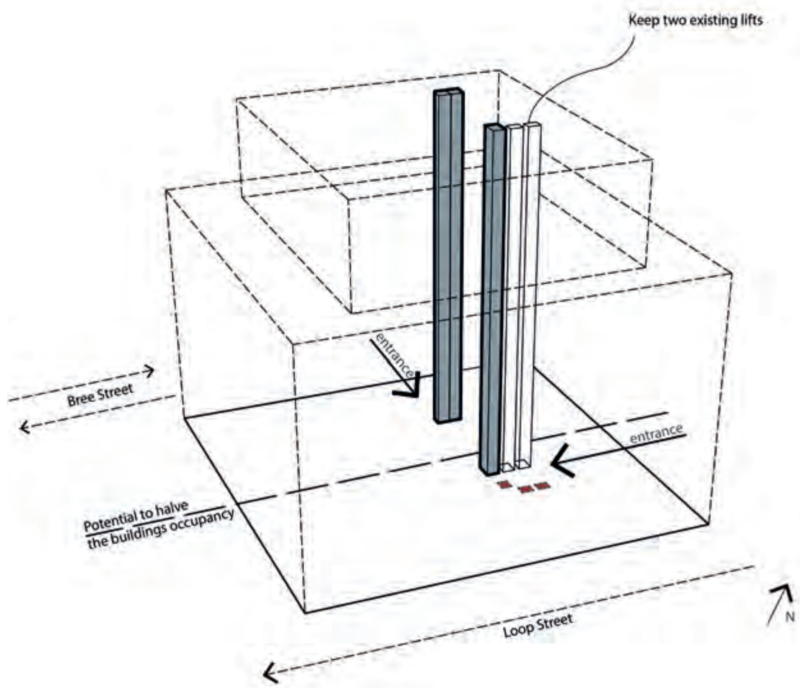


Figure 83: Two central lift cores are established – the existing core is kept with the introduction of a stretcher lift and a new core is introduced off Bree Street

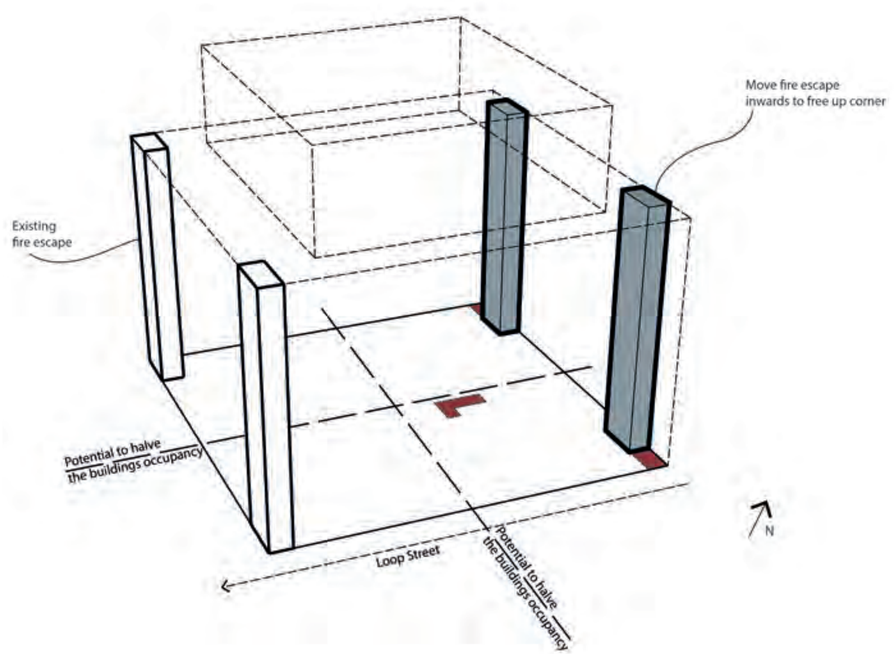


Figure 84: Two existing fire escapes are kept. Two further existing fire escapes are moved inwards on the north side of the building. The 5th existing fire escape is also demolished to enhance the permeability within the centre of the building

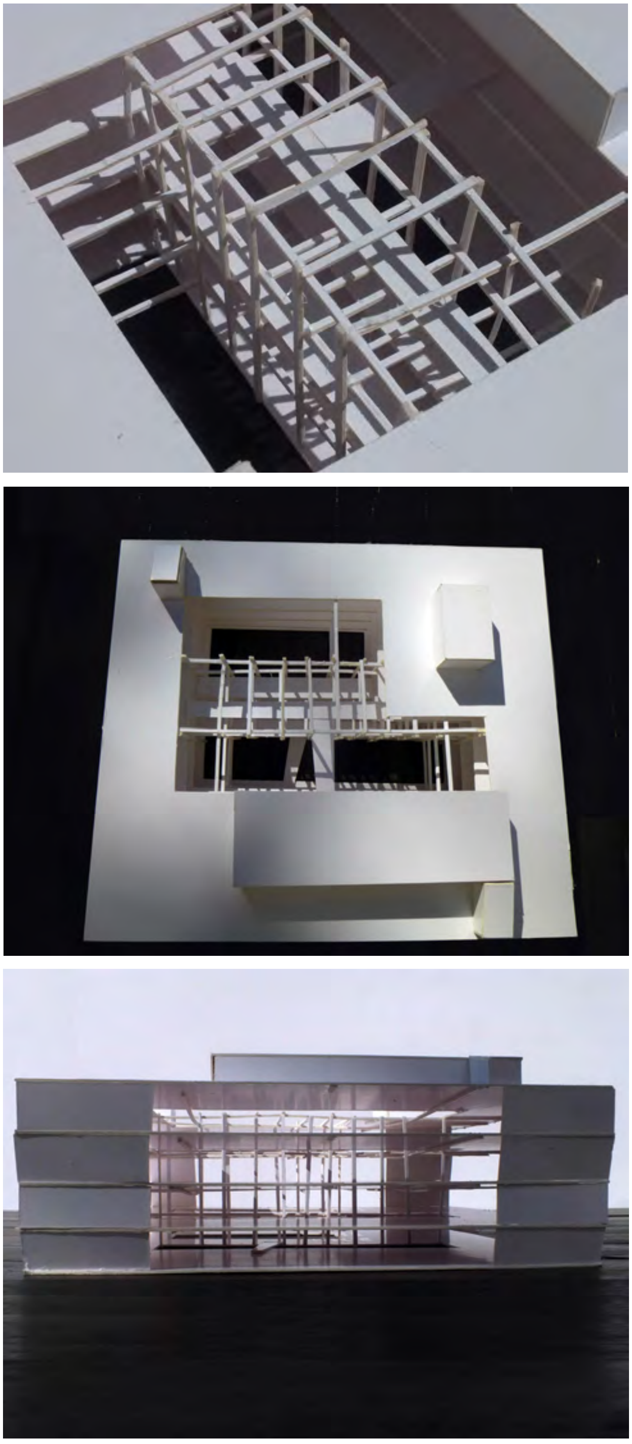


Figure 85: Model exploring the joining of the light wells while leaving the existing concrete frame in place

Figure 86: Collage exploring the idea of an open air courtyard with covered and open walkways, pulling and pushing of the frame, exterior balcony spaces and sun rooms

Occupancy Comfort

Within the realm of sustainability, the aim of architecture should be to maximise human comfort while minimising the reliance on fossil based energy (Smith, 2001). According to various field studies and research on this subject, people are comfortable in temperatures that range in between 15-30°C (Humphreys, 1992). The primary factors determining the state of comfort include air temperature, mean radiant temperature, air humidity, air motion, location and season, psychological state of mind, clothing and activity level (Bansal and Hauser, 1994). Furthermore, Humphrey states that the thermal discomfort is not brought on by the room temperature itself, but by the discrepancy between the actual temperature and the desired temperature (Humphreys, 1992). Humans are more tolerable of conditions in naturally ventilated spaces (as the thermal environment is predicted or known) rather than in sealed boxes, which increase the perceived comfort by nearly 5°C (Keeler and Burke, 2009). Therefore, adequate natural ventilation and air movement is not only important for the health and comfort of building occupants, but it is also a highly influential method of increasing the acceptable range of temperatures. As buildings will increasingly need to respond to rising temperatures, these statements are of extreme importance when addressing the design of buildings and support passive design strategies. Thus, within the transformation, rather than creating a 'sealed glass box', passive strategies have been incorporated and were used as much as possible.

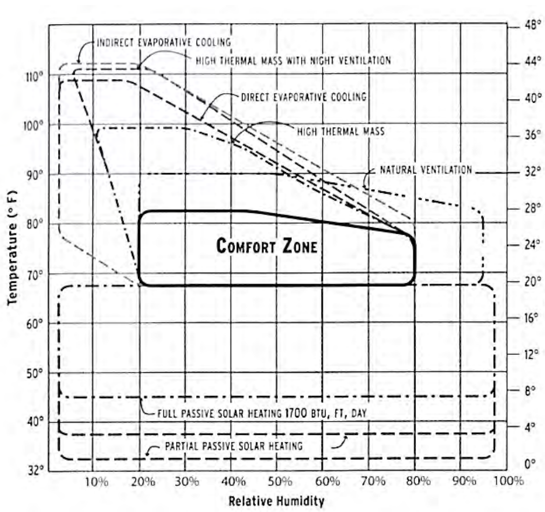


Figure 87: The limits of the human comfort zone can be extended by means of passive design - mainly through shading the sun, air movement and the use of thermal mass

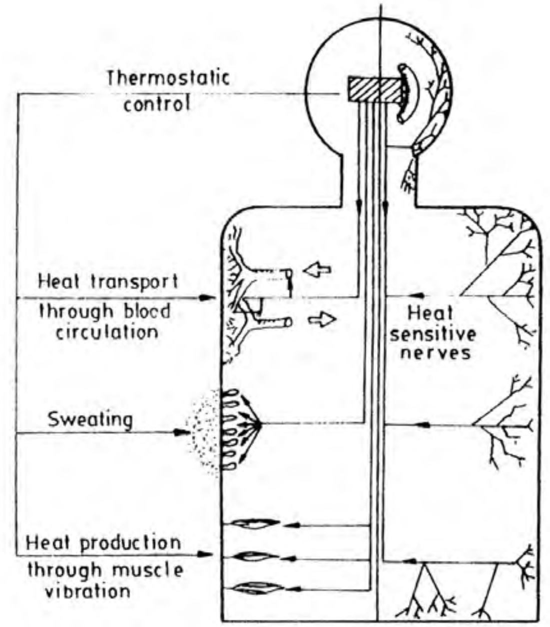


Figure 88: Heat balance in human beings

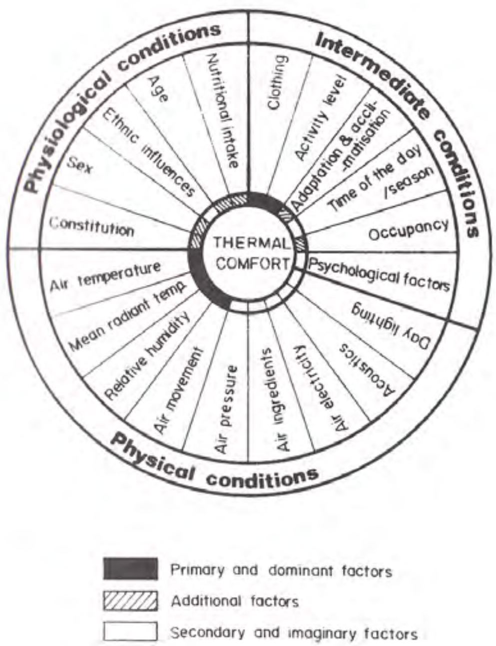


Figure 89: Various physical and physiological factors influence the state of thermal comfort

Traditionally, vernacular types of architecture have been considered as adaptive measures to their natural environment (Asquith and Vellinga, 2006). Rather than advocating their continued use, their re-interpretation within the current climate is of value in the southern and northern hemisphere, to build more resilient, critical regionally appropriate buildings. Exposed concrete is particularly helpful due to its high thermal mass and as such, the wall, ceiling and floor coverings shall be removed in the re-design of the Christiaan Barnard Hospital, to unlock the thermal mass potential of the slab. The exposed concrete soffits, together with raised floors consisting of sufficient insulation, create a heat sink, storing the afternoon sun's heat. Thus, the material properties of concrete can help to reduce CO_2 emissions in the long run, as well as save on running costs of the building.

Figure 90: Collage of exposed concrete surfaces, concrete frame roof structure and openable windows creating a naturally lit and ventilated interior space

Within the dissertation, further passive strategies are based on user control and the “adaptive comfort theory”. This theory reiterates that occupants can create their own thermal comfort and preference by modifying their environment, referring to the ability to open a window. Occupants are simply given the means to regulate the indoor climate, creating a situation that works with the context and climatic environment, rather than isolating a building and its occupants thereof. An anodised aluminium mesh screen, comprising of singular movable elements in response to the various orientations, was thus wrapped around the building, creating a uniform but unique façade. The new semi-transparent façade performs several functional and experiential roles at once; including providing privacy, as well as shading, yet allowing for natural light and ventilation to enter the building.

Figure 91: Occupants are usually dissatisfied when they have no control over their environemt

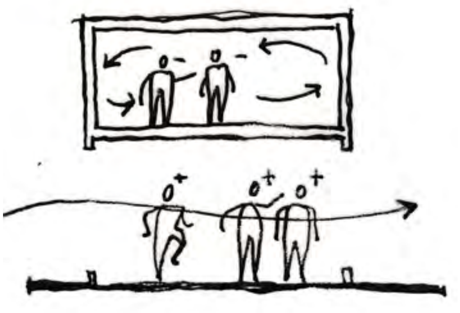


Figure 92: Building occupants are more tolerable of higher temperatures in naturally ventilated buildings

The aim of the additions was thus to create a more comfortable interior climate through the use of low-impact user controlled technologies. Additionally, the need for extensive mechanical cooling and heating (and large amounts of energy) to provide comfort within the interior was avoided. Any further central heating and cooling will be offset and covered by solar panels, resulting in a heating and cooling system that is as carbon neutral as possible.

The façade’s transparency additionally allows for a dynamic unique façade, giving architectural expression to the external building appearance, revealing and concealing the existing concrete frame, as well as reflecting the occupants within.

Layering

A change in the material pallet was selected to provide a clear distinction between the old and the new, to make one aware that the building is layered and has evolved over time. This is done by tectonically contrasting the existing monumental, heavy and durable concrete with a structural system that embodies a more lightweight quality. Steel was thus used as the structural element for the additions as it embodies the sought after qualities and appears less permanent through its ability to be dismantled. The new inserted structure is however downplayed, visible but not foregrounded, to allow the primary structure to read as such.

Subtle yet distinctive joints of the two were sought after within the design to reinforce the idea of a visible repair. This was achieved not only through the difference in materiality, but in allowing a slight recess or shadow gap (depending on the situation) where the two meet. On both the exterior and interior of the building, the zeitgeist and layered history is expressed, displaying the building as a material culture with the old and the new working together to arrive at a contemporary design.

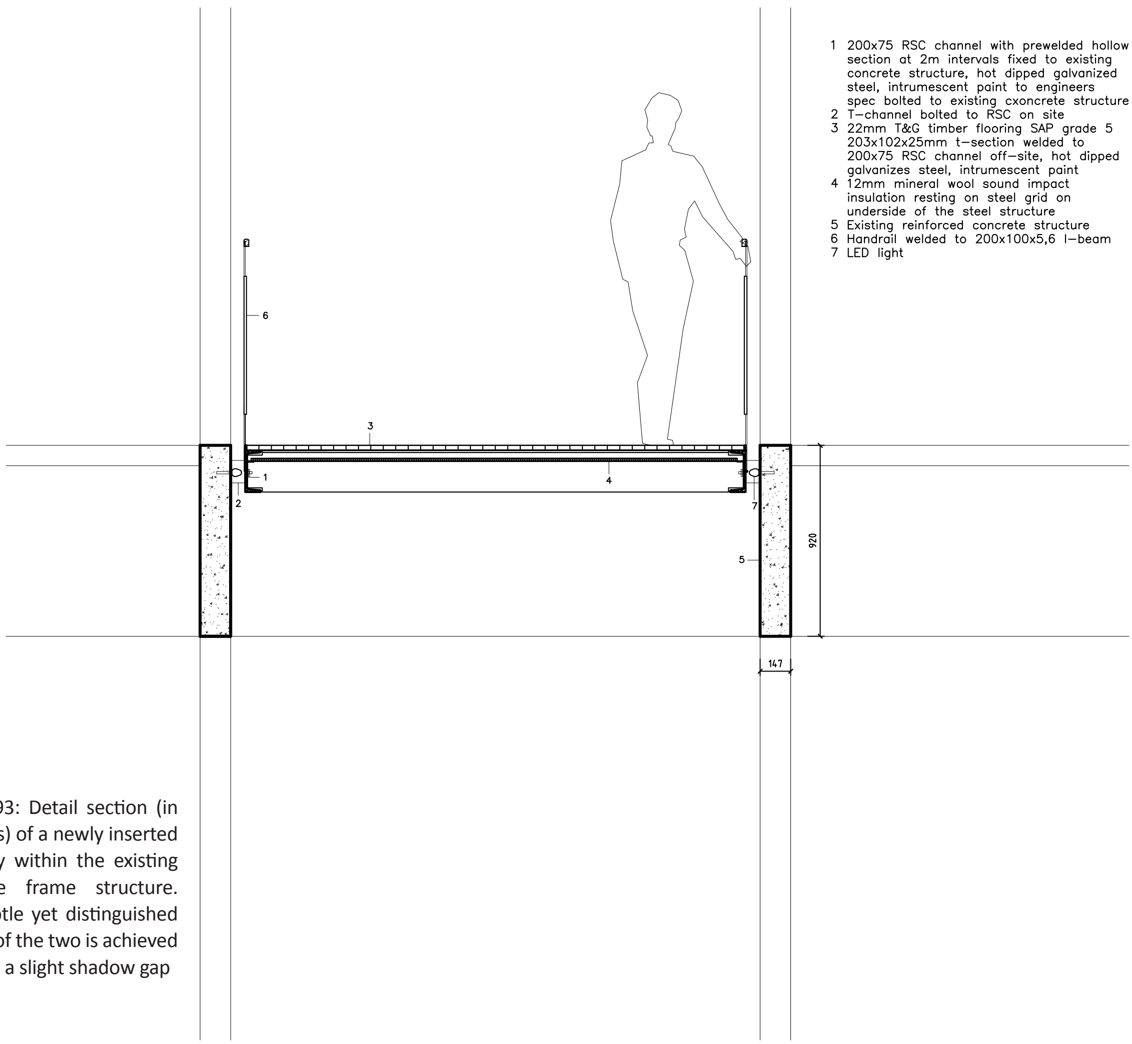


Figure 93: Detail section (in progress) of a newly inserted walkway within the existing concrete frame structure. The subtle yet distinguished joining of the two is achieved through a slight shadow gap

CONCLUSION

The built environment consumes large amounts of energy and contributes substantially to global CO_2 emissions. Two main sources within a building's lifecycle can be identified as the reasons behind this; namely the construction phase of a building and, in particular, the operational use of a building over its lifespan. In addition, as the existing building stock constitutes a large part of our cities, an urgent need exists to address and become involved in the transformation and environmentally conscious refurbishment of an already built environment.

Existing structures consist of a relatively large amount of embodied energy, which should be a considerable factor when deciding the future of older buildings. In light of this, the dissertation addressed the universal issue of 1960's building stock and whether to demolish or repurpose them once they have reached the 'end' of their lifespan. The Christiaan Barnard Hospital building is one such example, with the design operation aimed at showing the possibilities and promising future of a building otherwise deemed worthy of demolition.

The dissertation set out to combine two major challenges; environmental consciousness and the transformation and refurbishment of an already built environment The dissertation design exhibits the pragmatics of the re-use as positive opportunities (instead of limitations) in generating a much richer architecture. The economic, environmental and cultural benefits of the re-use, as well as the importance of layering within the city and not merely wiping the slate clean, but tackling and embracing the existing built environment.

With regards to environmental consciousness, the dissertation design attempts to address the need for a greater understanding and involvement of architects in tackling and increasing the energy efficiency of the existing built stock. A case for human participatory control methods and overall passive strategies was made. Buildings can be given pleasant internal conditions without the overload of technology; but rather through robust, sustainable, location driven design and the incorporation of occupancy driven environmental control. CO2 emissions can be reduced within such buildings, energy costs are much lower and most importantly, a comfortable living environment can be achieved. By doing so the dissertation presents a methodology for adaption when dealing with an existing structure and simultaneously making that structure resilient. In addition, the relatively large amounts of embodied energy in existing structures warrant greater recognition in a South African context as it further encourages the re-use of existing structures, with the ultimate goal to reduce the environmental impact while preserving the existing architecture.

The research and design contribute to the body of knowledge on building adaptions, the importance of embodied energy and need for energy-conscious renovations within contemporary architecture, with specific relevance to Cape Town. The design intention with the Christiaan Barnard Hospital strives to serve as a precedent for a methodology thereof, aiming to give this paradigm increased importance - encouraging improving upon reality rather than replacing it through displaying the transformation of the ordinary into something extraordinary.

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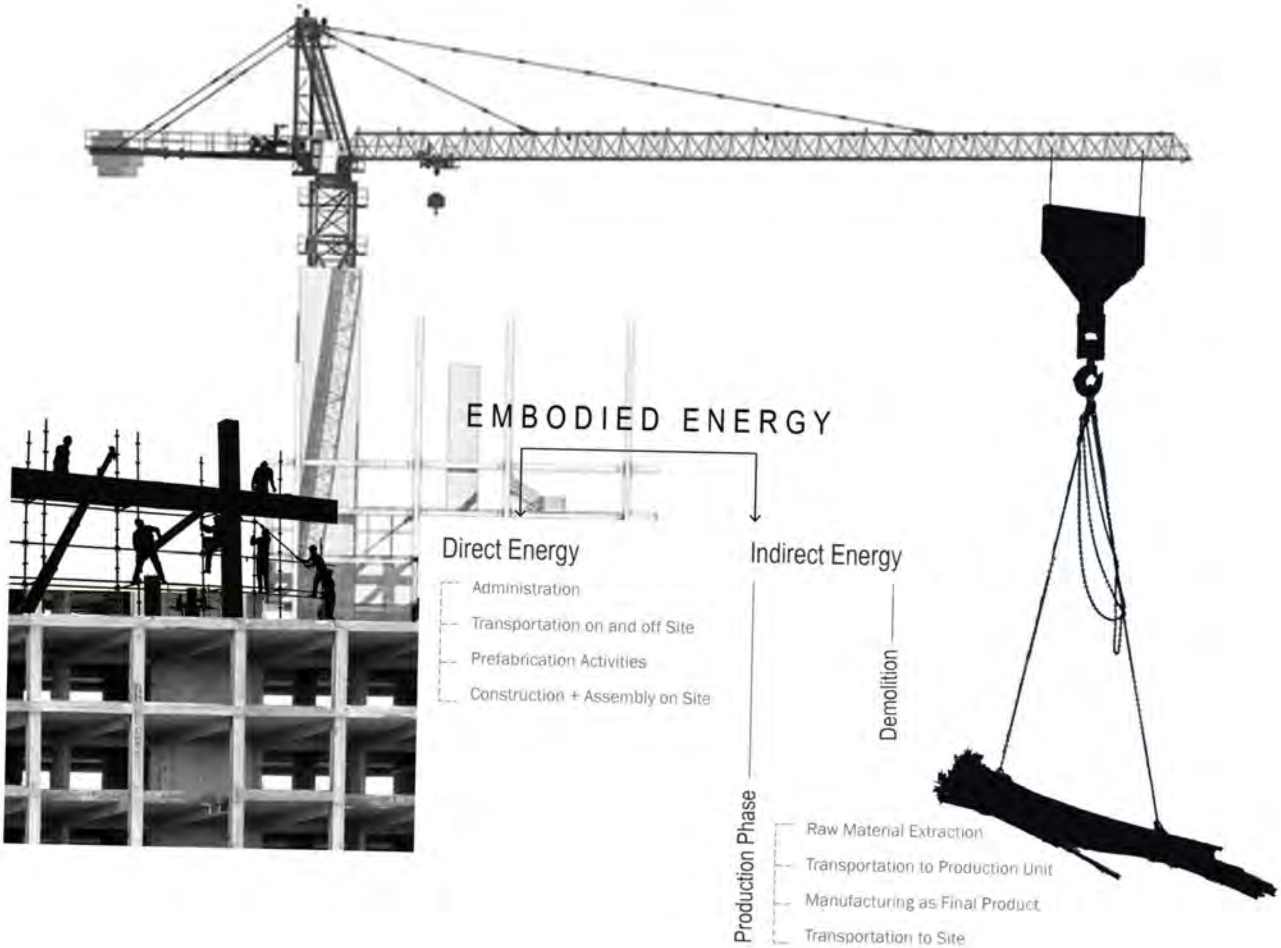
I DON'T BELIEVE IN
GLOBAL WARMING

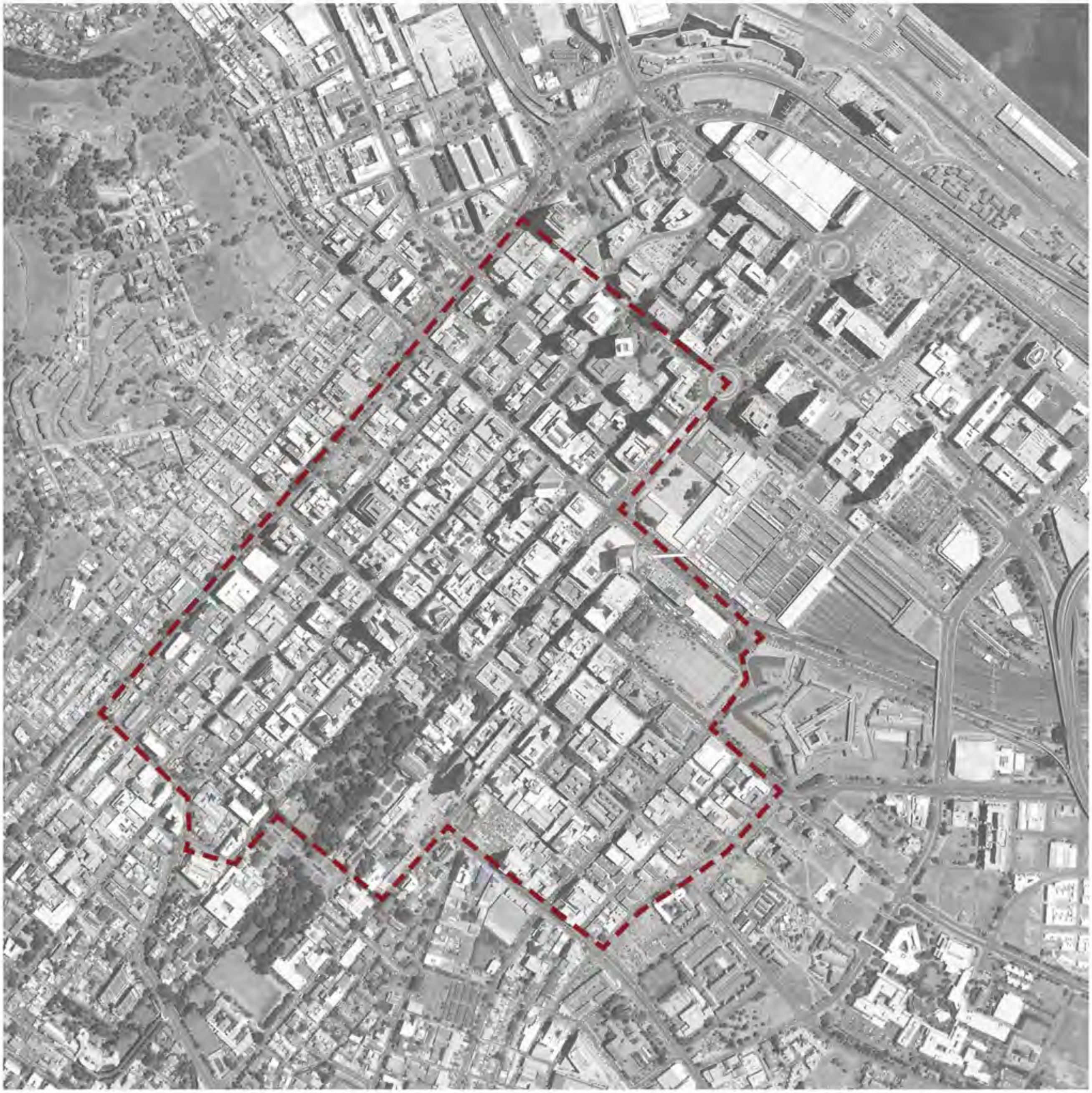


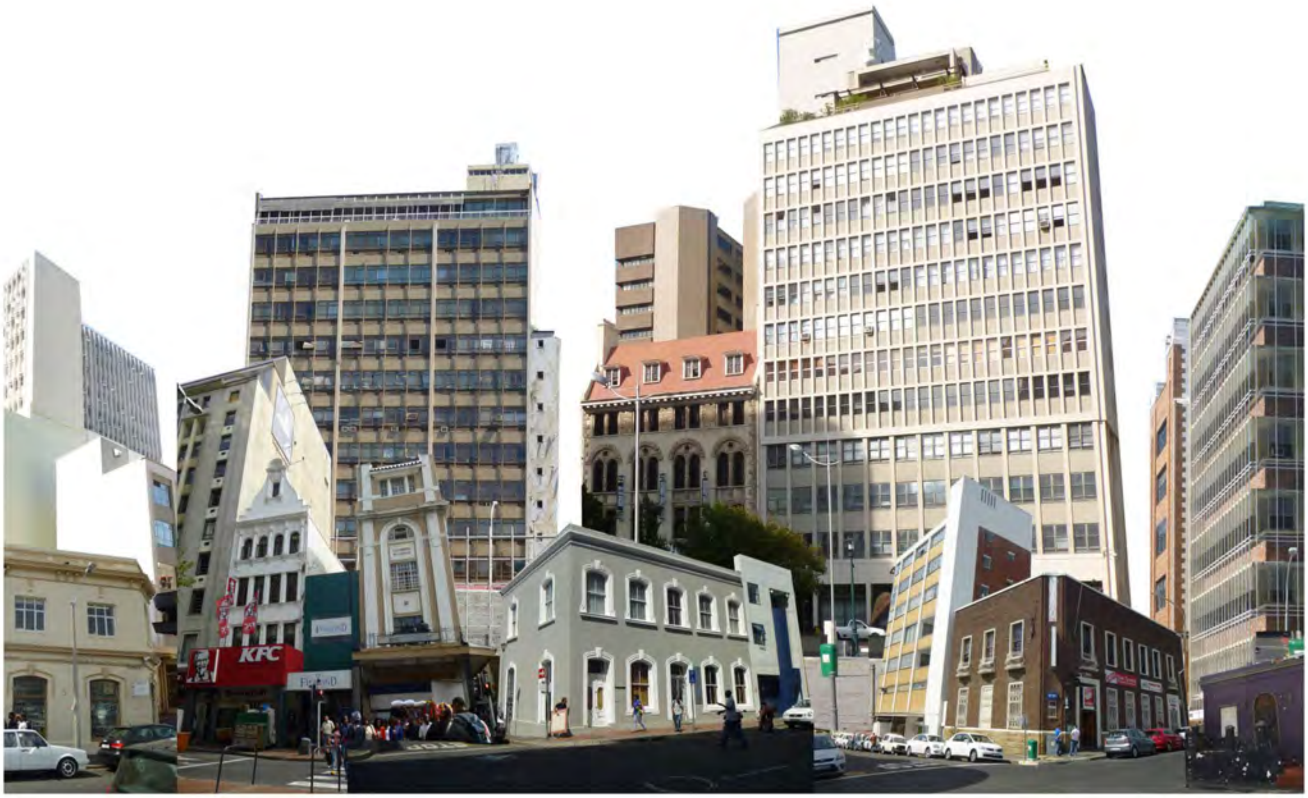
Life cycle energy of a building - Part 1

OPERATIONAL ENERGY

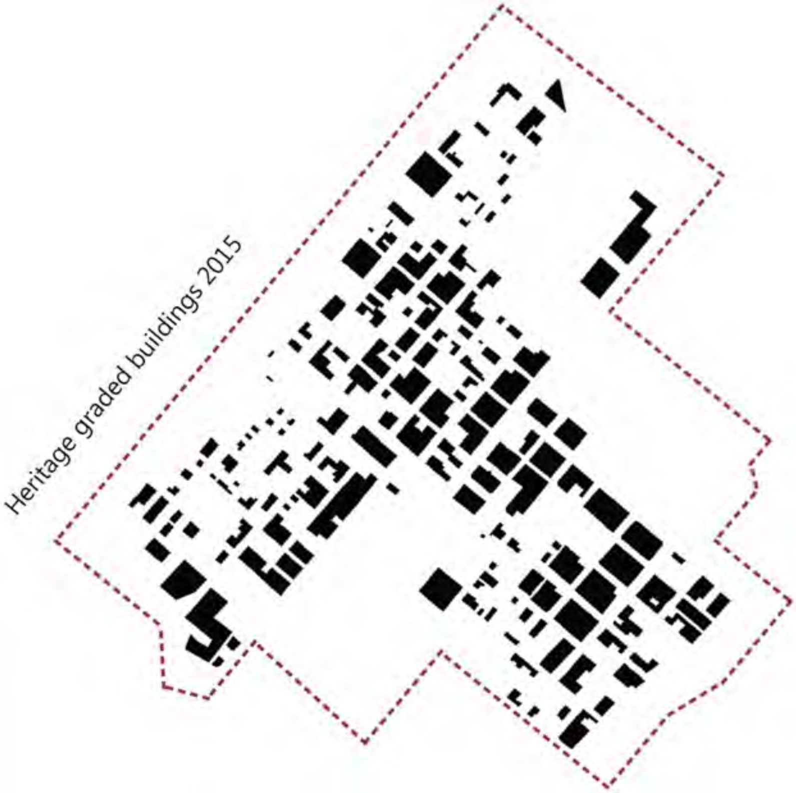
- Heating + Cooling
- Lighting + Ventilation
- Operating Appliances + Equipment
- Other Building Related Energy Use

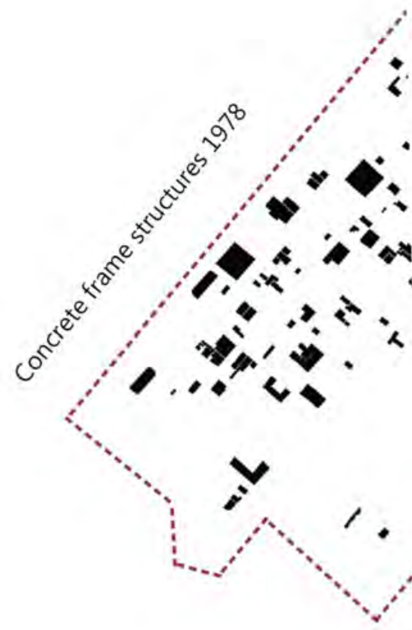
Life cycle energy of a building - Part 2




KFC

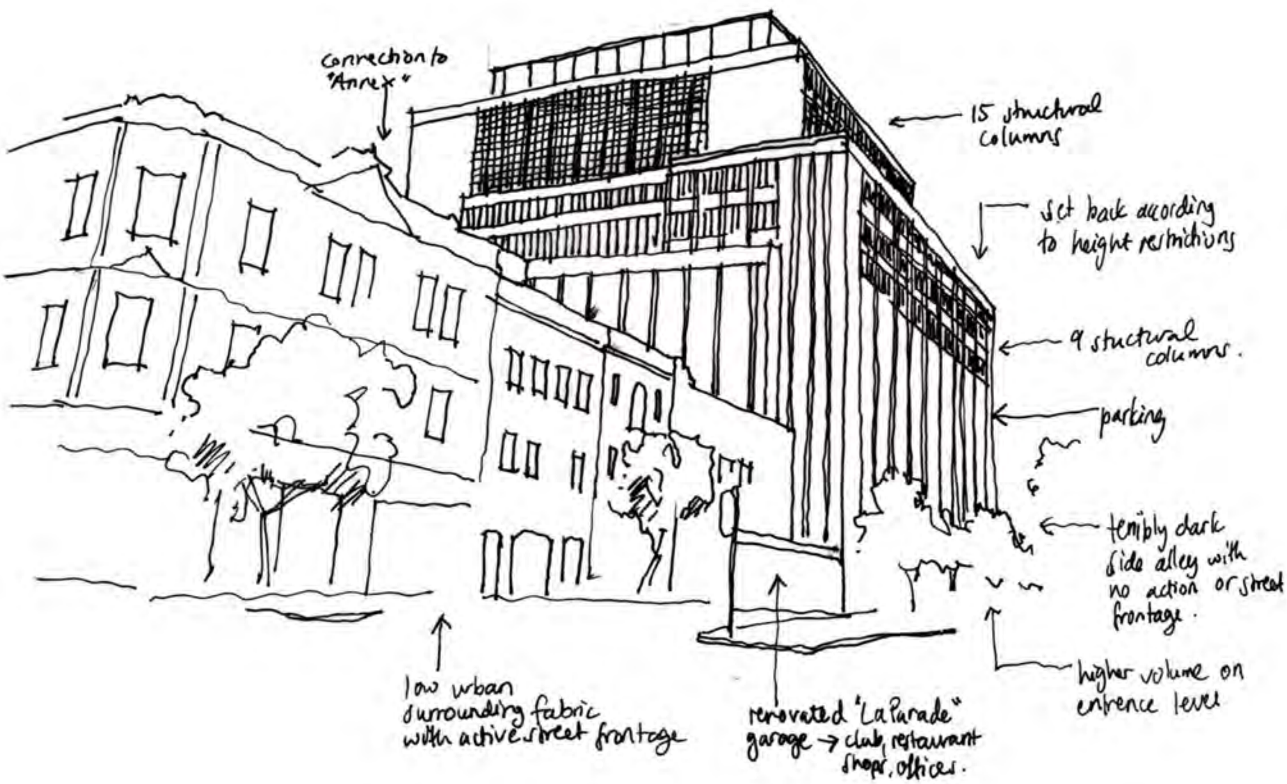

The recently demolished Tulip Hotel, Cape Town


Heritage graded buildings 2015


Concrete frame structures 1978


Concrete frame structures- not graded 2015

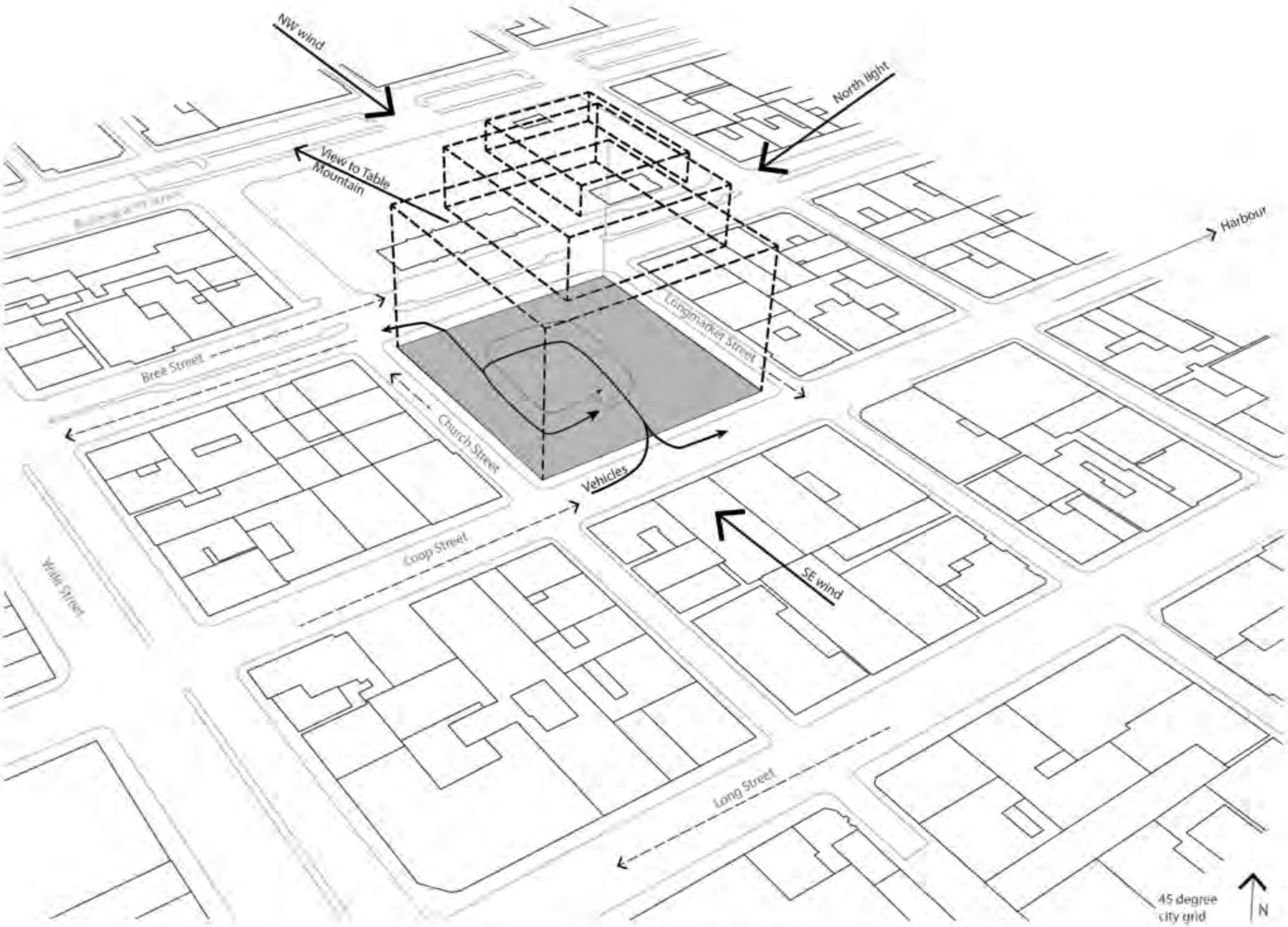
The Christiaan Barnard Hospital



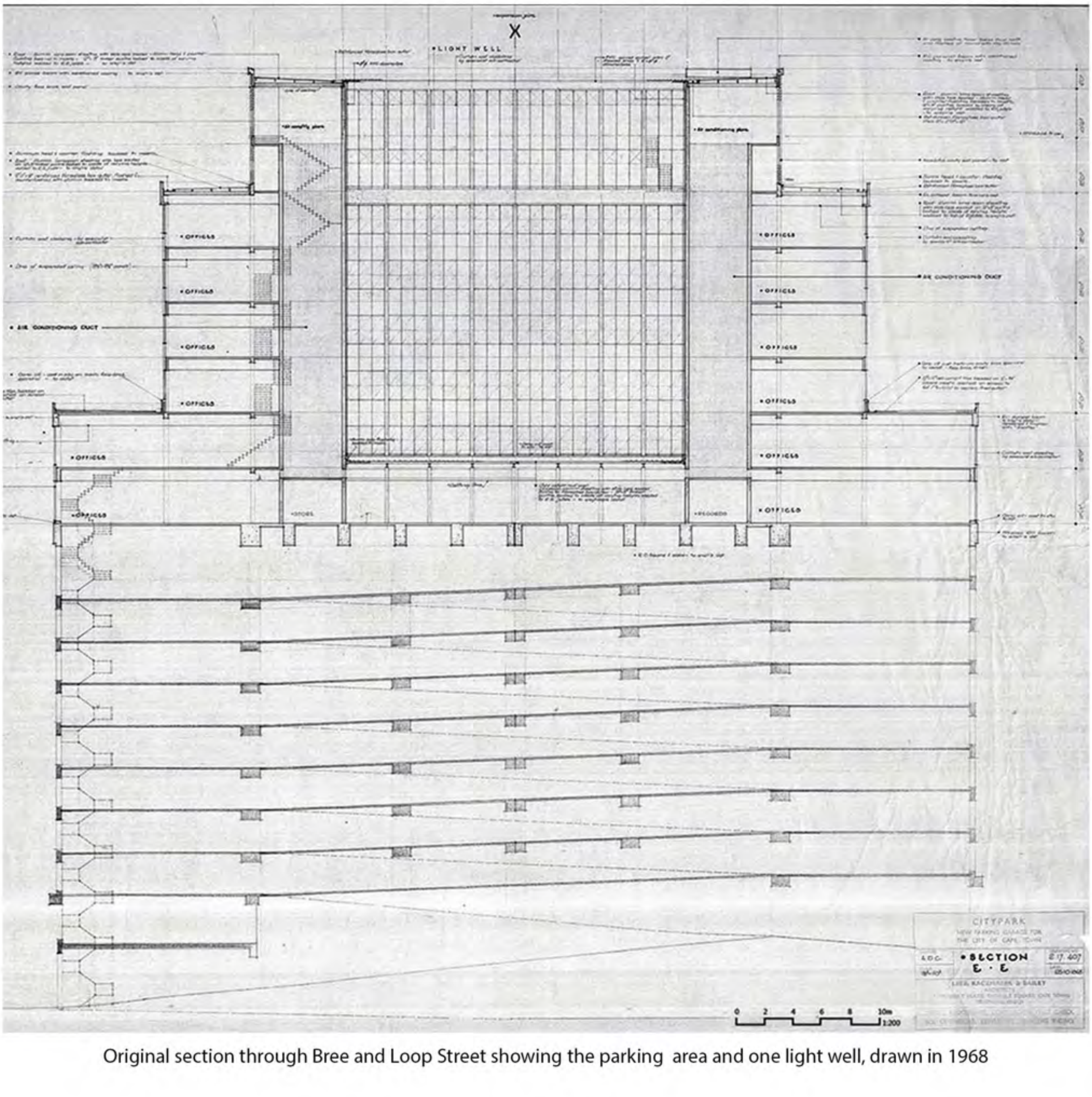
View of the Christiaan Barnard Hospital along Bree Street, looking towards Table Mountain


NETCARE

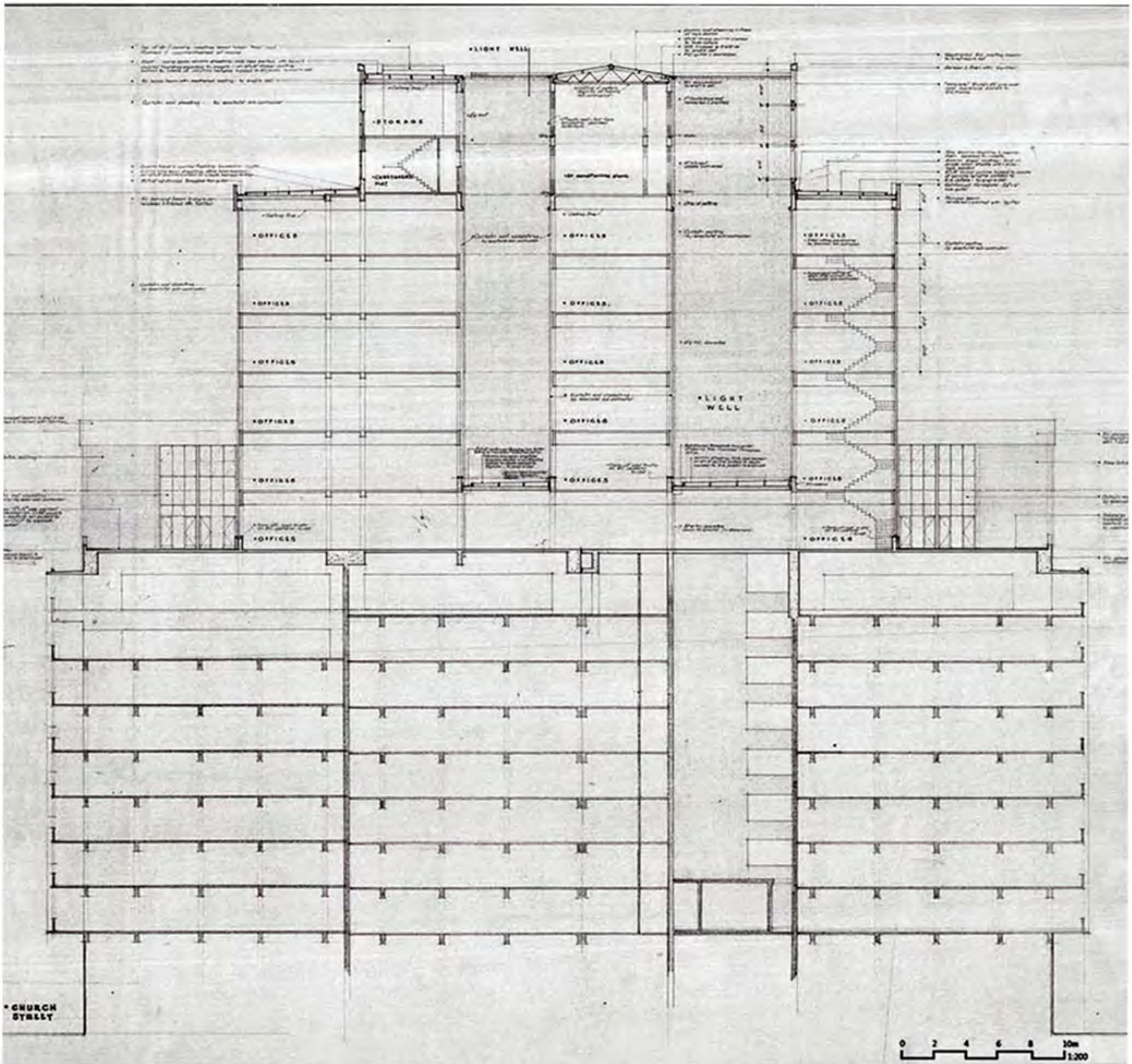

HOLLAND



The Christiaan Barnard Hospital



Original section through Bree and Loop Street showing the parking area and one light well, drawn in 1968

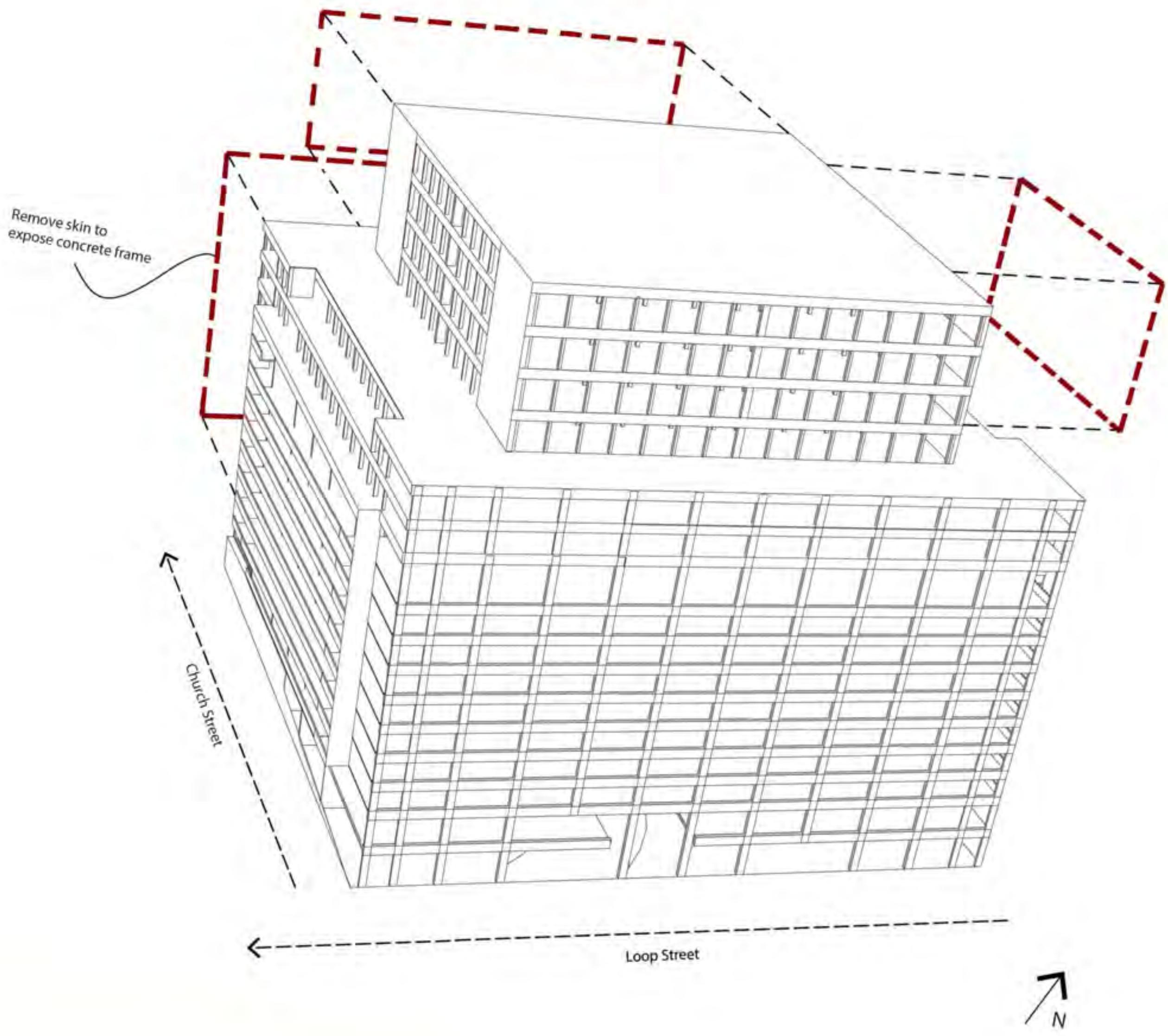


Original section through Church and Longmarket Street showing two existing lightwells, drawn in 1968

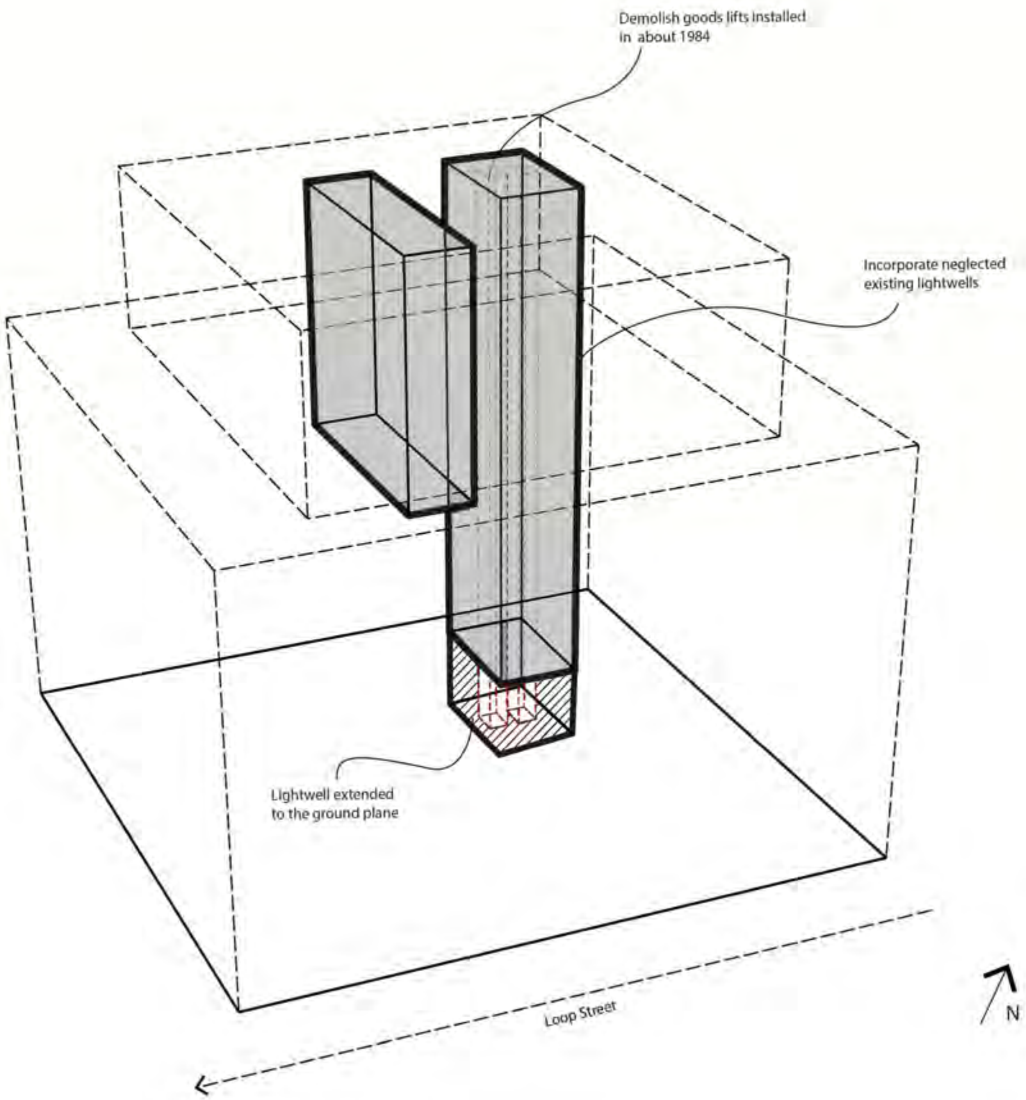
Street frontage on Loop Street

The two existing light wells

Existing ramps on the ground floors and parking levels

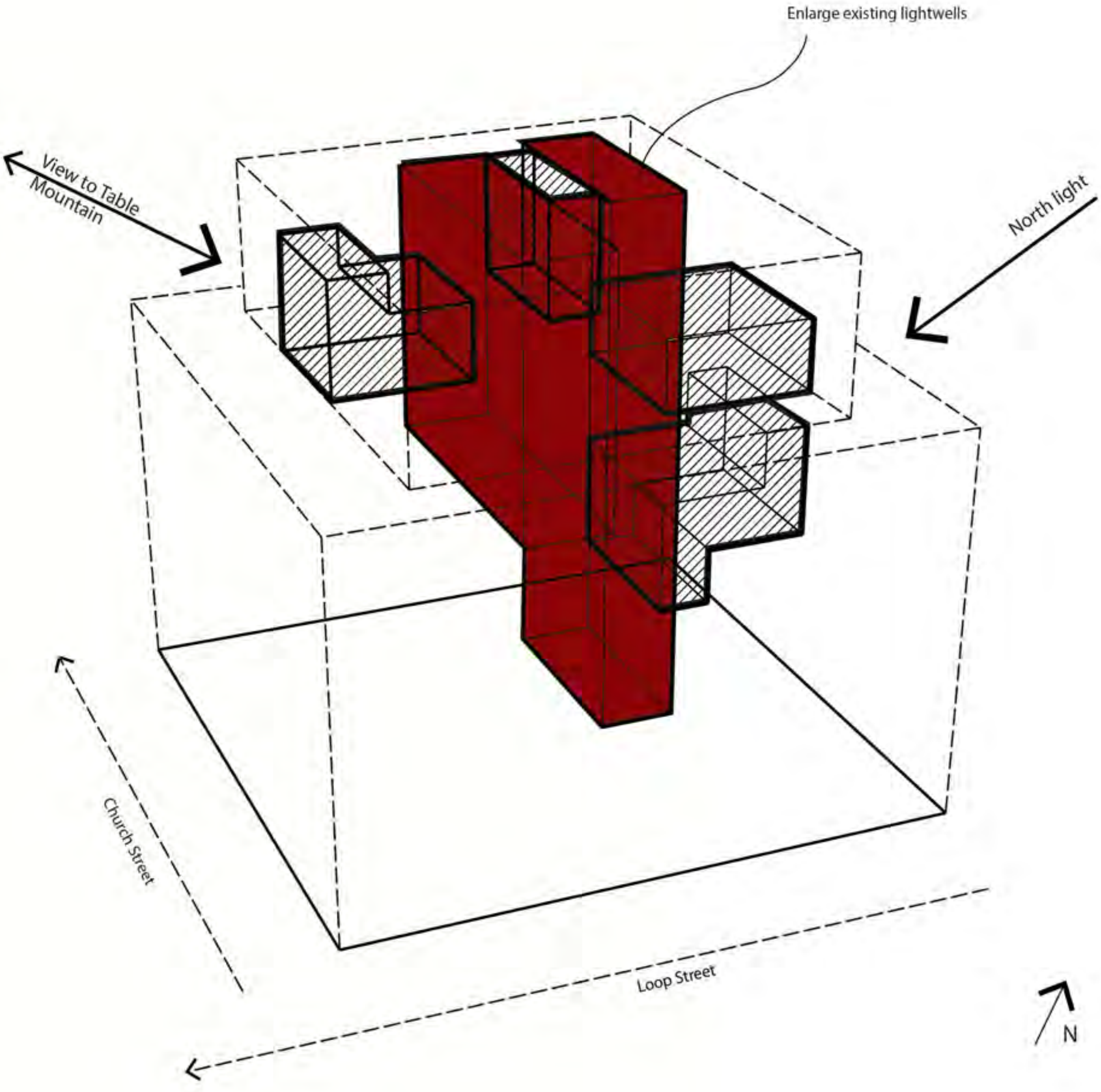


SHEARING
Expose existing structure and celebrate it



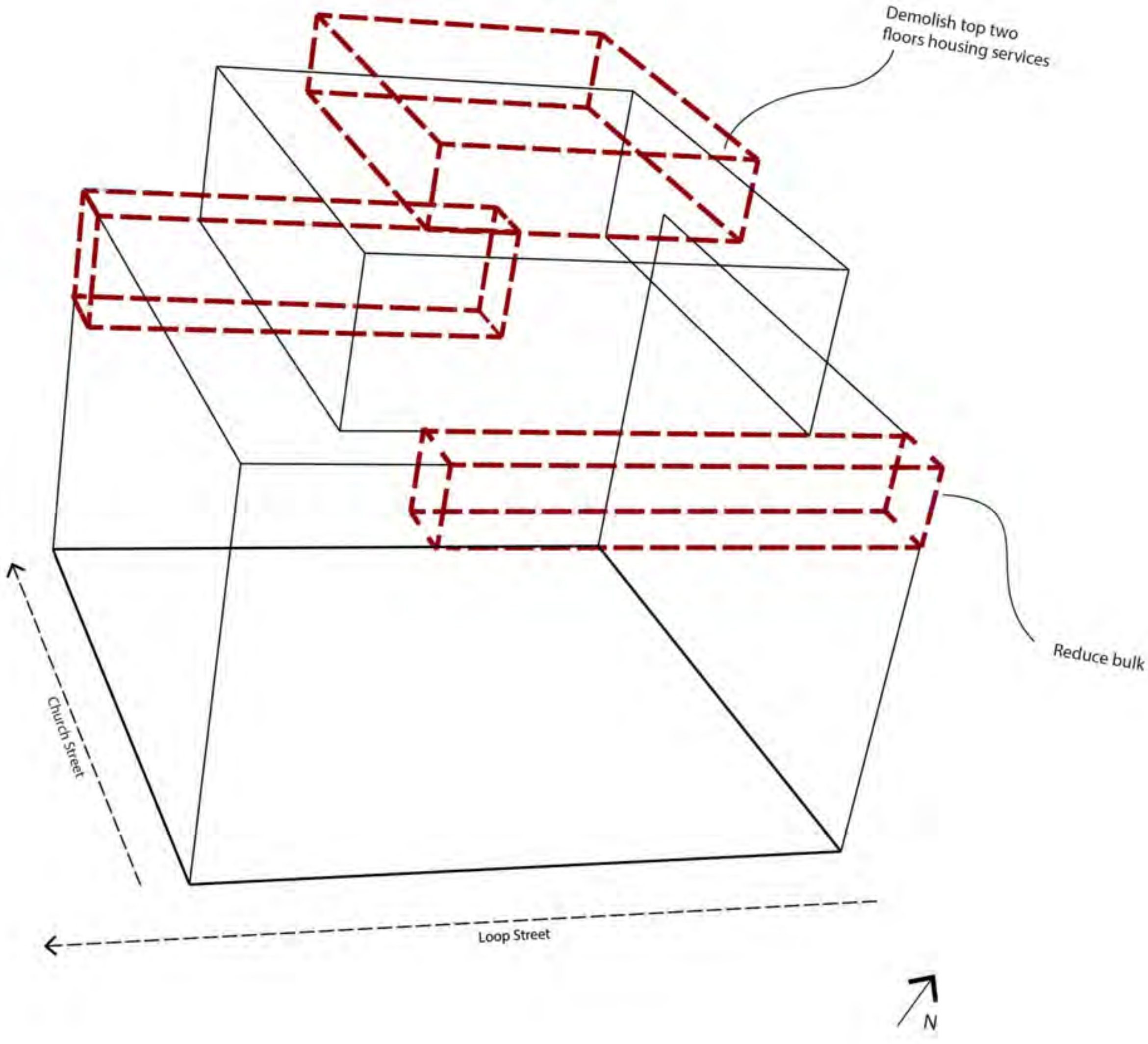
PUNCTURING

Re-establish existing light wells and extend them to the base of the building



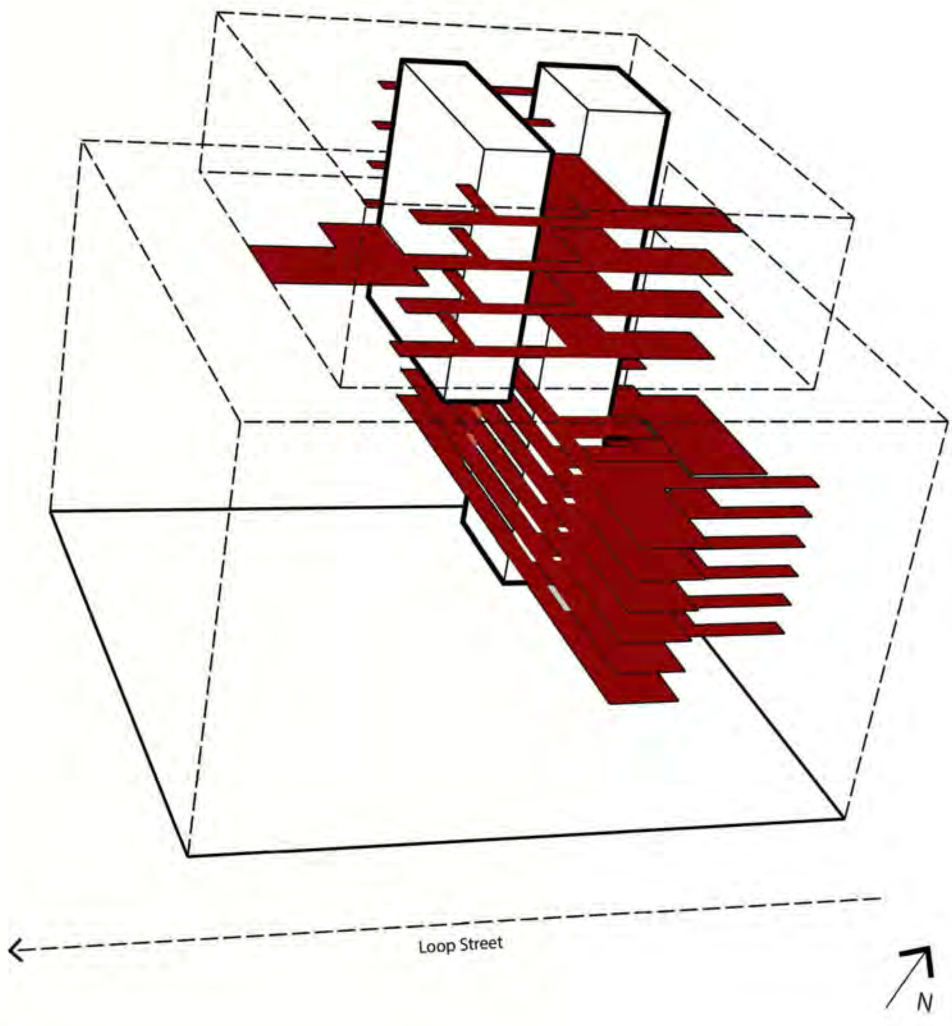
ENHANCING

Create further punctures and maximise natural light within the deep floor plate



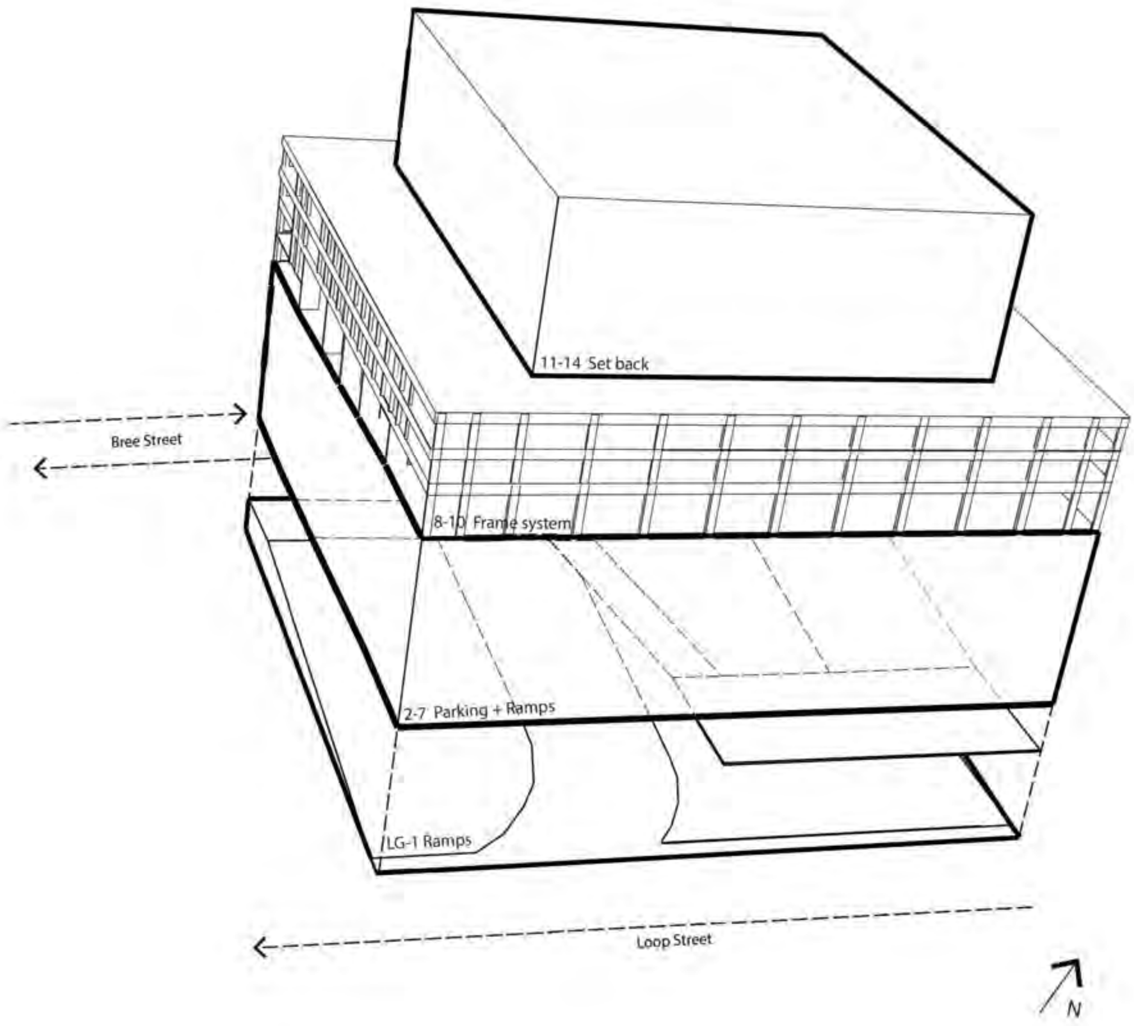
REDUCING

Cut away and reduce the building's bulk and street frontage

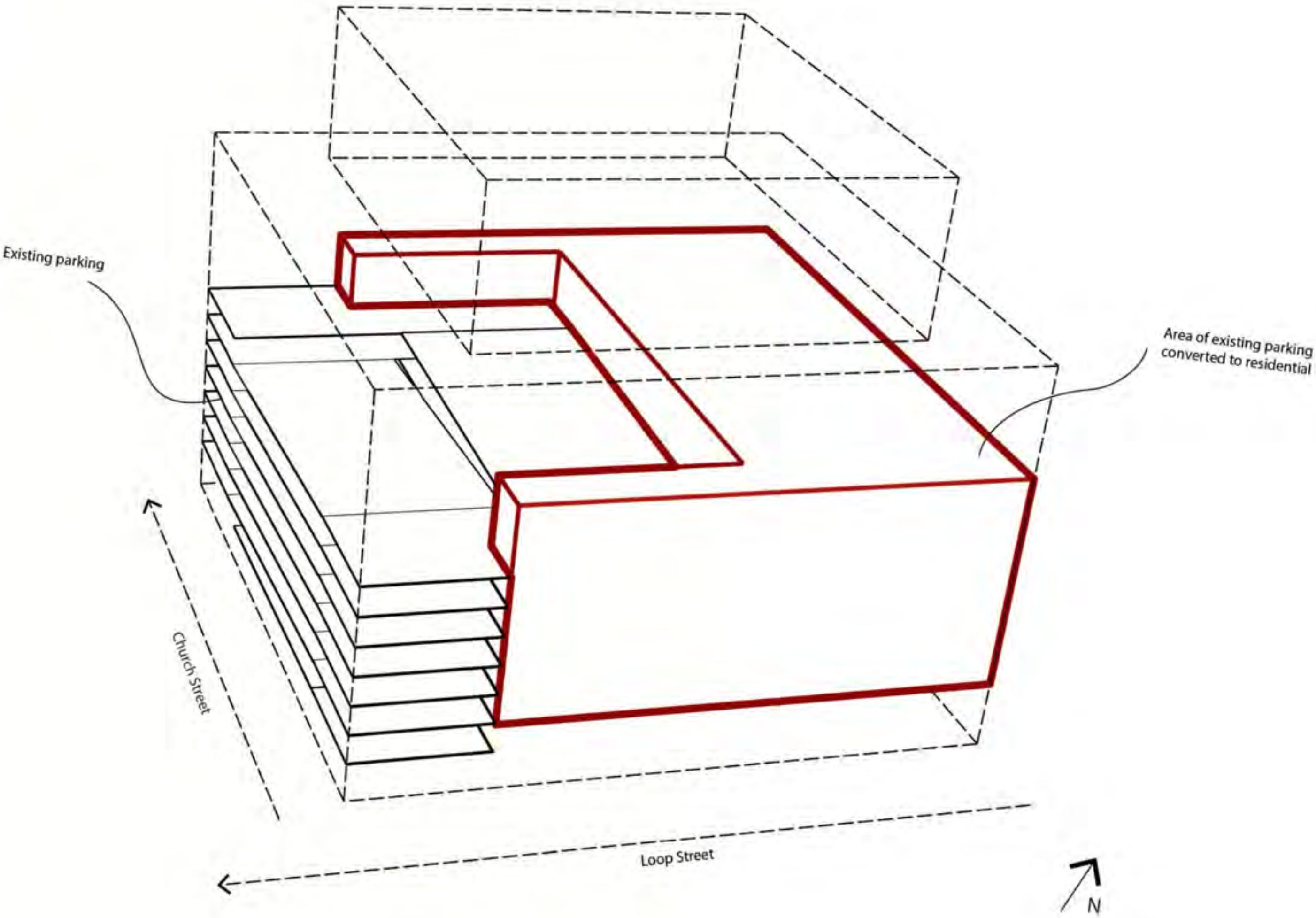


CIRCULATING

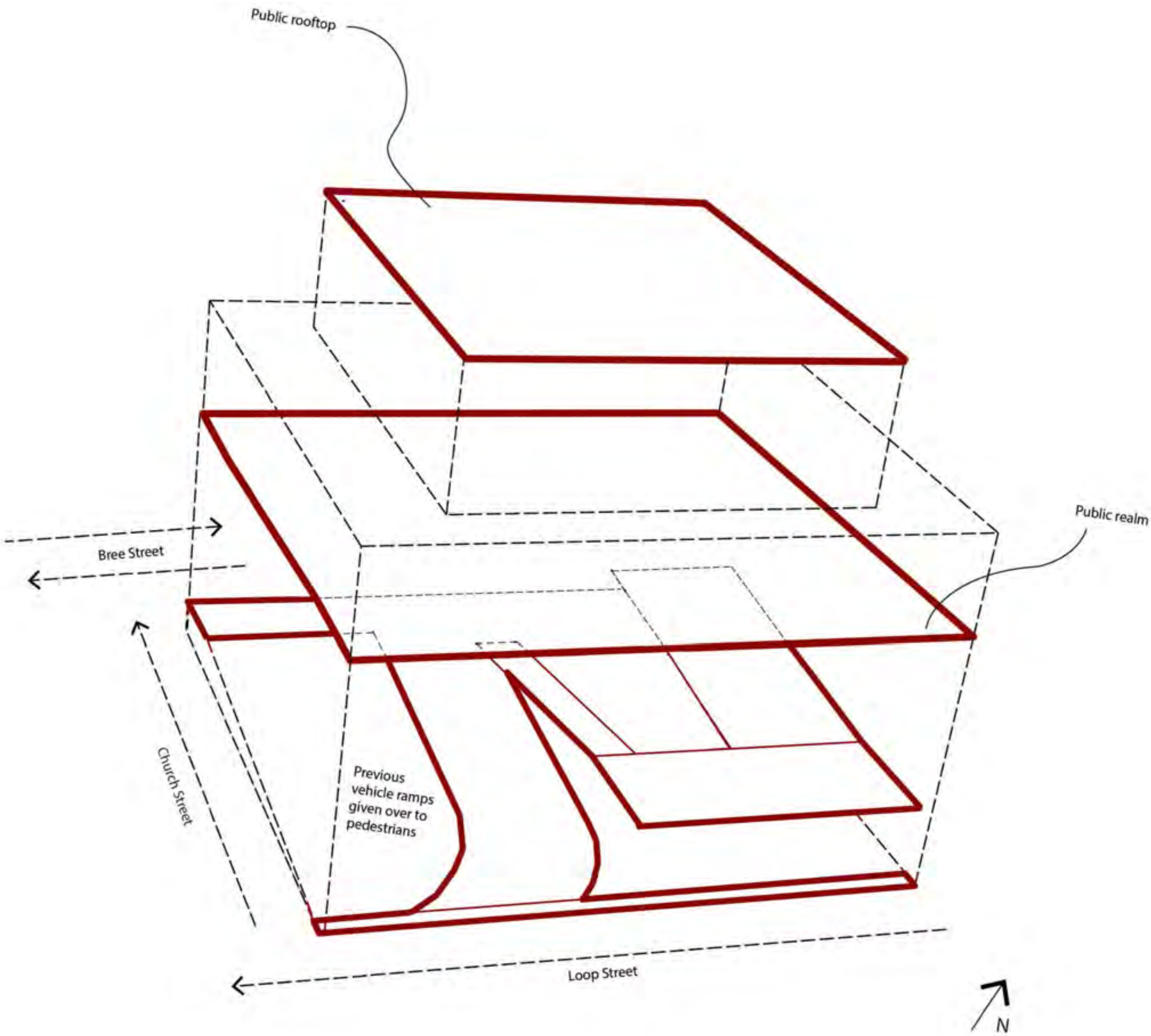
Incorporate social spaces within the central 'atrium' space



INHABITING
Structural conditions allow for various programs

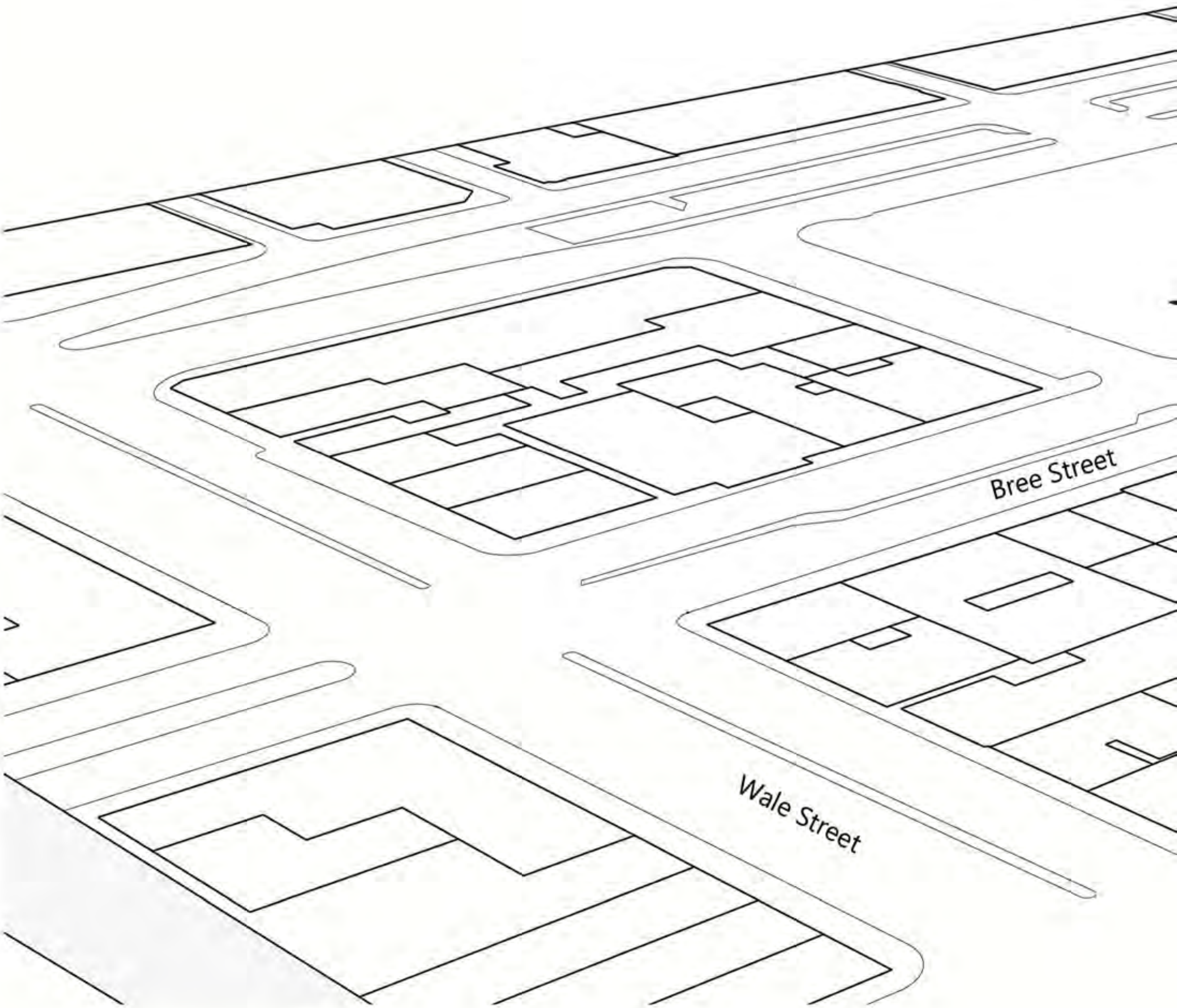


CONVERTING
Give over north facing parking area for residential use

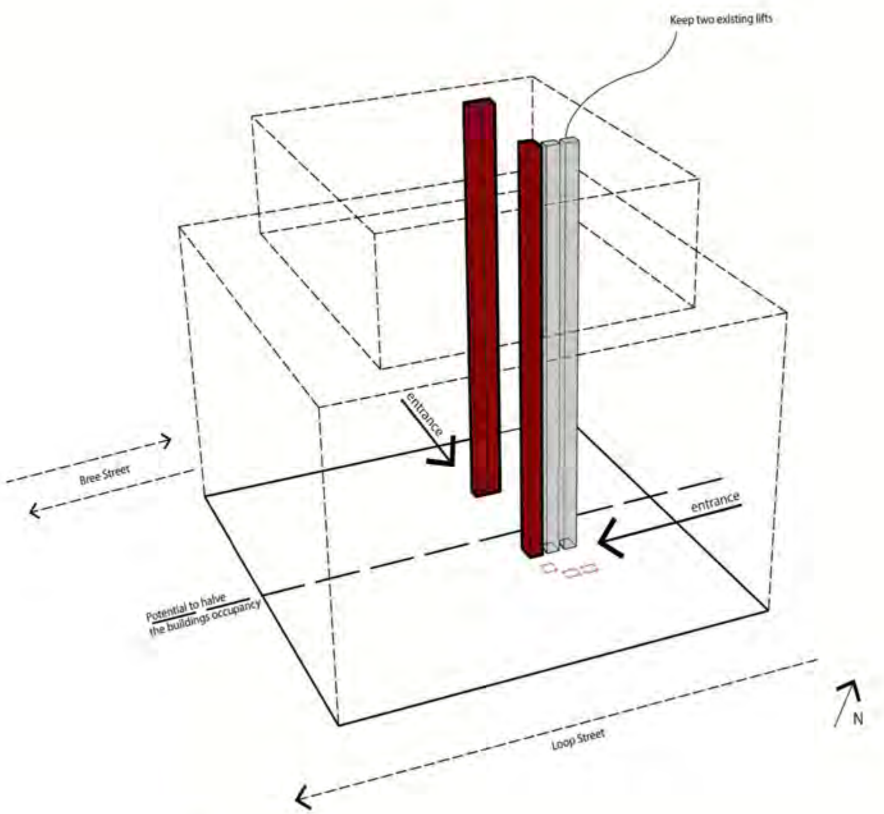


CONNECTING

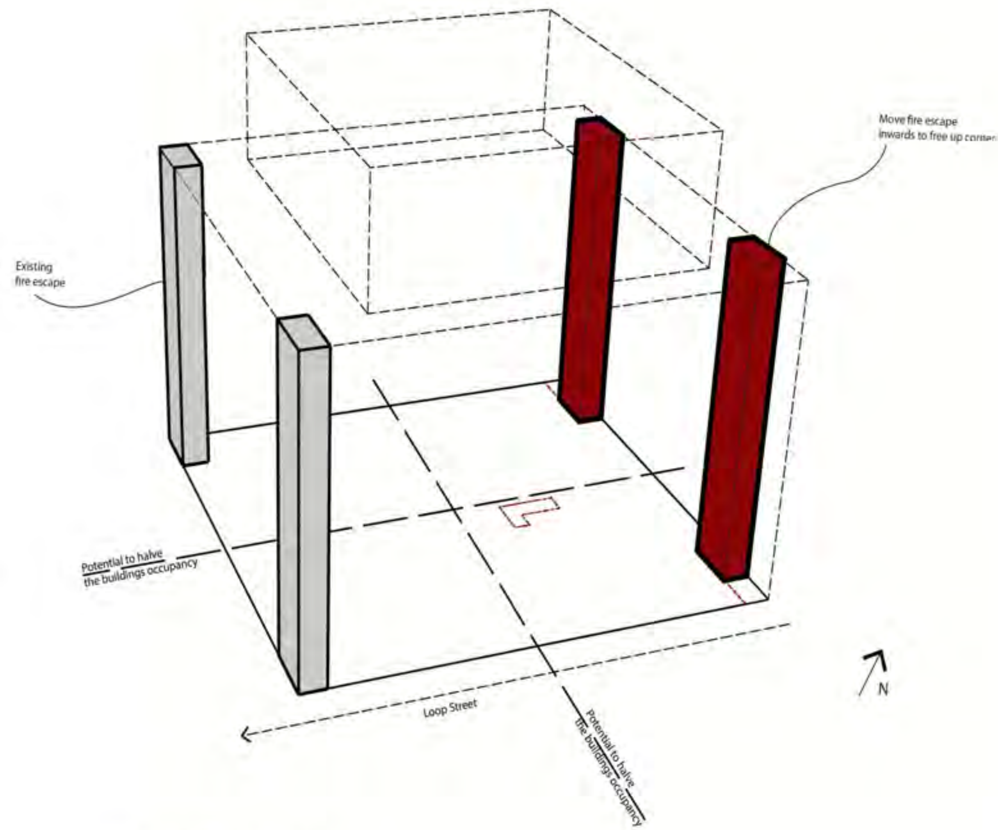
Accommodate further public space throughout



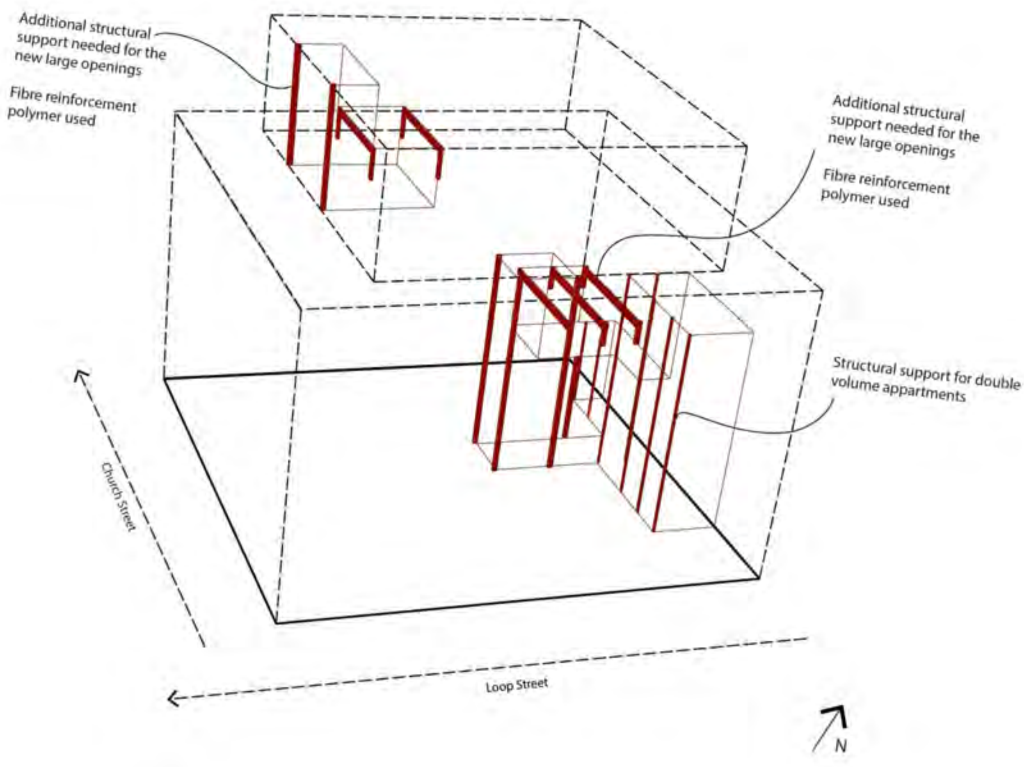
RECONFIGURING
Invert vehicle ramps to allow for greater pedestrian movement and public acce


Keep two existing lifts
entrance
entrance
Bree Street
Potential to halve
the buildings occupancy
Loop Street
N

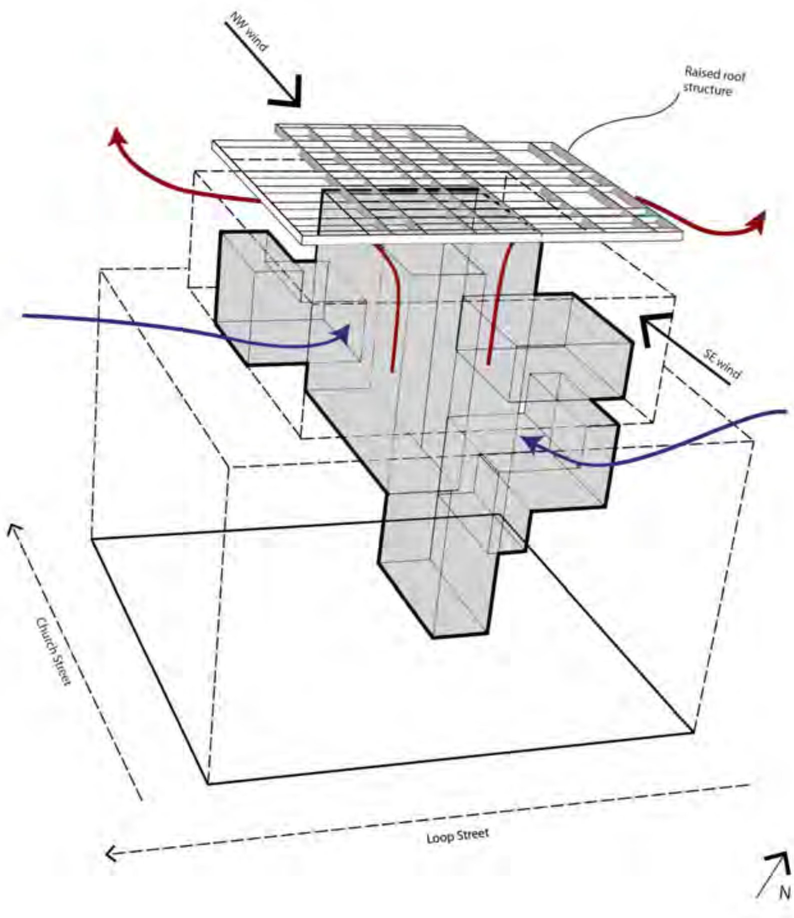
Lift Cores



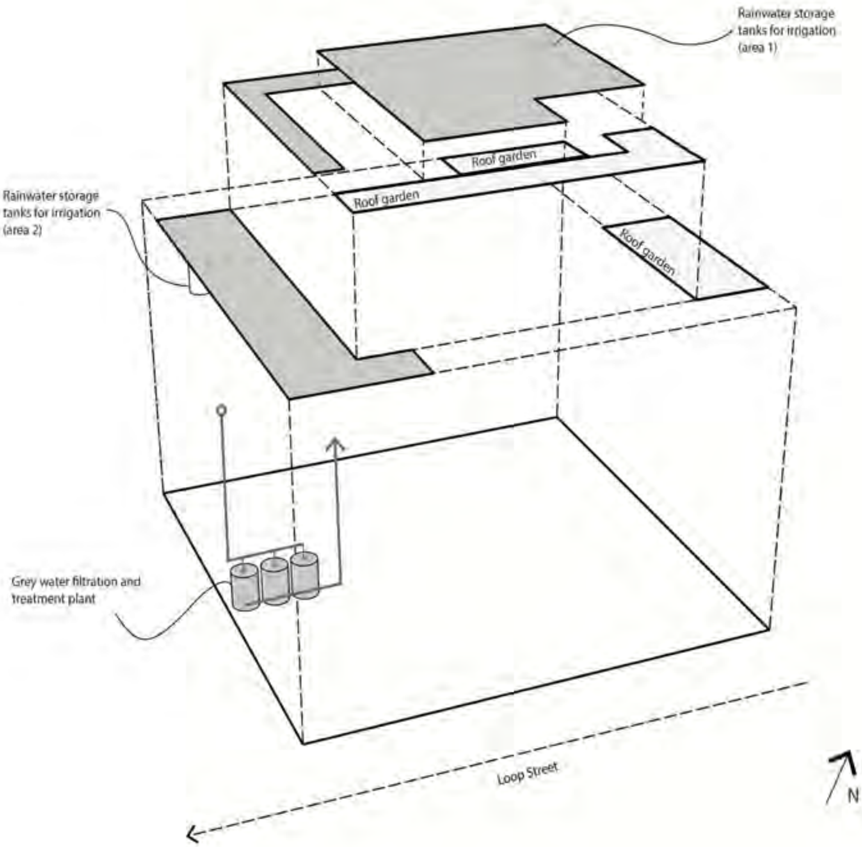
Fire Escapes



New Structure



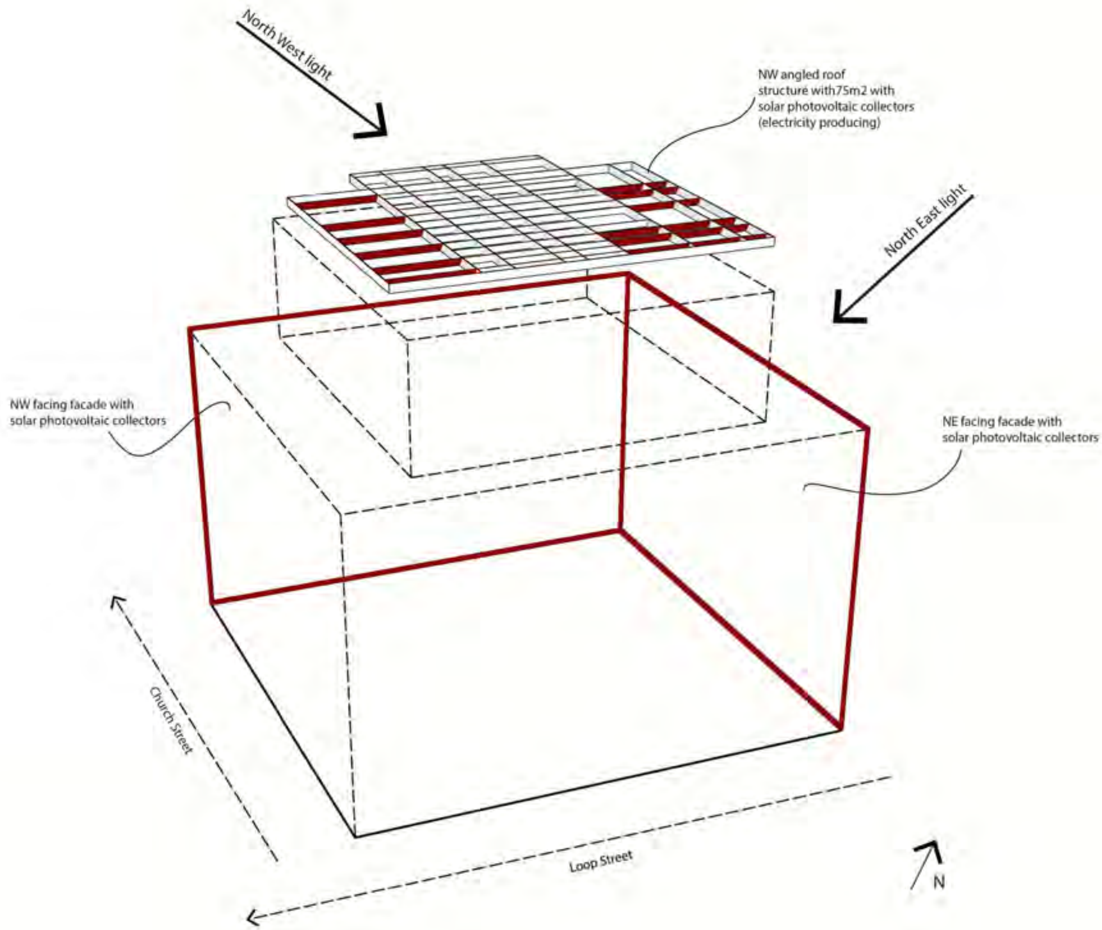
Natural Ventilation



Water Management

Total water consumption: 10 398m^3
Total water qualifying for grey water: 8 391m^3
Total fixtures requiring non-potable water: 1 198m^3
--> harvest 1/4 of the showers

Total roof area: 1 927 m^2
Total rainwater run-off per year: 840 m^3
--> used for irrigation

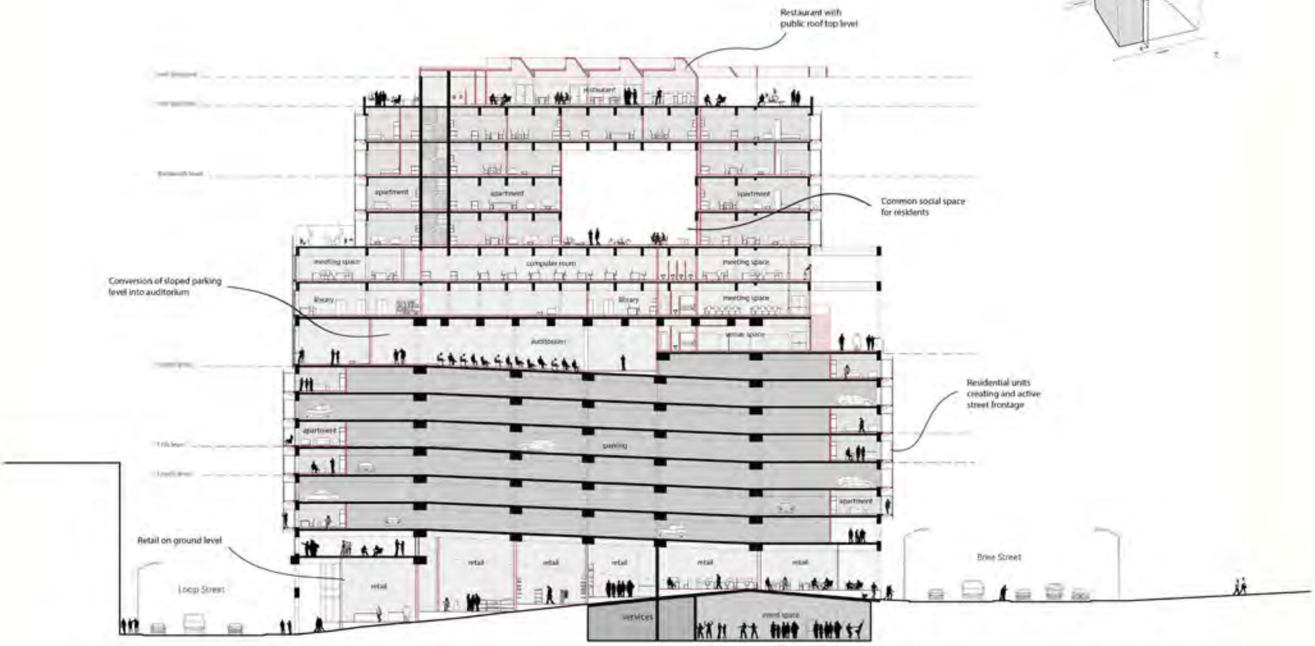


Solar Strategy

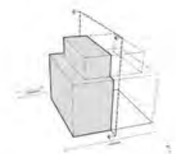
Can only contribute to the supply needs and thus used to cover a specific aspect - the heating and cooling of the overal building

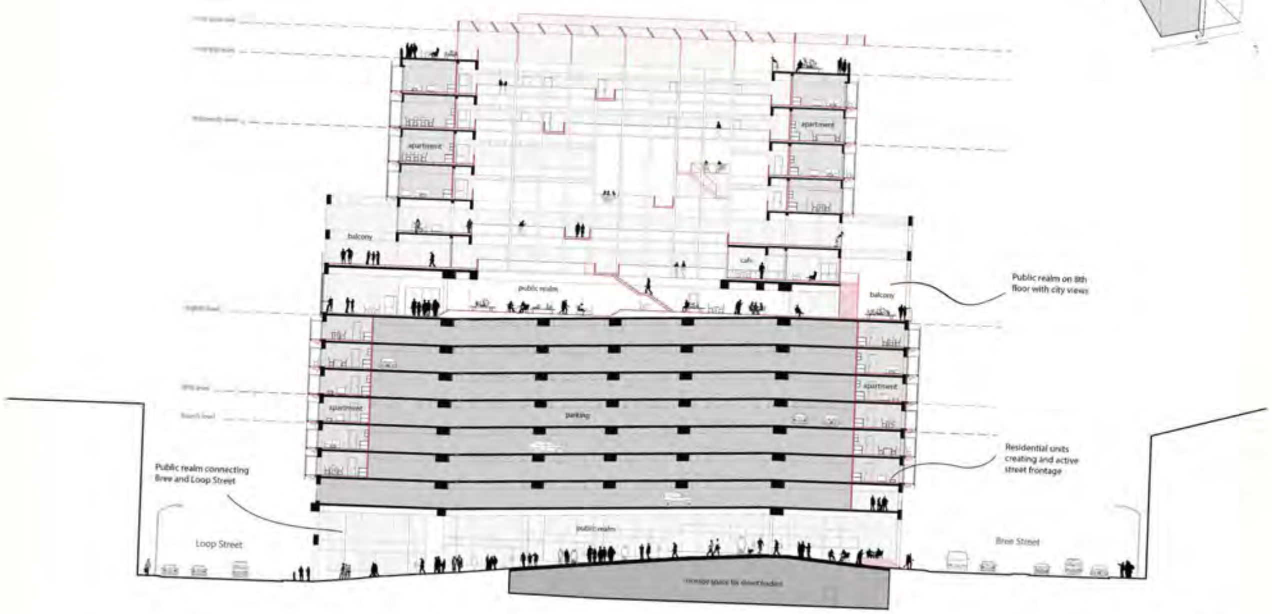
Control given to occupants within the residential units


ROOF STRUCTURE
FIFTEENTH LEVEL
Public and residential roof top
1:250
Fourteenth Level
THIRTEENTH LEVEL
Residential
1:250
Twelfth Level
Eleventh Level
Tenth Level
Ninth Level
EIGHTH LEVEL
Public zone with various facilities
1:250
Seventh Level
Sixth Level
FIFTH LEVEL
Parking and Residential
1:250
FOURTH LEVEL
Parking and residential
1:250
Third Level
Second Level
First Level
GROUND LEVEL
Public and retail
1:250



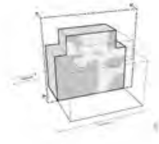
SECTION A_A
1:250



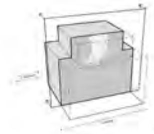


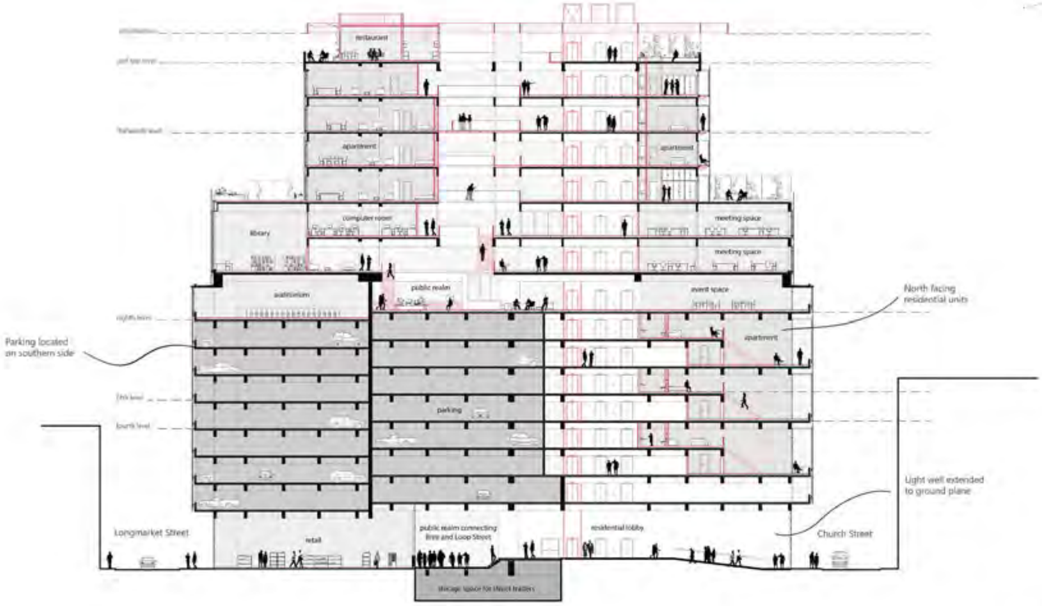
SECTION B_B
1:250

SECTION C_C
1:250

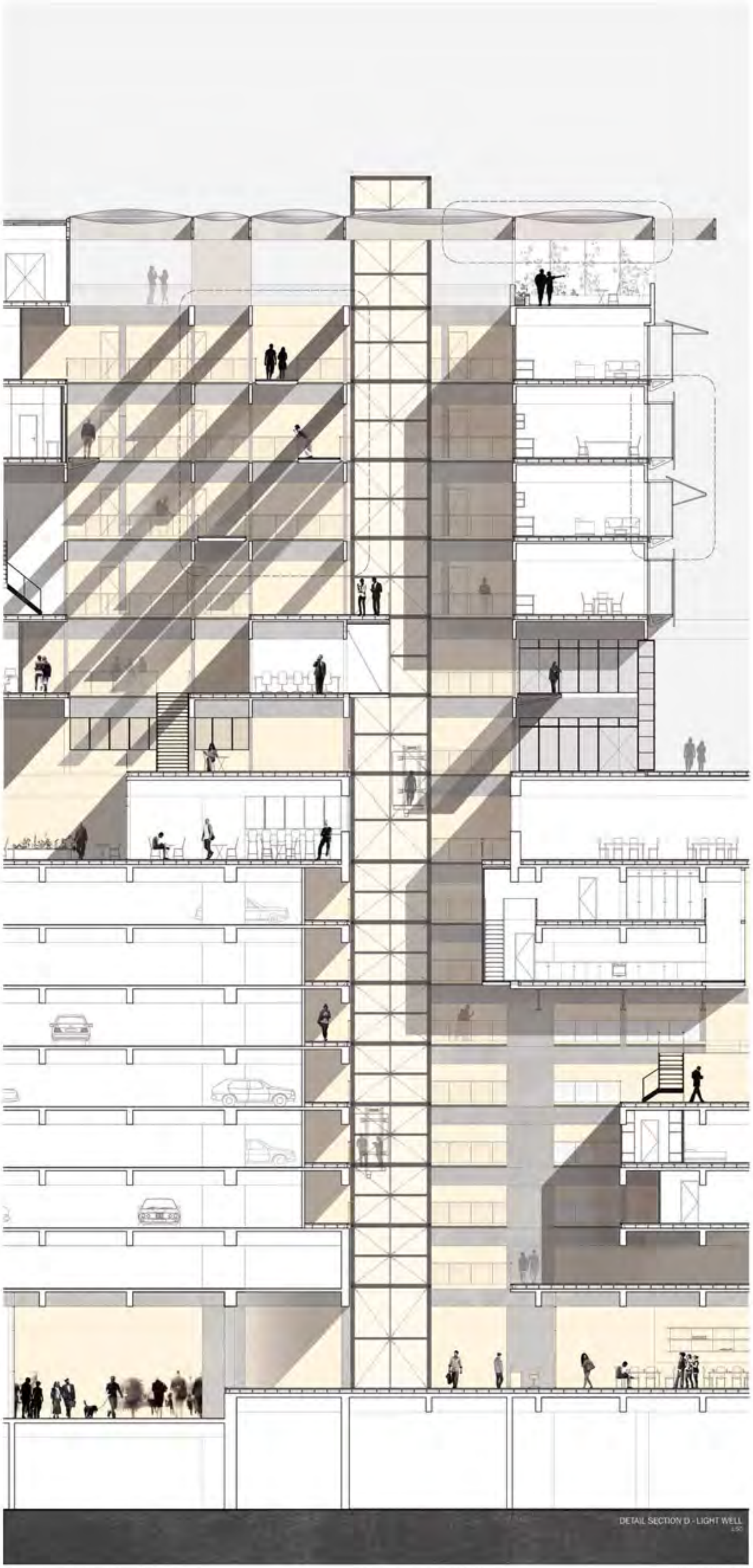


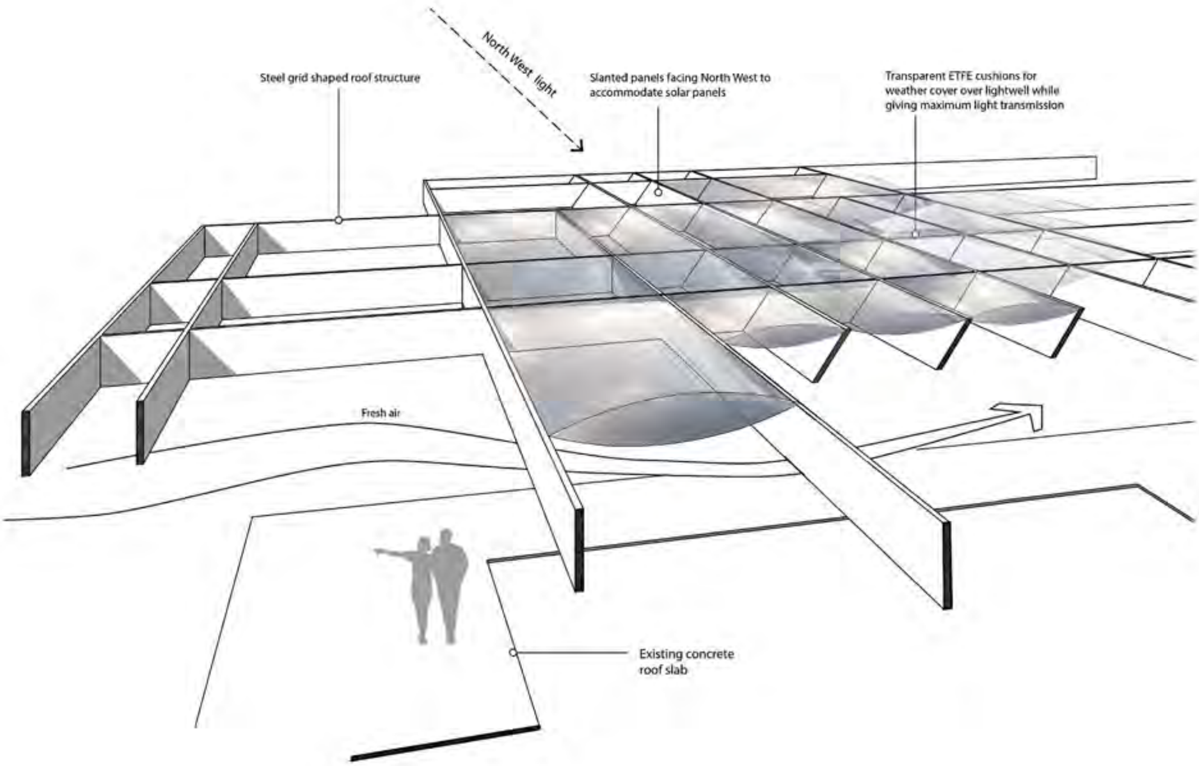
SECTION D_D
1:250



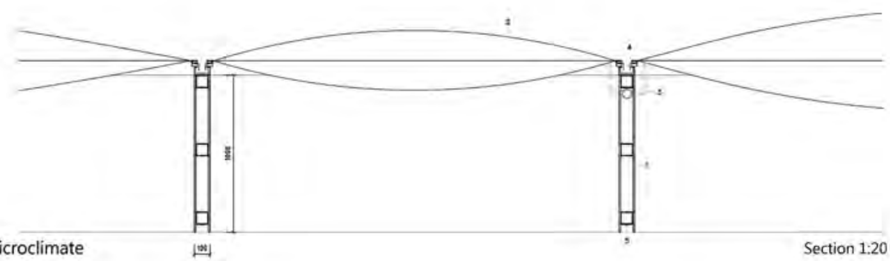


SECTION E_E
1:250


DETAIL SECTION D - LIGHT WELL
1:50



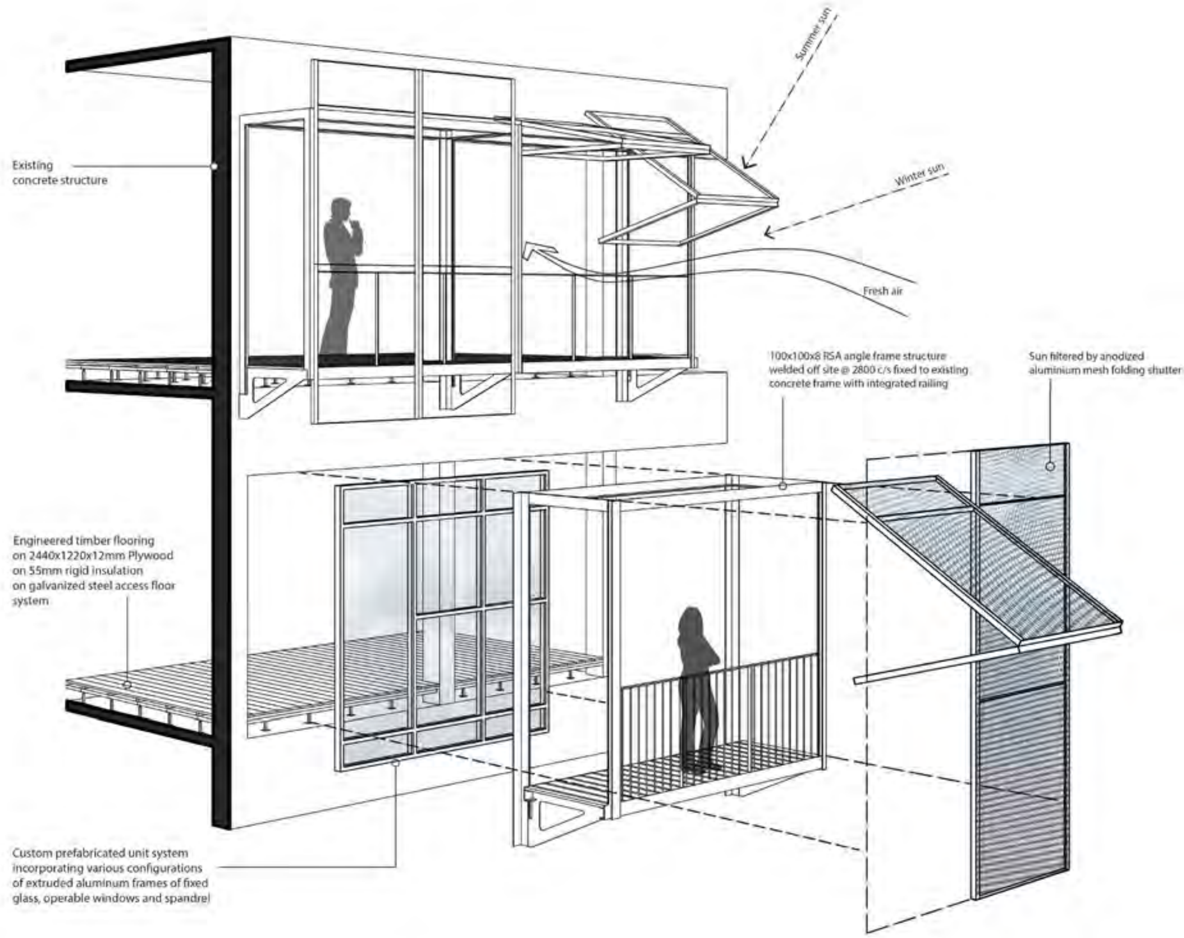
1 Prefabricated grid- shaped horizontal roof structure double walled flat steel beams with rigidly welded connections and slotted together on site
2 Three-layer inflated transparent EFTE cushion
3 Plastic air supply tulie
4 Insulated metal lined gutter
5 LED light



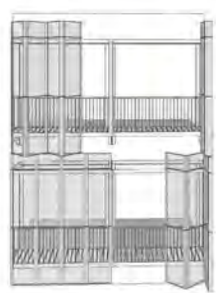
ROOF STRUCTURE

Achieving a naturally ventilated microclimate

Section 1:20

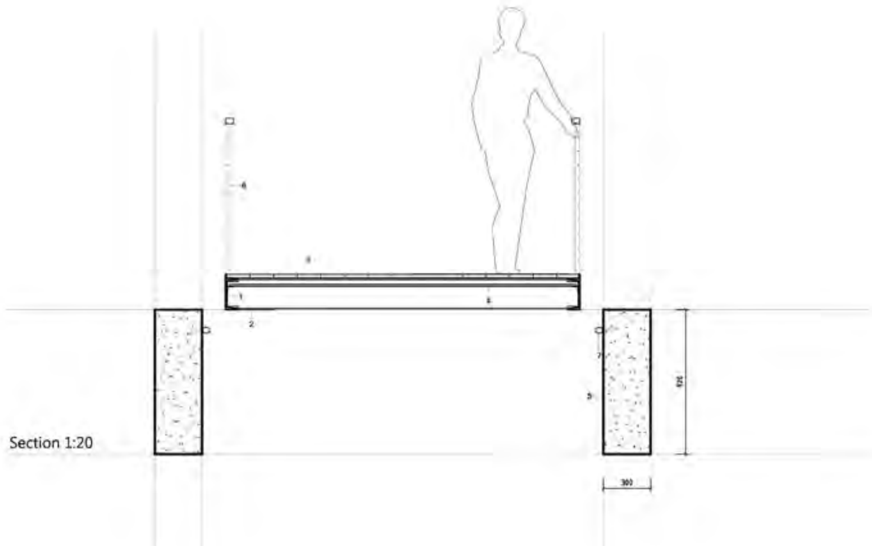


North and South Facade



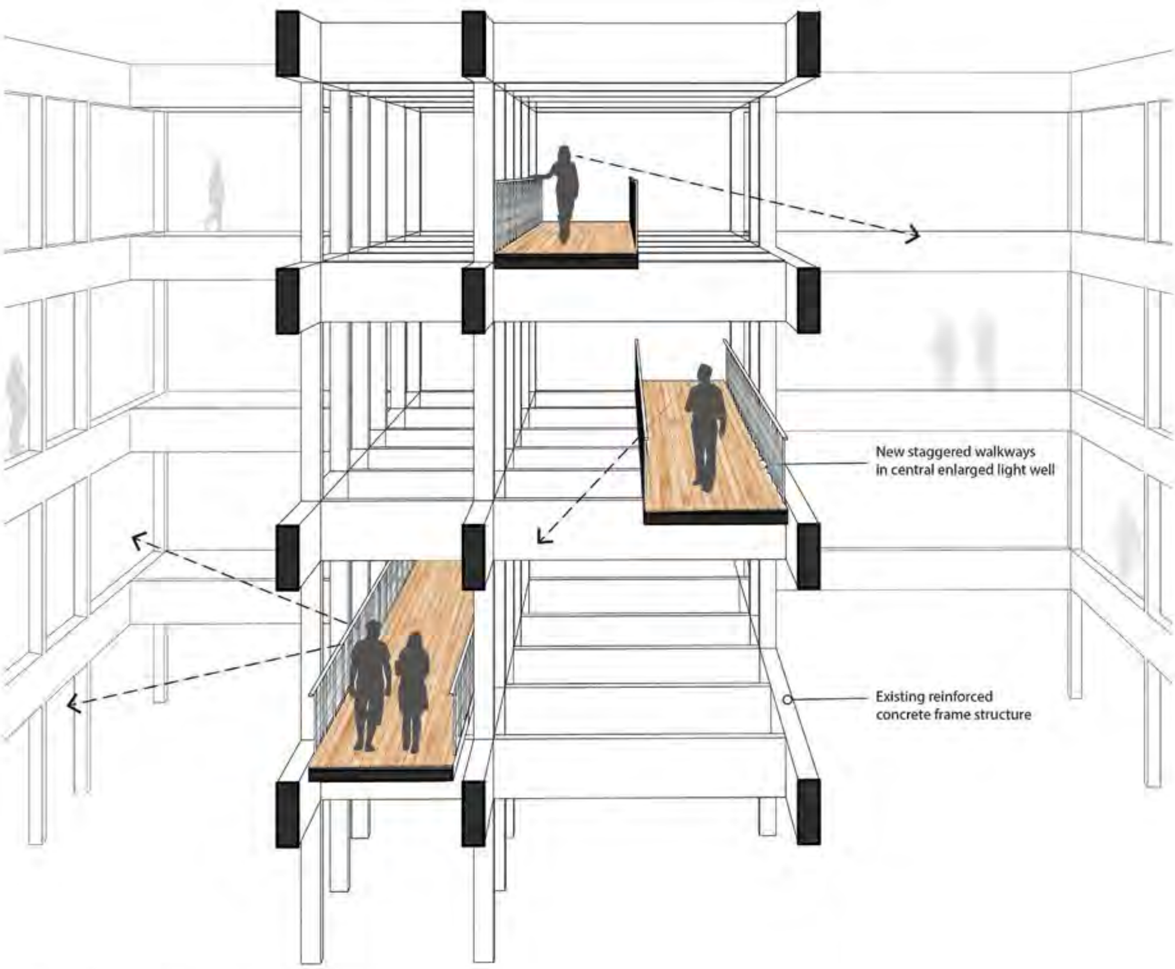
East and West Facade

FACADE ELEMENTS
Occupancy comfort based on user control



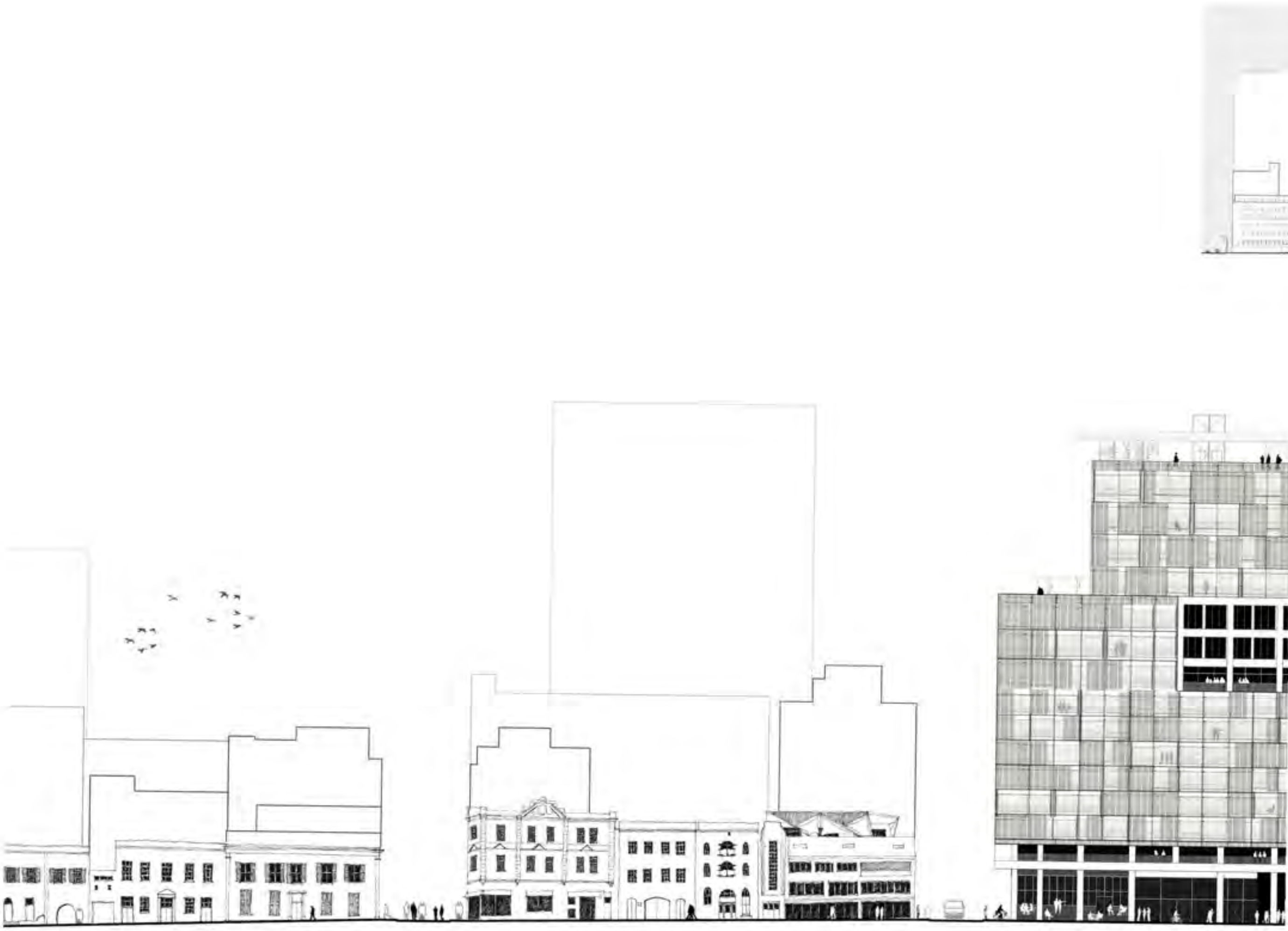
Section 1:20

1. 200x75 RSC channel . hot dipped galvanized steel, intrumescent paint to engineers spec bolted to existing concrete structure
2. 203x102x25mm T-section welded to RSC channel
3. 22mm T&G timber flooring SAP grade 5
4. 12mm mineral wool sound impact insulation resting on waffle grid on underside concrete structure
5. Existing reinforced concrete structure
6. Handrail welded to RSC channel
7. LED light

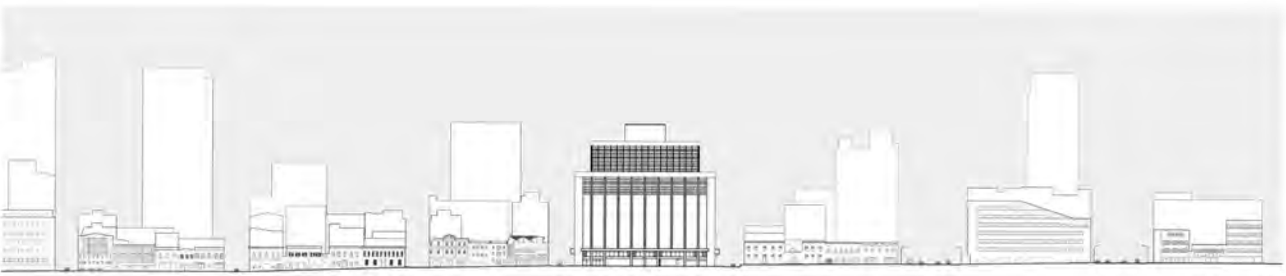


MATERIAL LAYERING

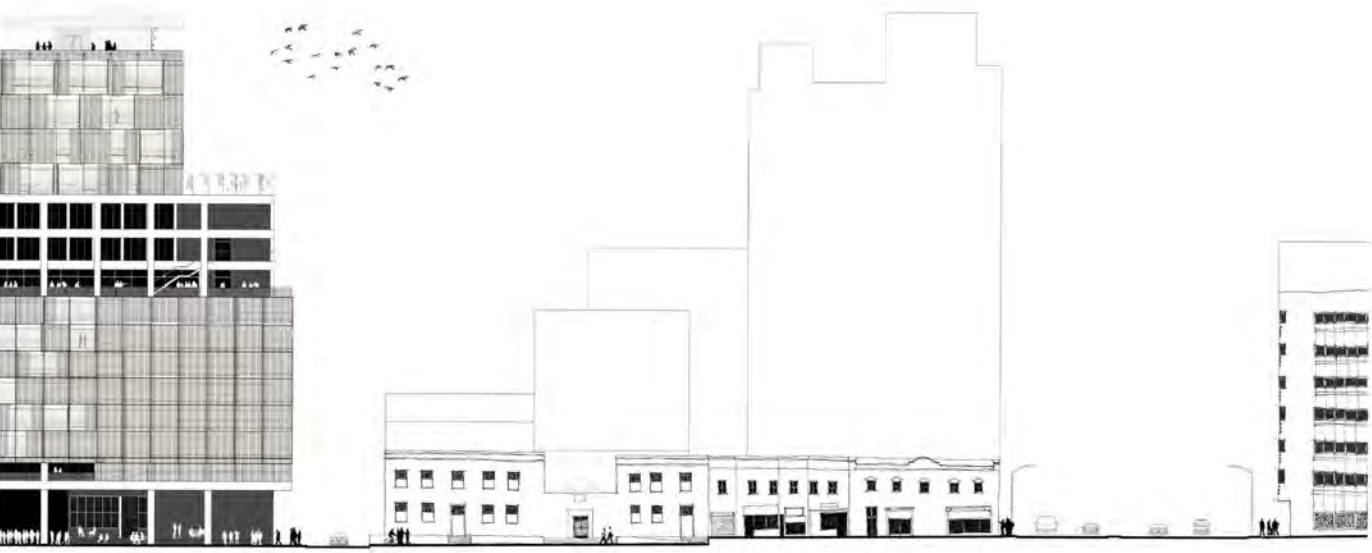
Integrating and expressing the old with the new



ELEVATION
1:250



ELEVATION
1:1000
The existing building - view from Bree Street



INTERNAL VIEW
Existing structure celebrated

STREET FRONTAGE ON BREE
Recessed Ground Floor contributes to the public realm

STREET SCAPE
Bree Street