Urban Bike-Sheds
Commuter cycle facilities infilling marginal urban spaces.

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Abstract

This research project investigates the potential of developing currently un-, and under-utilised compact sites within the existing urban built environment. The base programme of the project involves the provision of dedicated commuter cycling facilities in the central city.

Infill construction and cycling transport promotion are, each in their own right, recognised strategies for improving the sustainability of our cities as we move into the future. With vast amounts of countryside, New Zealanders have a strong traditional tendency to 'sprawl' rather than intensify existing urban areas. Many Asian and European countries set the benchmark for 'infill' development and optimum land use, often with fascinating displays of compact developments. Traditionally New Zealand has not had these same pressures to economically justify developing and occupying such tiny scraps of land. As the New Zealand built environment has spread, territorial authorities have sought to place limits on expansion, and are now making conscious decisions to further increase the building density in central city areas. With these strategies in place, continual rising land prices, and motor vehicle dependency caused by 'urban sprawl', it is time to start exploring these potential spaces left over from past development as a serious option for current development.

The concept of infill cycle facilities was conceived as a logical response to the rise in the popularity of cycling in New Zealand in recent years and the consequent need for additional secure facilities to cater for commuter cyclists, cycling to and from the central city. The increased popularity of cycling is a great thing for the health of participating New Zealanders, but to have any positive environmental effect cycling needs to also start replacing motorised commuter transport. Auckland is a city developed around the motor-vehicle and is highly dependent on this form of transport. Central Government has recognised the social and health benefits of cycling by committing $40 million to walking and cycling infrastructure over 2009-2012. Government spending on cycling infrastructure is a great way to encourage people into cycling and provide positive public awareness of the benefits. Progress from recent improvements on cycling infrastructure across the region is beginning to be seen with the increase in cycle movement statistics, increasing the number of people choosing to take their bike.

Similar cycling concepts have been designed and implemented internationally with great success. New Zealand, too, needs to take action to increase participation in alternative transportation and provide facilities to further encourage and meet the resulting demand. The fact that the basic design of the humble bicycle has generally remained unchanged over the last 120 years says something about the efficiency of this often unappreciated machine.
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1. INTRODUCTION

1.1. Project outline

This research project investigates the potential of developing currently un-, and under-utilised compact sites within the existing urban built environment. The base programme of the project involves the provision of dedicated commuter cycling facilities in the central city.

The underlying motivation for this project is to increase the building density of the existing framework of Central Auckland by infilling these under-utilised spaces. Intelligent solutions need to be developed for these challenging sites to seize opportunities for inner-city growth. Providing a meaningful programmatic concept to benefit the community with functional, convenient cycle facilities helps promote and encourage cycling as a form of transport in New Zealand. The success of such a concept relies heavily on how the buildings work for day-to-day users of the spaces, and from a wider view, how the concept is perceived by the public. The building’s plan must be impeccably rational, to overcome the compact nature of the proposed sites, in an effort to optimise the use of these minimal spaces. The compact nature of the sites means the bicycle facilities will act as independent satellite facilities dotted at locations around the city.

Infill construction and cycling transport promotion are, each in their own right, recognised strategies for improving the sustainability of our cities as we move into the future. Motor-vehicle congestion is causing huge damage to our cities and the environment. By improving cycling infrastructure through the city, the ease and convenience of cycling will improve. Resulting in less motor vehicle use and providing a recognisable visual statement to further raise the profile and popularity of cycling in Auckland.

1.2. Research aims & objectives

Auckland's land is very 'under-utilised' when compared to international examples of intensive, compact, urban infill. Within the New Zealand context such intensive developments are uncommon because of our expansive countryside and our historic tendency to allow urban sprawl. It seems that with such abundance, New Zealanders have traditionally taken space for granted. As development has progressed, however, vacant land is becoming scarcer and more expensive. As the built environment has spread, planners have sought to place limits on expansion and territorial authorities are making conscious decisions to further increase the building density in central areas. With these actions in place, there is an impetus to find ways and solutions to make use of un-, and under-utilised inner city micro-sites.
The purpose of the project is to investigate the viability of developing un-, and under-utilized marginal urban spaces. The spaces considered are selected from a variety of examples, and display a variety of un-, and under-utilised situations. Collecting an assortment of prospective sites in the early stages of research determined the validity of the continued application of 'micro-site' development as a viable means of urban intensification, with the potential to be used in a variety of programmatic situations.

With land costs continuing to rise, difficult and traditionally overlooked spaces become more viable, and appropriate for development. The usually restricted size of these spaces calls for innovative design and a creative architectural solution that meets the functional expectations of both those who will use the development and the broader urban fabric into which the structure will be inserted. The major design issue when working with sites of such nature is overcoming the spatial constraints that generally make them difficult for development. Design must maximise use of what little space is available, fully and succinctly.

The emphasis throughout this research project is on the benefits of such a development for the users and the community. The project demonstrates how, with a purposeful function and careful development, these under-utilised spaces can have a positive effect on their surroundings by attracting people and creating more lively central areas.

The concept of in-fill cycle facilities was conceived as a logical response to the rise in the popularity of cycling in New Zealand in recent years and the consequent need for additional secure facilities to cater for commuter cyclists, cycling to and from the central city. These cycle facilities provide a group of strategically located hubs where cycling commuters can safely store their bicycle, freshen up, change into work clothing, store belongings, and comfortably walk to their place of work - as well as increasing the profile of cycling in the central city.

Auckland cyclist numbers have shown an impressive increase in 2010 with the Auckland Regional Transport Authority's, Manual Cycle Monitoring in the Auckland Region showing a 34% increase in cycle numbers when compared with 2009, and a 54% increase when compared with 2001. However, the reality is that in New Zealand there are much higher numbers in recreational cycling than those who cycle as a form of transport. The increased popularity of cycling is a great thing for the health of participating New Zealanders, but to have any positive environmental effect cycling needs to also start replacing other forms of transport. The fact that large numbers of New Zealanders are involved in recreational cycling suggests they are put off cycling as a means of commuter transport for reasons other than a dislike of cycling per se. Providing effective facilities where people can safely store their beloved bicycle, quickly freshen up, change clothing, store excess belongings, and be in a close proximity to their work place, could dramatically reduce any inconvenience.

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Urban designer and author Kevin Lynch has said, "Places should have a clear perceptual identity: be recognisable, memorable, vivid, engaging of our attention." Making these structures visually appealing, recognisable and a talking point will also provide the opportunity to promote and raise the profile of cycling in Auckland through design.

Space utilisation is a critical design consideration where the facility needs to be both compact and user-friendly. The layout in which multiple bicycles occupy these compact spaces became a major and ongoing design problem. For a facility such as this, success is measured not simply on the aesthetic appearance, but also the rational arrangement of circulation and amenities. Lynch also stated, "The program gives the required character and equipment for each setting and specifies how form should connect with action and purpose." With this in mind the design has been focused on providing an environment that is functional, intelligent, efficient, and user-friendly.

1.3. Methodology

The emphasis throughout the research of the project has been on the possibility and potential of development of in-fill cycle facilities. This has involved numerous areas of research around the broader topic and research by design. Problems arising from the research have been identified through the implications on the early design explorations. The main area of research requiring a methodological approach was analysing statistical data obtained through the Auckland Regional Transport Authority's, Manual Cycle Monitoring in the Auckland Region. To ensure longitudinal comparability all of the manual cycle counts are conducted with a standardised methodology across all sites. All addition statistical breakdowns of data for the purpose of this project have been conducted in a similar uniform manner to maintain the statistical integrity of the information.

1.4. Document Summary

This document is arranged in four main sections. Following this introductory chapter, Chapter Two 'Micro-sites' analyses traditional and current development strategies in New Zealand and looks at international examples of successful compact infill. Chapter Three 'Cycling in New Zealand', discusses the origin of the bicycle, cycling efficiency, cycling trends in New Zealand, and explores efficient strategies for cycle storage. Chapter Four 'Project Development' discusses the site selection process, and builds an argument for the validity of such a concept within the New Zealand context. Chapter Five 'Design Strategy' examines potential factors imposing limitations on the design and develops strategies to overcome these limitations.

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2. MICRO-SITES

2.1. Introduction

The term 'micro-site' came to fruition in the early stages of the project and has been mentioned throughout the document to describe compact and under-utilised candidate sites. Typically, they are currently under-utilised sites or spaces within sites, and are often overlooked and under developed voids within the city's urban framework.

2.2. Urban Sprawl & Infill Development

'Urban sprawl' and how to combat this development trend, has been a frequent topic in planning literature of the past decade. Infill development is a technique used to intensify the existing urban environment, in an effort to rectify some of the negative social, economic and environmental impacts often associated with 'urban sprawl'.

The need for Auckland to change its development strategies has long been recognised by local territorial authorities, with the Urban Area Intensification - Regional Practice and Resource Guide, published in 2000, and the Auckland City: Growth Management Strategy in 2003. Along with numerous others, these publications discuss the issues associated with low density development methods commonly seen in Auckland and discuss strategies in place to change these habits. Urban sprawl is the most obvious consequence of low density development in New Zealand, and is traditionally linked with motor vehicle dependence.

"Once an arcane term used primarily by city planners and academics', 'sprawl' has recently emerged as part of everyday speech. Most often described as unplanned, scattered, low-density, automobile-dependant development at the urban periphery, sprawl now shares space on the covers of national news magazine with perennial "big" issues like health care and race relations, and it has become a prominent issues on talk shows and campaign trails."  

The Auckland City: Growth Management Strategy states that urban sprawl, "...has resulted in growing transport congestion and decreasing air and water quality while threatening the amenity and livability of urban areas." Anyone who has driven in peak hour Auckland traffic will appreciate these claims. The Auckland City Council has identified strategic nodal centres for higher density development, where targeted, well designed and supported infrastructure will encourage the use of public transport, cycling and walking. The Auckland Regional Council Capacity for Growth report

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suggests there is further space for 138,000 buildings within these nodal centres around the city. Strategies to encourage more central development are critical if councils are serious about changing the living and transport habits of Auckland residents. With a further projected 141,800 newcomers to Auckland over the next 20 years, it is even more important to get these growth strategies in place. Auckland currently has a road-based transport system and the typically car-orientated culture of a low density city that will not cope with too much population growth if other means of transport don’t become more widely used.

‘Infill’ development is a development strategy commonly used as a reaction to the effects of urban sprawl. It is a relatively new strategy in New Zealand and developers with minimal experience or long-term commitment have given ‘infill’ a negative image with poorly designed buildings achieving suboptimal outcomes for the occupants and the surrounding environment. Often driven by profit margins, there is generally little effort or guidance into the quality of design or its integration with its surroundings. It is important that territorial authorities push for density by design rather than by default, because currently few national or regional policies address issues of quality.

This research proposal assesses potential spaces, seeking to provide a meaningful option for the ‘infilling’ of these under-utilised or empty urban spaces in ways that meet the needs of the users and the surrounding environment.

Internationally, Japan is a country commonly recognised for its ultra efficient compact architectural design. Most likely, this achievement reflects Japan’s high land prices and limited space. These financial and limited spatial circumstances have encouraged designers to produce creative schemes to optimise use of the available resources. It is primarily high land costs that motivate these types of ultra compact structures internationally. Traditionally, Auckland simply has not had these same pressures to economically justify developing and occupying such tiny scraps of land. But, with the combination of the continual rise in land prices and the negative environmental effects caused by ‘urban sprawl’, it is time to start exploring these spaces left over from past development as a serious option for development.

Of course, a site could appear to have development potential yet be rendered unviable by the ‘unseen’ - for example, complications of land ownership, the presence of underground services, required access and egress for adjacent sites. The particular restrictions and issues vary depending on the particular site, but a lot of these implications simply require a creative solution to overcome the issue. It is the problem solving and creative solutions to these problems that make compact infill architecture such a fascinating concept.

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2.3. Review of current practice - Four Examples

2.3.1. Billboard Building, by Klein Dytham Architects

Billboard Building, by Klein Dytham Architects was constructed in 2005, in Tokyo, Japan. The site is positioned between the side of an existing building and a well used road. It is a triangular shaped site that is 11m in length by 2.5m wide, tapering down to only 60cm at the smallest point. The building was constructed with a steel structure, moulded concrete panels, and a stencilled glazed facade. The building is occupied by a jeweller Masako Ban, who is the wife of architect Shigeru Ban. The design displays a very elegant solution to a very narrow and two-dimensional site.

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2.3.2. Love House, by Takeshi Hosaka Architects

Love House, by Takeshi Hosaka Architects was constructed in 2009, in Yokohama, Japan. The site is nestled between two existing buildings and is dimensionally only 10m in length by 3m in width. The building is timber framed and has no artificial lighting, acquiring light only through a large triangular sky-light. A curving staircase is the centrepiece of the design that runs the entire length of the building.

Figure 2.2: Love House (2009) by Takeshi Hosaka Architects.

2.3.3. **RoofStructure S, by Shuhei Endo Architecture Institute**¹³

RoofStructure S, by Shuhei Endo Architecture Institute was constructed in 2005, in Kobe, Japan. The difficult site is a slim strip of land on a hillside above a railway line. The building's triangular footprint is 20m in length, and 4m wide, tapering down to 1.5m at the thin end. The building has a steel structure and is distinguishable by its metal strip roofing that is continuous and encloses the building's side. The design displays how creative solutions, even on the most difficult sites, can result in practical and fascinating buildings.

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2.3.4. The Sam Kee Building, by Brown and Gillam Architects

The Sam Kee Building, by Brown and Gillam Architects was constructed in 1913, in Vancouver, Canada. The original site was purchased in 1903, but in 1912 the City of Vancouver re-claimed all but 2m of the site for widening of the street. With no monetary compensation the owner constructed on the narrow plot the following year, out of spite. The steel framed building is only 1.5m wide at the ground floor, and currently holds the Guinness World Record as the narrowest commercial building in the world, although this has been disputed.

3. CYCLING

3.1. Introduction

Auckland cyclist numbers have shown a significant increase in 2010. The Auckland Regional Transport Authority's 'Manual Cycle Monitoring in the Auckland Region' program describes a 34% increase in commuter cyclist numbers when compared with 2009, and a 54% increase when compared with 2001. These are both significant increases, but the reality is that in New Zealand there are much higher numbers in recreational cycling than those who cycle as a means of transport. NZ cyclist group, BikeNZ CEO Kieran Turner voiced his concern at this in an interview in 2009: "Cycling is growing strongly in New Zealand with an 80% growth in recreational cycling since 2000. However, very few Kiwis are choosing cycling as a mode of transport. A feeling of insecurity and low awareness of cyclists on the road, combined with minimal or poor cycling infrastructure mean New Zealanders are turning to more expensive solutions such as driving."  

The increased popularity of cycling is a great thing for the health of participating New Zealanders, but to have any positive environmental effect these cycling trips need to start replacing other modes of transport. The fact that large numbers of New Zealanders are involved in recreational cycling suggests they are put off cycling as a means of commuter transport for some reason other than a dislike of cycling. Auckland motorists generally give very little consideration to cyclists on the road. Figures from the Transport Ministry show the number of cyclists hit by cars and killed on New Zealand roads fluctuated between eight and twelve a year over the last five years, while 143 were seriously injured in 2009. These figures are the reason cycling advocacy organisations such as BikeWise and CAN (Cycle Advocacy Network) are compelled to promote and publicise bicycle awareness. Possibly, the best way to reduce these figures is through safety in numbers; the more cyclists there are on the roads, the more motorists might take notice. The Government has recognised the benefits cycling has on communities, by committing $40 million to walking and cycling infrastructure over 2009-2012. A large portion of infrastructure funding will contribute to upgrading and development of cycle-ways around our cities. Cycle-ways are great for providing safer cycling environments and increasing cycle awareness, but as cyclist numbers increase further other forms of infrastructure, such as storage facilities, will be required to accommodate the additional cycles.

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17 Clark, Peter. Dramatic increase in cyclist numbers in Auckland. Website: http://www.arta.co.nz/newsroom/media-releases.html?releaseid=f65df252-5056-a41f-92be-1bd33fc0d104a. accessed 12.06.2010
3.2. The Bicycle

Numerous individuals have been credited as the original inventor of the bicycle. There are many myths about where and by whom the first bicycle was truly invented. The best known of the claimed inventors is probably Leonardo da Vinci - a drawing of his showing a chain driven, pedal powered, two wheeled machine that is thought to have been drawn in the 1490's, was discovered in the 1960's. However, many historians believe da Vinci's bicycle sketch was a fake because of the suspicious circumstances of its discovery.

Apart from da Vinci's sketch, there have been bicycle-looking inventions dating back as early as the 1600's, but it wasn't until the late 1800's that a bicycle much like what we commonly use today was designed. During the late 1800's the inflatable tire was first applied to the bicycle by an Irishman who was trying to give his young son a more comfortable ride on his tricycle. It is rumored the young inventor's name was Dunlop. The fact that the basic design of the standard modern bicycle has generally been unchanged over the last 120 years is a huge credit to the design and, in particularly, the efficiency of this often unappreciated machine.

The efficiency of the bicycle is very impressive when compared to other machines, so much so that the Austrian philosopher Ivan Illich in his essay, Energy and Equity, wrote: "Man on a bicycle can go three or four times faster than the pedestrian, but uses five times less energy in the process... Equipped with this tool, man outstrips the efficiency of not only all machines but all other animals as well."\(^{20}\)

As a vehicle for personal transportation, the modern bicycle is extremely efficient. Whitt and Wilson\(^{21}\) presented a detailed discussion, with extensive references, of the power and energy requirements of cycling in their book *Bicycling Science*. They state energy needs depend on a number of factors, including speed, gradient, weight of the rider and the type of bicycle. At 24km/h on a ‘roadster’ bicycle, the energy use was given as 24.4kcal/km, which equates to about 360km/l of petrol. By comparison, a moped and rider at 32km/h equates to approximately 100km/l, while a car with one occupant at 50km/h equates to approximately 16km/l. Thus, we can say that cycling is over 22 times more energy efficient than a car and six times more energy efficient than a moped. When comparing the energy figures against other means of transport the true efficiency of cycling becomes apparent, and on top of this cycling produces negligible carbon emissions when compared with motorised or other non-motorised forms of transport. All of this on top of the benefits of physical exercise resulting in healthier people.

### 3.3. New Zealand Cycling Trends

Cycling as a means of transport in New Zealand, according to the 2006 census, has a very low participation rate. 'The New Zealand household travel survey'\(^{22}\) indicates a drop in cycling numbers nationwide since the first survey in 1989/90 when cycling took up 1.1% of the total time spent travelling, while driving a car or van was at 56.7%. The last data survey 2005-08 published in June 2009 shows the cycling percentage to have dropped to 0.7%, while car/van driver had increased to 64.0%. Both these trends are and will continue to have negative effects on the environment if they are not modified to reduce our fossil fuel dependence. Australian website Askmen.com published an article early this year titled “Top 10 bicycle-friendly cities”\(^{23}\), based on the cycling population percentage and cycling infrastructure. The article displays how poor New Zealand's cycling as a means of transport participation rate is when compared on an international scale, by listing the top three cycling cities; Amsterdam, The Netherlands; Copenhagen, Denmark; and Bogota, Colombia, as

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\(^{22}\) The New Zealand Household Travel Survey is an ongoing survey of household travel conducted for the Ministry of Transport. Each year, people in over 2000 households throughout New Zealand are invited to participate in the survey by recording all their travel over a two-day period. The statistics in this Guide uses data from 12 700 people in 5 650 households, collected between March 2003 and June 2006.

having cyclists percentages at 40%, 32%, and 30% respectively of total transportation. New Zealand, with 0.7%, obviously has a lot of work to do to achieve these types of figures.

Current cycling trends in Auckland are efficiently analysed through the annual publication 'Manual Cycle Monitoring in the Auckland Region'. The publication is based on a one day snapshot of cycling in the region, taken during the second week of March each year. In 2010, cycle movements were counted from 84 sites (28 within Auckland city), and over 12,000 cyclist movements were recorded across the region. Before this programme began in 2007, four of the seven regional councils conducted their own cycle monitoring independently of each other, using different methodologies. This meant it was very difficult, if not impossible, for any comparisons to be made across the region. In 2007 the 'Regional Cycle Monitoring Working Group' was set up to provide reliable and consistent cycle movement data. The working group was primarily established to identify areas of high movements to aid in the positioning of the proposed cycle facilities, and the chronological breakdown of the movements was used to predict the possible demands on each of the facilities.

Of the twelve traditionally recorded sites (pre 2007) within Auckland city, the 2010 results show a 34 per cent increase when compared with 2009, and a 54 per cent increase when compared with 2001. Another interesting trend to come out of the data is the difference between morning and evening numbers. As has traditionally been the case, more cyclists were recorded over the morning period. This difference noted in 2010 is consistent with the figure recorded in 2009, with 55 per cent of total movements being recorded in the morning period. Of the 12 sites, the busiest site in 2010 was the intersection of Tamaki Drive and The Strand with a total of 704 movements (up from 456 movements in 2009). Consistent with 2009, Patiki/Rosebank Road has the lightest cyclist traffic (70 movements). All sites have recorded increases in total cyclist numbers in 2010 compared with 2009.

Statistical research for this project has been conducted using seven of the monitoring locations positioned around the central business district to obtain an estimate of the number of cyclists entering the central city. (Shown in Figure 3.4) This information is extremely helpful in gaining an understanding of approximate numbers of commuters cyclists in the city, that otherwise would have been highly difficult to obtain and emphasizes the planning advantages afforded by the provision of this type of detailed data and the value of good, basic data collection.

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Over recent years the government has recognised the benefits that cycling has on communities, participant health, and the environment, by committing $40 million to walking and cycling infrastructure over 2009-2012. Government spending on cycling infrastructure is a great way to encourage people into cycling. It not only provides safer, more efficient infrastructure for users, but may also increase public awareness of the benefits of cycling. Progress from recent improvements on cycling infrastructure across the region is beginning to be seen with the increase in cycle movement statistics, increasing the number of people choosing to take their bike.

A more coercive strategy to get people to ride bicycles into the central city would be to severely restrict car-parking and car access to the inner city and build bicycle facilities over car parks. Although a different direction has been taken in this project, this could be an area of further research.

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Clark, Peter. *Dramatic increase in cyclist numbers in Auckland*. Website: http://www.arra.co.nz/newsroom/media-releases.html?releaseid=f65df252-5056-a41f-92be-1bd33fcfd104a. accessed 12.06.2010
3.4. Cycle storage

A major design issue when working with a site of such compact nature is overcoming the limitations that generally make them undesirable for development. The initial and most restricting of these limitations on the design is the lack of space. This restriction compels the designer to find innovative ways to use what little space there is available. For the utilisation of bicycle storage, space and how it is used becomes ever more pressing. The spatial geometry of bicycle storage becomes an influential design consideration.

Traditionally, bicycle storage has been carried out in a crude manner; with simple formed steel racks that provide the cycle with little protection from thieves, the elements, or from scratches or dents from the rack itself. Nowadays it is common for bicycles to cost thousands of dollars, so there is a greater requirement to provide secure bicycle storage solutions that ensure bicycles are protected. Numerous design companies and magazines have recognised this need and have held design competitions in an effort to re-design the bicycle rack, hunting for aesthetically designed rack solutions to match the thoughtful design going into the bicycles themselves. Some notable examples of such competitions are: CityRacks design competition by New York City Department of Transport in 2008, a competition for both indoor and outdoor bicycle racks that attracted over 200 entries from...
around the world\textsuperscript{26}, and Monument magazine - 'Design a Bike Rack' competition in 2010, to solve what they describe as, "... an age old problem: where to put the bike?"\textsuperscript{27}

Because there is incomplete standardisation of bicycle size and configuration, it is important to design a storage system to fit the majority of commonly used bicycle styles and sizes. For commuting purposes the three most commonly used bicycle styles are the 'road bike', the 'mountain bike', and 'the touring bike'. The three have similarly sized frames, but differ in the design and width of the handlebars.

The width of each of the handlebar designs varies slightly according to the size of the bicycle frame. From personal testing of each style, 'road bike' handle bars can be up to 450mm in width, while the wider 'mountain bike' styles are up to 620mm. These dimensions are fairly generic, but there are occasional exceptions with larger bicycles designed for extremely tall people. In 2009 the New York organisation 'New York Transportation Alternatives' (transalt) published a booklet on cycle storage in commercial buildings after a law was passed in New York City to provide cycle access and storage in

\textsuperscript{26} New York City Department of Transport. \textit{CityRacks Design Competition}. Website: http://nycityracks.wordpress.com/ accessed 10.07.2010

\textsuperscript{27} Cueva, Cesar, and Carrigan, Lisa-Maree. \textit{Design a Bike Rack}. Monument Magazine Pg 31, Issue 97, June/July 2010,
the workplace. The booklet provides building owners and tenants with guidelines to provide an acceptable level of space for both access and storage of bicycles. It summarises these access requirements as follows:

"Generally, horizontal parking will require 2 feet (600mm) by 6 feet (1800mm) per bicycle parking space. For vertical parking, you will need 4 feet (1200mm) by 2 feet (600mm) and a height of 6 feet (1800mm) for each space. Finally, you should provide for an aisle of at least 1500mm wide to allow room for maneuvering."

These spatial suggestions have been confirmed with other research. Measurements of a typical adult road bicycle confirmed that it fitted within these guidelines (1740mm long by 600mm wide by 1050mm high) with apparently little margin for error. The challenge was to envision a way to reduce these standard dimensions, through altering traditional storage configurations to use the limited space more effectively.

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28 *Bring in the Bikes: A guide to bicycle access to commercial buildings in NYC.* Published by NYC Transportation Alternatives 2009.
3.5. Review of Current Practice - Five Examples

The use of cycles is growing rapidly in popularity internationally. Major cities around the world are adapting infrastructure to better accommodate the increasing numbers of cycles on the roads and to encourage more people to use them. Cities are recognising the benefits cycling has on communities, and on the environment, and are providing state-of-the-art storage facilities to encourage people to get on their bikes.

3.5.1. International built

3.5.1.1. BikeStation, USA:29

'Bikestation' serves as a franchise company providing system support and knowledge to individual operators who are responsible for the day-to-day operations of each facility. The franchise works with a number of agencies and organizations in the planning, development and implementation of bike-transit related projects. Local operators vary between locations but consist of non-profit, for-profit and transport departments of local councils. BikeStation Long Beach was the first facility of its kind to open in the U.S. in 1996. The BikeStation franchise has grown tremendously over the past 14 years, now with eight facilities across the United States. All of the BikeStation buildings are located close to multi-nodal transit hubs to encourage further alternative transport. The Facilities provided by BikeStation vary depending on the location, ranging from simple storage for 30 cycles, to large purpose built centres housing 100+ bicycles including showers, lockers, cycle repairs, cycle rentals and cafe facilities.

29 BikeStation. Website: http://www.bikestation.com/ accessed 12.06.2010
3.5.1.2. JFE Engineering, Cycle Tree, Japan.

In contrast to the other examples, the Cycle Tree demonstrates the future of cycle storage where large numbers of cycles and strict spatial limitations require extreme innovation. The Cycle Tree, a fully automated mechanical parking system for housing a large number of bicycles in a limited space, was designed by a Japanese steel work company. The fully automated machine senses a tag on a member's cycle once in the loading dock and takes the cycle beneath the ground for storage, returning the cycle when the member's card is swiped at the loading dock. The retrieval process generally takes only 15 seconds but can take longer at busy times or on larger "trees".

The Cycle Tree has been used in numerous applications around Japan including the Kasai Station Bicycle Parking Lot in Tokyo which is the largest underground mechanical cycle parking system in the world storing 6,480 in the Cycle Tree system.

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3.5.2. International un-built

3.5.2.1. The Breakaway, We Are You: 31

Figure 3.12 - The Breakaway bicycle centre concept. Designed by We Are You

The Breakaway is the design for a new bike centre in the city of Philadelphia by Swedish Architects 'We Are You', for an international competition. Its mission is to promote bicycling in all its forms, and to become a hub for bike commuters, messengers, biking tourists and racers. The facade consists of an automated vertical bike parking system designed to mark the site in the city and encourage more people to cycle. Being a theoretical design the mechanical parking facade system has not been practically implemented and there is no indication of the number bicycles the facility could house.

3.5.3. New Zealand built

3.5.3.1. Bike Central, New Zealand 32

Bike Central is an Auckland based cycle storage facility, and is the only New Zealand based multifunctional cycle storage facility discovered to date. The facility has a wide range of services including cycle storage, showers, lockers, a cafe, and bike rental, but is primarily based on cycle sales and repairs. The main issue with the facilities provided at the Bike Central store is the opening hours. Because the cycle storage is store-person controlled the facilities can only be used between 7am and 6pm weekdays, and 11am and 5pm weekends. This is a huge limitation and reduces the convenience of what would otherwise be a good concept.

31 The Breakaway. Website: http://www.archdaily.com/59611/the-breakaway-we-are-you/ accessed 12.06.2010
32 Bike Central. Website: http://www.bikecentral.co.nz/ accessed 10.09.2010
3.5.4. New Zealand un-built

3.5.4.1. Bike-Station Feasibility Study: Auckland, New Zealand

While researching various cycle facilities around the world a feasibility study for a BikeStation franchise in Auckland was discovered. The report was published in January 2007, and was funded by the HSC's Bike Wise Community Programme. The study discusses the need for such a facility in Auckland, how it would benefit the city, analyses some possible locations, and looks into potential sources of funding for such a development. The study suggests a preferred location to be in or near the Britomart transport centre for connectivity with existing transport modes as in the American BikeStation example. The study suggest four scenarios for the facility's location; three of which are within the existing Britomart complex buildings, and the fourth is a new building in the car parking area to the east of the existing main structure.

As a result of the feasibility report the author was commissioned to continue with the next stage of feasibility. According to online information the author, Phil Hurdle, addressed the Auckland City Council about the report in April 2007, but there has been no further development on the concept as far as we are aware.

33 Hurdle, Phil. Feasibility Report into a BikeStation for Auckland's CBD. January 2007
4. PROJECT DEVELOPMENT

4.1. Site Search

Optimal 'micro-sites' for re-development were located by both a physical and a virtual search of the Auckland central business district. This involved cycling and walking the streets, and searches using Google maps, studying the spaces behind, between and above existing structures, looking for small parcels of land that could be considered left-over or under-utilised, with potential for development. The initial selection process included any parcel of land that was either vacant or partially vacant, and therefore under-utilised, and was deemed to have potential for development. A database of 60+ (over 40 within the CBD) potential micro-sites was compiled, ranging from service lane spaces, to awkward 'leftover' corners of unusual shaped sites (see appendix A). This large number of potential sites identified is consistent with previously published research reporting that in 2006 there was 146 hectares of vacant land for business development in the Auckland city council region, giving an estimated 9 years of development until capacity is exhausted. These figures are for the wider Auckland city area but by using a similar selection process, the number of prospective sites discovered in the city centre supports the validity of micro-site development within the Auckland CBD.

After completing the search also of city fringe suburbs and discovering many potential sites, the validity of the idea of compact infill development within city fringe suburbs came into question. These fringe suburbs, where the original searching was conducted, were initially chosen because of their recent development and the close-knit culture surrounding these smaller community centres. However, the principal motivation encouraging more intensive use of 'micro-sites' is the pressure of continually rising land values. This pressure is likely to be far greater within the centre of the city than on its periphery where under developed land may be more greatly available. Consequently, in this project, the 'micro-site' search was refocused on the Auckland city centre where the higher building density and land prices make such a concept more feasible.

The existing purposes of the sites identified in this search ranged dramatically. In the early exploration stages the search was made as inclusive as possible in an effort to identify sites from a variety of situations with a range of possibilities and in order not to exclude sites which might provide unanticipated opportunities.

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34 Capacity for Growth Study. Auckland Regional Council. 2008
4.2. Selection Criteria

As previously mentioned, the site search had discovered the existence of numerous 'micro-sites' with the potential for development, within the parameters of the project. Each of the discovered sites brought individual and varying possibilities and limitations that could have strong influence on the final design. Some of the characteristics that would need to be overcome through design were; large or obstructive neighbouring buildings, surrounding environments not suitable for the proposed function, restricting widths that were simply too small for construction, or un-avoidable transport or service requirements of the space.

The initial idea of selecting an individual or small group of micro sites to further analyse was complicated by the initially undefined nature of the proposed design outcome. The design outcome was initially deliberately undefined through the early stages of the project to allow plasticity and evolution of design. It was only after the initial searches that the idea of providing bike facilities was decided. This initial lack of programme, forced consideration of the precise function any compact infill structure might be intended to achieve. Originally, the idea was to seek out these 'micro-sites', and this search, and consequent database, would resolve and present a perfect site in which a programme could easily be decided, dictated by the needs of the site’s individual context. After an initial appraisal, it was decided that the simple selection of two or three sites would be impossible to
achieve within the original parameters. It was at this point that the Cycle facility concept came to fruition, consequently providing the basis for a systematic selection of the final sites.

The programmatic function of a commuter cycle hub requires maximum convenience and accessibility covering as much of the central city as possible. To achieve these functions it was decided to explore the possibility of providing cycling commuters with these cycling stations strategically positioned across the city, to achieve the maximum city cover. The locations would provide commuters with a facility where they could safely store bicycles and get organised before and after the working day.

To inform the selection of suitable sites, 'ideal' locations were considered to be those within a comfortable walking distance to a user's place of work. To achieve this, exploration was conducted into the speed and distance the average walker could comfortably travel, to determine the ideal number and positioning of the proposed facilities, to provide for workers over a maximum of the central city. Further stations can be established on other micro-sites as demand requires in the future.

After carrying out a number of measured and timed walking trips it was found that the average leisurely walking speed is approximately 5 km/h. meaning the average walker can travel one kilometer in 12 minutes on reasonably level ground. This average of 5km/h was fairly accurate when compared to walking averages found online. From these tests it was decided that a comfortable walking distance after a lengthy bicycle ride would be up to approximately 500 meters, resulting in a six minute walk. It is assumed that the majority of commuter cyclists will be able bodied and have a reasonable standard of base fitness, so this six minute reference may be considerably lower in many cases.

![Figure 4.2 - Map showing identified 'micro-sites' and ideal locations using 500m walking circles.](image)
The 500m walking distance acts as an ideal or target spread between the proposed cycling facilities across the city. The actual walking time will be an approximate guide, and for the assumption of 6 minutes there is an accepted area of variation above and below this time when there is a incline or decline to some workplaces.

4.3. Final Sites

The use of the walking circles (figure 4.3) gave a clear, systematic indication of the ideal positions of the proposed cycle hubs. In all three cases there were previously identified potential 'micro-sites' located within a close proximity. After selection the final three sites were rechecked for suitability and fortunately they offered varying situations and complexities, and are suitable sites to showcase the proposed programmatic solution. The final three selected sites are located at; 1-5 Upper Queen Street, 20 Shortland Street, and 162 Victoria Street.
4.4. Site Analysis

4.4.1. Site One - 1-5 Upper Queen Street

*Figures 4.4 & 4.5 - Photograph and aerial plan of 1-5 Upper Queen Street.*

**Site area:** The site area of the proposed Upper Queen Street location is approximately 157sqm. It is a triangular shaped site running north to south with a length of approximately 26m by 11m width.

**Adjacent Properties:** The Upper Queen Street site has tall buildings along two of its three major boundaries. The third boundary, on the south-east, is on the road side with a sizable 3m footpath running along Upper Queen Street. The adjacent National Bank property to the north of the site is approximately 7m in height at the boundary. The property to the west of the site is an old industrial building approximately 12m in height at the boundary. On the western boundary stands a solid brick wall showing various stages of old construction, which is currently used for small advertising posters.

**Solar Access:** Because of the presence of a building on the western boundary of the site, the central point at ground level will enter shade at 2.30pm in June; the sun will just clear the top of the building on the northern boundary. In December the building on the western boundary will cause the central point of the site to be shaded at approximately 4.15pm. Because of the orientation of the site and the adjacent buildings built right on the boundaries, consideration will need to be given to the design of the building to make best use of what little sun is available. There are three trees along the footpath on the boundary edge. The two northern most trees are reasonably substantial and will further affect the solar access of the site from the eastern morning sun.
**Land forms/Characteristics:** The Upper Queen Street site has the advantage that it sits on a busy arterial road and is in close range to the bustling Karangahape Road. This has the advantage of extra security because of the number of people frequenting the area, and the prime visibility of the site. The site is on a reasonable gradient rising to the north. From the southern point of the site there is an approximately 1.5m incline over the 28m south-east boundary on the footpath edge. From the highest point of the footpath next to the site the level increases another 1.7m to the north-western corner; producing a 3.2m increase in level from the southern point to the northern boundary.

**4.4.2. Site Two - 20 Shortland Street**

**Site area:** The overall site area of the Shortland Street site is approximately 2016sqm, although the proposed area for development is a small 182sqm built up area in the south-east corner of the site. It is rectangular shaped and is approximately 13m in length by 14m wide.

**Adjacent Properties:** The Shortland Street site has tall buildings along two of its four boundaries. The site has street frontage on the northern boundary (Fort Street) and southern boundary (Shortland Street). The adjacent property on the east of the site is approximately 60m in height and has a solid concrete wall running full height at the boundary. The property to the west of the site has a slightly smaller building at approximately 45m in height and again with a solid wall on the boundary.

**Solar Access:** The large building on the east of the site will impact on the morning sun to the proposed area for development. In June, this building will cause the area to be in shade until 11.30am. In December this will cause shade of the area until about 12.15pm. On the western side of the site the sun will disappear behind the neighbouring building at approximately 2.30pm in June. In December
the building will block the sun at about 3.30pm, although as the sun sets the site will come out of shade for a while soon after 4pm.

**Land forms/characteristics:** The proposed Shortland Street site is currently used as an Auckland city council car parking area. The site has obviously been built on in the past. Demolition of the previous building is the reason for the existence of this interesting vacant site. On the Shortland Street boundary of the site there is a steep 3.5m wall down to the existing car park level. The small rectangular area of the site that was seen to have development potential is at the higher Shortland Street level and looks to be an area left over after the former building's demolition. There are still many indications of a demolished building’s structure around the place, giving the site an interesting character.

### 4.4.3. Site Three - 162 Victoria Street

![Image of site](Figure 4.8 & 4.9 - Photograph and aerial plan of 162 Victoria Street.)

**Site area:** The overall area of the Victoria Street site is approximately 2016sqm, although the proposed area for development is a small 182sqm area in the south-west corner of the site. It is an area at the site’s rear, left empty after development with vehicular access.

**Adjacent Properties:** The Victoria Street site has buildings on three of its four boundaries. The site has street frontage on the northern boundary (Victoria Street). The adjacent property to the west of the site is approximately 12m in height and has a solid concrete wall running full height at the boundary.

**Solar Access:** The large building on the east of the site will impact on the morning sun to the proposed area for development. In June this building will cause the area to be in shade until 11.30am. In December this will cause shade of the area until about 12.15pm. On the western side of the site the
sun will disappear behind the neighbouring building at approximately 2.30pm in June. In December
the building will block the sun at about 3.30pm, although as the sun sets the site will come out of
shade for a while soon after 4pm.

**Land forms/characteristics:** The proposed Victoria Street site is also currently used as an Auckland
city council car parking building, although this does not seem to be the building’s original purpose.
From the Victoria Street boundary on the north, a vehicle ramp slopes down about 8m towards the
southern boundary. The adjacent property to the south has a similar vehicle service lane also running
along the western boundary down to Wellesley Street to the south. There is obvious potential for
development with the added possibility of dual access, by taking advantage of both sites’ existing
access. The proposed area for development does not have the same street frontage as the other two
sites but the possible advantages of the duel access from two busy streets makes up for this.
5. ARCHITECTURAL OUTCOME

5.1. Design Strategy

The compact nature of the proposed sites means the facilities will act as a network of independent buildings across the city, with the possibility of developing additional sites as cycling numbers increase and demand requires. The primary function of each facility will be based on commuter cyclists, providing 24 hour secure bike storage, and shower and change facilities. A variety of additional cycle related services will also be included as the individual sites require. These could include; bike sales and repair, bike rental, food/coffee vending, and travel and tourist information. The architectural design of such a concept calls for,"... a unique response to the land and the program." Therefore, in some situations additional non-cycling related functions may also be included depending on the individual site, and surrounding environment. However, the primary function of each building is to provide efficient and convenient cycle storage, and success of this function will ultimately determine the success of the overall concept.

The cycle storage component of the proposal requires strict spatial planning, and creates a benchmark for the rational design of the available space. Working within the limitations of restricted space has given a first-hand understanding of the difficult reality of compact infill development, a fact usually sidestepped within the pages of the glossy coffee table infill books. In designing for compact spaces efficiency and functionality may be compromised. From the beginning the project seeks to provide meaningful design solutions to benefit the community. Providing these facilities is the beginning of this process, but to really promote and encourage people to cycle, the buildings' layout must be completely rational and user-friendly, while the interior and exterior environments of the structure need to create a distinguishable sense of identity for members that use the cycle storage, to the wider public who use the public facilities and have this new structure in their community.

While the design strategy would be the same for each of the three sites, the design outcomes would be specific to the individual constraints and requirements of each site. One of the three sites - 1-5 Upper Queen Street - has been selected to 'showcase' the design strategy. This site was selected as being the most challenging site because of its size and shape. It is assumed that if a successful design can be developed for this challenging site, it could easily be adapted for the less difficult sites.

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5.2. Design Analysis

The site at 1-5 Upper Queen Street is in the Karangahape Road precinct of the District Plan, with the following restrictions imposed; 35m height control for the site, 4:1 site density ratio, and site development must include either retail, commercial, residential functions. These restrictions have generally been adhered to. Because of the small land area of the site, the 4:1 site density ratio is the most restricting of the plan rules. This density ratio means that the total floor area of the building over all levels must not be larger than four times the site area. Because of the 157 sq. m site area of the proposed site it is allowed a maximum total floor area of 628 sq. m.

5.2.1. User Estimates

As mentioned in the Chapter Three of the project, current cycling trends in Auckland are most efficiently analysed through the annual publication 'Manual Cycle Monitoring in the Auckland Region'. The publication is based on a one day snapshot of cycling in the region analysing cycle movements from 84 sites, 28 of those within Auckland city. Statistical research for the project has been conducted by analysing seven of the cycle monitoring locations around the central business district to obtain an estimate of the number of cyclists entering the central city. (See figure 3.4 for mapped locations)

The monitoring takes place over commuter hours at each of the locations, between 6.30-9.00am and then again between 4.00-7.00pm, which matches the projects intention of providing primarily for commuter cyclists. The information provided in the publication is highly useful not only because it presents a count of the total number of cyclists passing through each intersection over these hours, but it also maps the direction in which cyclists are travelling, and documents the time at which cyclists pass through the intersection, in ten minute intervals.

This additional information was highly valuable because it meant it was possible to breakdown the directional and time information to get a further understanding of the directional movements at each of the locations, with a reasonable amount of accuracy. (See Appendix B for cyclist movement breakdown analysis).

Using that information, it was calculated that 74.3% of the morning cycle movements over the seven locations were heading into the city centre. So, with a total of 1624 morning movements over the seven sites, 1206 of them were heading towards the CBD. It was decided that an initial target for the three sites, would be to provide facilities for 20% of the cyclists coming into the city. Achieving this requires cycle storage and shower/change facilities for 241 in total over the three initial sites, meaning a target number of 80 cycle spaces at each of the buildings.

The time increments were helpful in determining each of the buildings usage at any one time. Having cyclist information in 10 minute intervals and knowing the average number of the total movements towards the city meant the expected occupancy rates over the busy morning period could
be determined. (See Appendix C for time interval breakdown) Over the busiest 10 minute period of
the morning, between 7.50 - 7.59am, there are 152 cyclists entering the city. Providing facilities for
20% of them over the three sites means at the peak there will be approximately 7.5 cyclists entering
each of the three buildings over this 10 minute period.

5.2.2. Building Programme

The primary programme for the building is to provide facilities for commuter cyclists,
cycling in and out of the central city. These primary facilities will provide members with 24 hour
secure bike storage, shower and change facilities, secure personal lockers and an area for relaxation
after their ride. It has been decided after initial spatial explorations that there is adequate space to
include additional services. To keep with the overall concept of the building and add to the value of
the primary services these additional spaces will include; a cafe, and a shop providing cycle sales,
rental and repair. The areas and arrangements are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Location (Level)</th>
<th>% Total Floor Area (Approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle Storage</td>
<td>Levels 1, 2, 3, 4</td>
<td>30%</td>
</tr>
<tr>
<td>Showers, Toilets, &amp; Changing</td>
<td>Level 2</td>
<td>10%</td>
</tr>
<tr>
<td>Lockers</td>
<td>Level 2</td>
<td>1%</td>
</tr>
<tr>
<td>Relaxation Area</td>
<td>Level 1</td>
<td>9%</td>
</tr>
<tr>
<td>Cycle Sales/Rental/Repairs</td>
<td>Ground Level</td>
<td>9%</td>
</tr>
<tr>
<td>Cafe</td>
<td>Ground Level</td>
<td>7%</td>
</tr>
<tr>
<td>Circulation &amp; Services</td>
<td>All Levels</td>
<td>34%</td>
</tr>
</tbody>
</table>

5.2.3. Planning

The building’s layout in both plan and vertical arrangement has been carefully considered to
best utilise the limited space available. Numerous combinations and arrangements have been
considered throughout the development of the design. The final proposal has been developed using the
combination of features listed above and provides a design that is functional, efficient, and user-
friendly. With the high level of importance placed on the building’s users, a helpful strategy was to
analyse in detail the stages of interaction, and likely use, of the user with the building. Considering the
building’s use like a production line, the strategy highlighted the stages of use, and created a clear
sequential flow of activities, increasing the building’s overall efficiency.
Cycle Storage: The difficult triangular shape of the site means the optimum cycle storage arrangement is a single row of 20 cycles over four levels (80 in total). Stacking the cycles in a vertical manner is the best use of space and raising them off the ground opens up the ground floor for retail space. Because of the large area required to store 80 bicycles, utilising the vertical surface results in additional space for other functions at each level and means the bicycles are easily displayed to the building’s exterior. Occupying the slender southern end of the site is the ideal location as it is a prominent position on the site’s street frontage.

Showers, Toilets and Changing Areas: The positioning of the bicycle storage means the wider northern end of the site can contain the bathroom and lounge functions that will benefit from the wider available space. The ablutions are separated for male and female specific areas to provide a more comfortable environment for each gender.

Each of the areas includes:

- 4x Private showers - with space to change in and out of clothing.
- 3x Toilets.
- 4x Wash-hand basins - with mirrors and bench space.
The figures provided in Section 5.2.1 User Estimates were a good base for deciding the approximate number of facilities the building will require, and were used in conjunction with the New Zealand Building Code to determine final numbers. Providing a total of eight showers at each of the buildings exceeds building code requirements for the number of occupants and means that in the busiest periods there will be sufficient shower numbers.

**Lockers:** Secure personal lockers have been provided for the storage of personal items. They have been positioned on Level 2 near the ablutions, for convenience as it is likely they will most often be accessed before and after showering and/or changing.

**Relaxation Area:** A relaxation area has been included in the design where members can sit down, take a breather and remove cycling shoes or gloves after a ride into town. It has been positioned on Level 1 to provide direct access when a member first enters the building. Its position and layout means it is incorporated into the circulation space to get people into the area to create a social environment.

**Cycle Sales/Rental/Repair:** A shop selling, renting, and repairing bicycles has been located on the ground floor on the site’s southern end. Internal lift access is provided to create a directly link between the shop and the members cycle storage areas. This means members can book in a service while they are working and shop staff can easily access and move cycles between the two areas. On top of the convenience factor, the function of the shop has also been selected to encourage and provide interaction with the street and the public.

**Cafe:** The cafe has also been selected as a service to provide further interaction with the public at street level. It is a prime location for a cafe, with members likely to want breakfast, coffee, and a paper before an up to six minute walk to work in the morning, on top of the usual heavy foot traffic in the area.

**Circulation:** The main circulation is positioned in the centre of the building, consisting of a lift intended primarily for vertical cycle movements and a stair. The position of the circulation provides a clear main entry at the core of the building, separation between the cycle storage areas to the south and the lounge and ablutions to the north; and acts as a central light well to filter natural light into the buildings centre.

### 5.2.4. Services

As the project is aiming to promote the message of sustainability through cycling, the building would ideally also reflect sustainability ideals. Doing this will further promote a positive environmental
impact and is important if the overall concept is to be taken seriously. To achieve this, the building has been designed to be as efficient as possible to reduce the energy requirements of its use. The nature of the proposal means the majority of energy consumption will be on weekday mornings between 6.30 and 9.00am, when members arrive at the facilities before work, shower and relax before heading off to work. Apart from this daily peak, the energy required for the building will be relatively low. There may be a small number of members coming in throughout the day, a slight rush in the evenings with much smaller energy requirements, and the requirements of the cycle shop and cafe during standard opening hours.

The building has been passively designed to reduce the amounts of energy required for mechanical heating and ventilation. Different external treatments have been adapted depending on the required level of privacy and weather protection of the internal functions, to provide natural light and air-flow around the building.

The most significant energy cost of the building will go into the hot water provided for showering, it is proposed that some water collection will be achieved off the building's roof but because of the small surface area this will not be sufficient. To help reduce the significant water heating energy requirement, evacuated tube collectors have been proposed positioned on the roof directly above the ablutions area. This is an ideal northern location for solar gain, but because the amount of water required for the showers alone is potentially over 2400L per day even with low flow shower heads (80 times 5 minute showers at 6L per minute), the energy sourced from the sun is not going to cover these demands, but will significantly reduce the energy output in warmer months.

Natural forms of ventilation will be incorporated into the design where possible, to encourage controlled airflow around and across the building. The ablutions area on Level 2 is the only area where mechanical ventilation is a necessity because of the large amount of moisture created from the showers in a small area.

5.2.5. Interior Environment

It has been an ongoing concern throughout the year that the building must have a strong sense of identity in order to avoid a 'car-park building' feeling to the interior spaces. To achieve this, the cycle storage area of the design has been lifted above the ground and given a prominent position spread over four levels on the building's facade. This position along the front the building means the cycles can be made clearly visible from the exterior, offering the opportunity to maximise natural light into the building's interior. The vertical circulation shaft running through the centre of the building is treated as a vertical light down through the building. The materials used in the interior cycle storage areas of the building have been influenced by the traditional utility designed nature of bike sheds to provide a hard wearing environment, in contrast with other functions of the building where softer materials are used to create more comfortable interior environments.
5.2.6. Exterior & Streetscape

As previously mentioned the site has been divided by the vertical circulation running up the centre of the building, creating a clear entry and visual break in the building’s facade. The external form incorporates recognisable features that can easily be adapted through further designs. Raising the cycle storage areas off the ground floor provides the opportunity to position retail premises on the ground floor. "We tend to view the street in relationship to the ground floor uses: its vitality, and the interaction with people in the street, affects how we feel there." The inclusion of cycle sales and rentals, and a cafe on the ground floor both complement the primary concept of the proposal, but also provide the opportunity for strong interaction with the public in the street, creating lively interaction with the building.

Figure 5.3 - Diagram showing vertical arrangement of functions.

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6. CONCLUSION

This research project investigated the possibility of developing currently under-utilised and empty, compact sites located within the existing built environment for the insertion of compact cycle storage facilities to the central city. Infill construction and cycling transport promotion are, each in their own right, recognised strategies for improving the sustainability of our cities as we move into the future. The ideas in are not new in themselves, but together provide an innovative concept, conceived as a logical response to the rise in the popularity of cycling in New Zealand in recent years, the consequent need for additional facilities to cater for cyclists, adapting transport habits in Auckland, and to increase the intensity of the existing urban built environment.

The study confirmed the validity of 'micro-site' development within the Auckland context, by compiling a comprehensive database in the early stages. Investigation of cycling trends revealed a recent increasing trend in cycling participation, but also highlighted New Zealand's low participation in cycling when compared internationally.

The research suggests the development of the proposed urban bike sheds would hugely benefit the community by providing facilities for the increasing number of commuter cyclists on the roads - through the promotion of cycling as a means of transport, and to show how development of these under-utilised spaces can have a positive effect on their surroundings by attracting people and creating more lively central areas. The final design outcome provides a functional, intelligent, efficient and user-friendly solution, in an effort to optimise the use of the compact site.

6.1. Critical Appraisal

Overall the project has achieved its aim of demonstrating the viability of compact infill construction in central Auckland, and provided evidence that cycling as a means of transport is increasing and is likely to continue to do so in the future. The conclusions suggest the development of the proposed urban bike shed would hugely benefit the community; by providing facilities for the increasing number of commuter cyclists on the roads, through the promotion of cycling as a means of transport, and to show how development of these under-utilised spaces can have a positive effect on their surroundings by attracting people and creating more lively central areas.

As far as the sequential development of the project has gone I am happy with the concept and the design solutions to the problems that arose throughout the research. An alternate approach to the design implementation used would be to design a standardised system of cycle storage, rather than a specific design approach as this project has done. The specific design approach used here was suitable for this particular project because the project intended to make use of these under-utilised micro-sites and required a more complex and specific design under these spatial limitations. However, a standardised system could create the potential for a much more extreme approach to the promotion
of cycling. By designing a standardised modular system dimensionally based on a series of car-park spaces one could simply replace for example 6 car-parking spaces, with 30 bicycle-parking spaces, or 10 car-parks with 50 bicycle-parks. Replacing car-parks with bicycle parking could have positive results. The most effective way to get people cycling and using alternate forms of transport into the central city could be to restrict or limit car-parking spaces.

There is a great deal of fascinating information available on bicycles and infill development and with the time limits imposed on the project, it was only possible to provide a brief background on the broader topics.

6.2. Suggestions for further research:

- The financial feasibility of the Urban Bike Shed concept. Analysing the validity of the concept from an economic point of view by working out the cost of the site and of building and maintaining of the facility to determine the annual cost per person and whether or not people would be prepared to pay that.
- Design a standardised system of cycle storage, rather than a specific design approach as this project has done. A standardised, modular system could be dimensionally based on car-park space and simply replace X amount of car-parks with 8 times X amount of bicycle parks.
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9. APPENDIX

9.1. Appendix A - Identified micro-site images

Images of all the identified micro-sites in the CBD
1 Galatos Street  
7 Gore Street

8 Galatos Street

118 Greys Ave
128 Halsey Street
135 Halsey Street

168 Hobson Street
246 Hobson Street
329 Karangahape Road

373 Karangahape Road
36 Kitchener Street
16 Liverpool Street
9.2. Appendix B - Cycle movement analysis


Used to get an estimate of the number of cyclists commuting into the CBD. (See section 5.2.1)

<table>
<thead>
<tr>
<th>Movements Toward the CBD</th>
<th>Total Cycle Movements</th>
<th>Total Morning Movements</th>
<th>Morning movements towards the CBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>VICTORIA STREET/WELLESLEY STREET/HALSEY STREET (SITE 1)</td>
<td>162</td>
<td>82</td>
<td>62</td>
</tr>
<tr>
<td>PONSONBY/KARANGAHAPE/ NEWTON/GREAT NORTH ROAD, NEWTON (SITE 2)</td>
<td>559</td>
<td>242</td>
<td>204</td>
</tr>
<tr>
<td>KARANGAHAPE ROAD/QUEEN STREET, AUCKLAND CENTRAL (SITE 3)</td>
<td>582</td>
<td>274</td>
<td>176</td>
</tr>
<tr>
<td>SYMONDS/KARANGAHAPE/ GRAFTON ROAD, GRAFTON (SITE 4)</td>
<td>597</td>
<td>283</td>
<td>192</td>
</tr>
<tr>
<td>STANLEY STREET/ GRAFTON ROAD, GRAFTON (SITE 5)</td>
<td>93</td>
<td>47</td>
<td>46</td>
</tr>
<tr>
<td>TAMAKI DRIVE/ THE STRAND, PARNELL (SITE 6)</td>
<td>936</td>
<td>498</td>
<td>352</td>
</tr>
<tr>
<td>FERRY TERMINAL, AUCKLAND CENTRAL (SITE 7)</td>
<td>395</td>
<td>198</td>
<td>174</td>
</tr>
<tr>
<td>Totals:</td>
<td>3324</td>
<td>1624</td>
<td>1206</td>
</tr>
</tbody>
</table>

Percentage of morning movements towards the CBD: 74.3%
9.3. Appendix C - Cyclist interval analysis


Used to get an estimate of expected user numbers at each facility. (See section 5.2.1)
Appendix D - Development sketches

Early project planning and development sketches
9.4. Appendix E - Design progress as of 16.08.2010

Design development presented at critique three on 16.08.2010
(Subject to change before final submission)
9.5. Appendix F - Design progress as of 01.10.2010

Planning sketches as of 01.10.2010

(Subject to change before final submission)
9.6. Appendix G - Final Design Proposal

Sample of work from Final Presented 29.10.2011
Urban Bike Sheds:
Commuter cycle facilities infilling marginal urban spaces.

Locations of the 45 identified potential 'micro-sites' in the Auckland CBD and existing cycling lanes.

Final site selection from the 500m (6 min) walking circles.