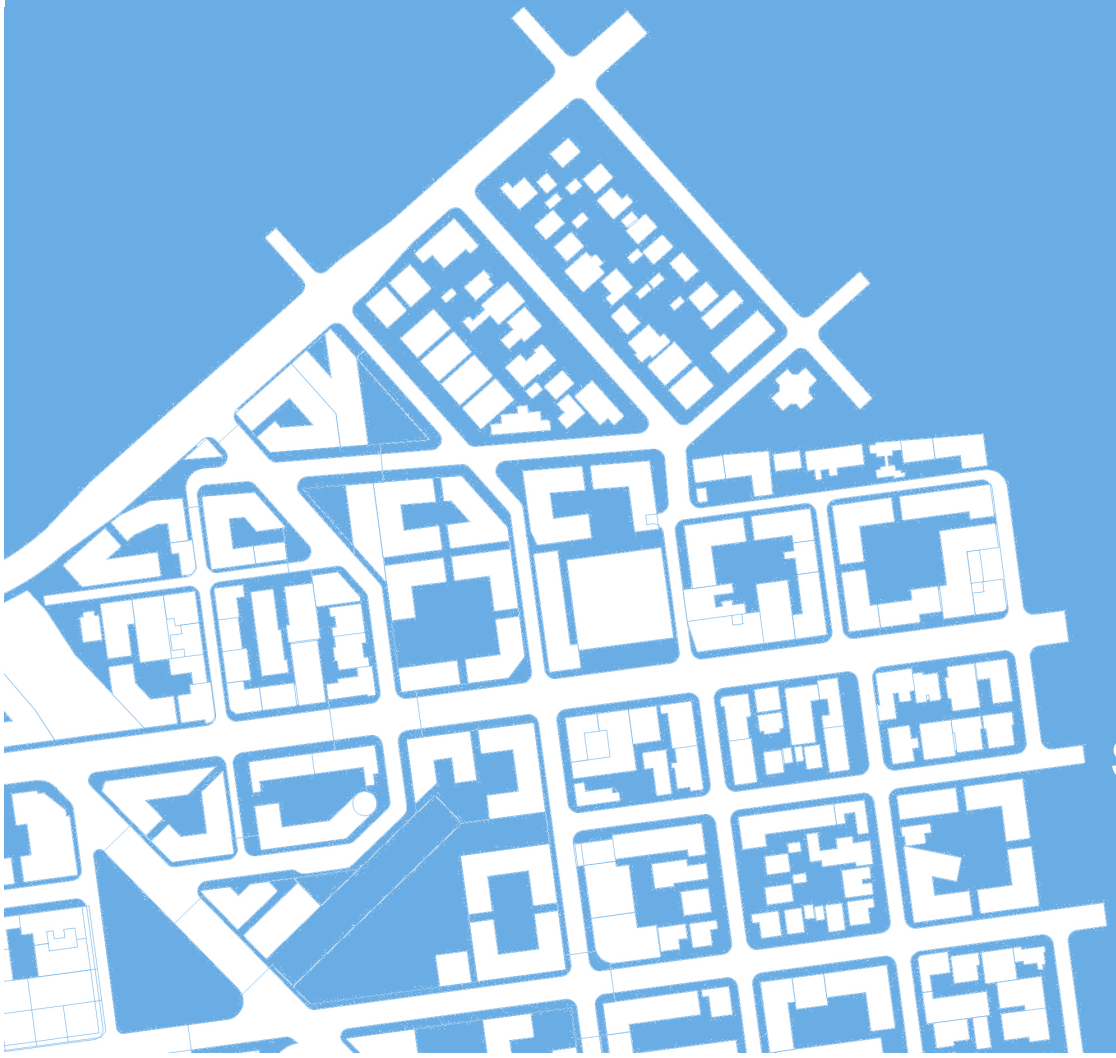
jeppe station

access+density+intensity



URBAN DESIGN RESEARCH REPORT
ARPL 7017
MASTER OF URBAN DESIGN

STUDENT - HEINRICH MELCHER
Student No. 452366

SCHOOL OF ARCHITECTURE & PLANNING
UNIVERSITY OF THE WITWATERSRAND
SUPERVISOR - DIAAN VAN DER WESTHUIZEN

OCTOBER 2012

Jeppe Station: Access+Density+Intensity

by
Heinrich A. Melcher

A research report submitted to the
Faculty of Engineering and the Built Environment, University of the Witwatersrand,
in partial fulfillment of the requirement for the degree of

Master of Urban Design

Johannesburg 2012

Supervisor:
Professor Diaan van der Westhuizen

The copyright of this research report vests in the University of the Witwatersrand, Johannesburg, South Africa, in accordance with the University's Intellectual Property Policy.

No portion of the text may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, including analogue and digital media, without prior written permission from the University. Extracts of or quotations from this research report may, however, be made in terms of Sections 12 and 13 of the South African Copyright Act No. 98 of 1978 (as amended), for non-commercial or educational purposes. Full acknowledgement must be made to the author and the University.

An electronic version of this research report is available on the Library webpage (www.wits.ac.za/library) under "Research Resources".

For permission requests, please contact the University Legal Office or the University Research Office (www.wits.ac.za).

COPYRIGHT

I declare that this research report is my own unaided work. It is being submitted to the degree of Master of Urban Design to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other university.



(Signature of candidate)

24 day of OCTOBER year 2012

DECLARATION

For Sjanet, Heike, Renée, Marcel and Amelie, for all your love and kindness.

DEDICATION

introduction
Pages 001-008

theory
Pages 009-029

analysis
Pages 030-069

concept
Pages 070-075

design
Pages 076-101

conclusion
Pages 102-104

references
Pages 105-107

TABLE OF CONTENTS

Patronage of a commuter railway station can be increased by improving the design of the station environment. Literature on the subject of public transit and the built environment showed that three factors of the built environment impact on transit patronage: station access, land use density, and land use intensity. An analysis of the built environment surrounding Jeppe Station, Johannesburg showed that the part of the station environment located east of the commuter railway line was generally less supportive of the station regarding the three mentioned factors. The station environment located east of the railway line has a lower density and a lesser intensity. Access was found to be limited in a north-south direction across the railway line, thus affecting access to the station from both sides of the railway line. The design proposal largely focused on improving access, density and intensity east of the railway line. This involved increasing densities through infill development and increasing intensity by encouraging mixed-use development east of the railway line. Access to Jeppe Station was improved by creating a north-south pedestrian spine that crossed the railway line.

ABSTRACT

introduction

Transportation and in particular public transportation can be considered the backbone of urban development and redevelopment. It structures urban form and provides the framework for an integrated and sustainable city environment. If developed poorly, such as providing little modal choice, a city's transportation can restrict development, limit choices and make it difficult for the poor to survive in the city. If developed properly, such as providing a wide range of modal choices serving numerous destinations, a city's transportation system can help alleviate poverty, help urban integration, and on a social level, help promote inclusion. The above will, of course, be substantiated in the following theoretical section by academic literature.

Central to the creation of a well-planned and developed transportation network is the implementation of public transportation where needed, as well as supporting the role of existing public transportation systems, where it exists and serves the city. Of course, there are a number of modes of public transportation that can fulfill this function, such as rapid rail, commuter rail, light rail, Bus Rapid Transit (BRT), and in South Africa, the mini-bus taxi. Ideally, these modes of public transportation need to support each other, with the lower-order modes functioning as feeder systems for the higher-order public transportation modes. In this research report, the focus is on the Metrorail commuter rail system, which is a higher-order public transportation mode, operating directly below the Gautrain rapid rail system.

Although this research report focusses on the Metrorail commuter rail line traversing the central parts of Johannesburg, it is not the rail system and its functioning that is the primary subject of concern. Instead, this research report concerns itself with access to Jeppe Station, which is the point of access to the abovementioned commuter rail line. Here the concept of accessibility comes into play. In terms of accessibility, public transport involves two parts. The first part involves access to a station facility and this has to do with aspects such as catchment area, walking distance and the design of the built environment. The second part of accessibility has to do with the public transportation system, its functioning, its service area and its costs. This research report concerns itself with the former, namely improving access to a public transit station (in this case Jeppe Station) and in so doing, improving patronage of the public transit system as a whole.

As mentioned, access to the station facility has to do with the design of the built environment surrounding a transit station, or as it is known: the catchment area of the station. Because it has to do with the design of the built environment, it is a subject that relates directly to urban design. In other words, the proficiency with which the built environment around a station is designed and consequently developed, makes a significant impact on whether a public transit station is accessed and used or not. By the same token, if a station is poorly supported, urban design can be used to improve station access and patronage. The literature study to follow will provide many design principles, guidelines and measures that can be implemented to improve access to a public transit station. It is the aim of this research report to apply these design principles, guidelines and measures to the Study Area in order to improve access to and patronage of the Jeppe commuter rail station.

An advantage of the Jeppe Precinct (as will be presented in the Analysis), it that it is very neglected and has deteriorated significantly, with many building having deteriorated to the point that they have been demolished or they need to be demolished. The word 'advantage' is used precariously because this state of affairs within the precinct allows a greater measure of freedom to implement design interventions, which in the end may enable to precinct environment to better serve the modern-day needs of the Jeppe station and its current demographic profile. This is not to say that the historic value and character of the Jeppe Precinct is not acknowledged and respected in this research report. On the contrary, attempts are made throughout to understand the historic evolution of the precinct, to reinstated some of the strengths of the historic urban pattern, and to utilize the remaining historic character as best possible. This is a position statement that needs to be made before proceeding with this research report.

This research report proposes a design for the redevelopment of the Jeppe Station precinct, which is located east of the Johannesburg Inner City. Improving the station precinct environment should facilitate access to and use of Jeppe Station, which should have a direct impact on the use of this rail-based public transportation system. This point of departure is embodied in the following problem statement, project question and study goal of this research report.

PROBLEM STATEMENT

Commuter railway station precincts in South African cities generally do not facilitate access to the station facility due to poor station precinct environments. These precinct environments typically have poor pedestrian connections, a lack of modal integration and low-density urban environments that do not encourage people to access and use rail-based public transportation.

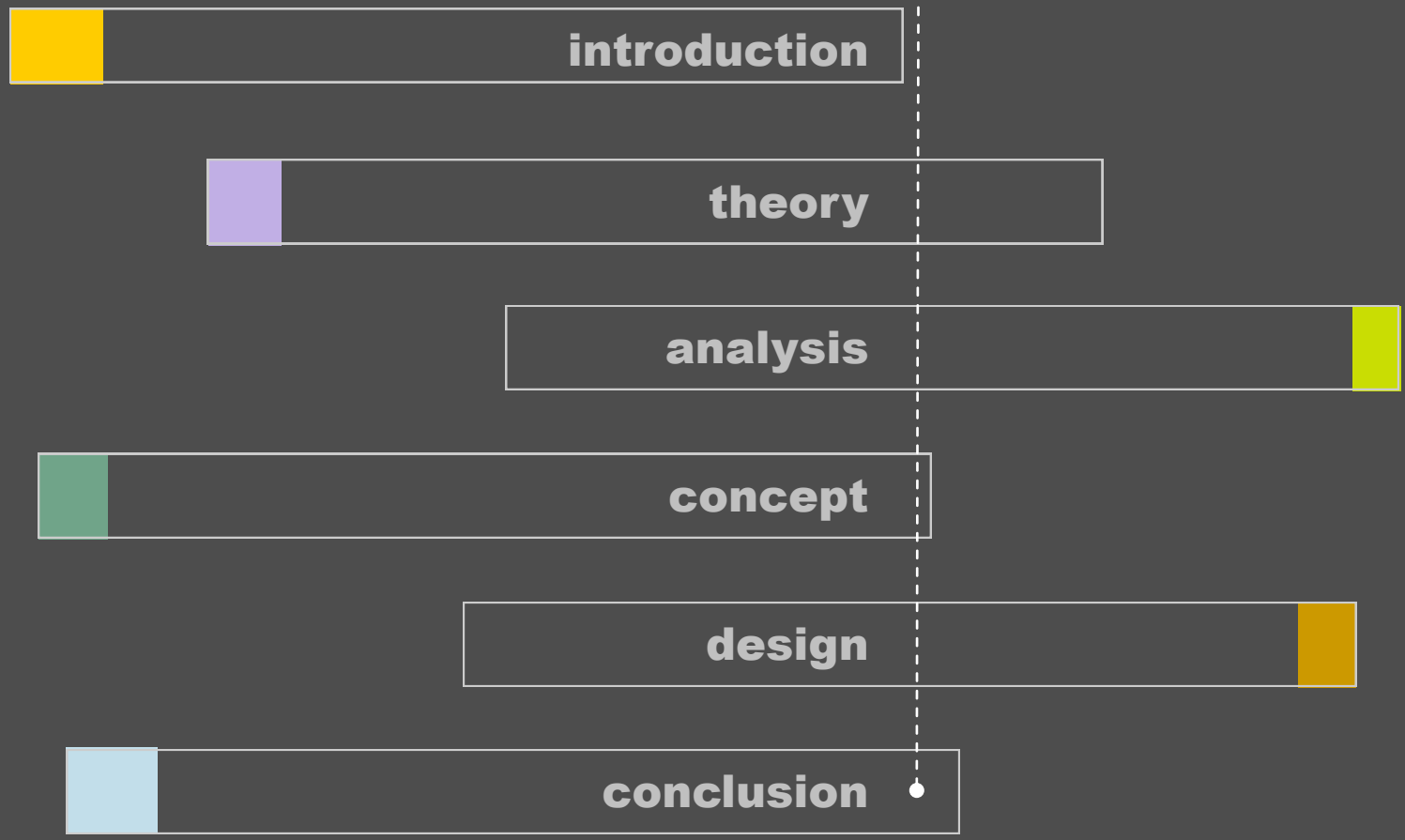
PROJECT QUESTION

Is it possible to improve access to and patronage of a commuter railway station by improving the design of the station precinct? This research question requires a literature study to determine whether a causal link has been established between the design of a public transit station precinct and patronage of the public transportation system.

STUDY GOAL

The goal will be to design the redevelopment of the Jeppe Station precinct to facilitate access to and the use of the station facility. This goal requires employing design principles associated with Transit Oriented Development (TOD), such as improving pedestrian connections, enabling modal integration, increasing land use mix, and increasing the urban density of the precinct environment. This needs to be done within a Developing World context, thus addressing the need to access public transit in a manner that is specific to the Developing World and its urban population.

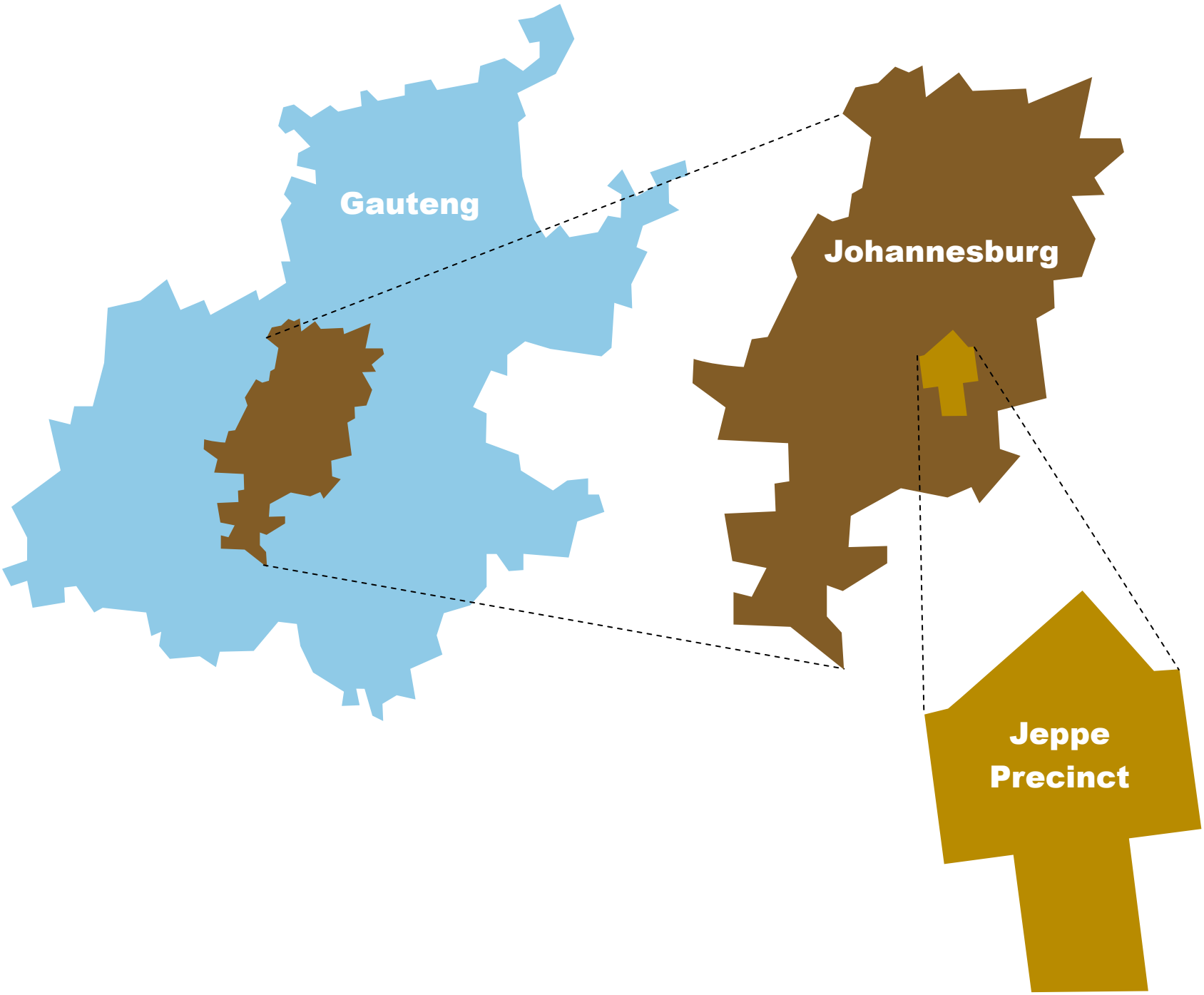
The Jeppe Station precinct contains all the elements required to prepare a suitable design to enhance patronage of the Jeppe Station. It has a fine-grain built environment that provides character, it has a historical component that is embodied in a number of older buildings, and it has a pedestrian scale that has not yet been destroyed by the eastward expansion of the Johannesburg Inner City. In addition, the Jeppe Station precinct is located on a strong east-west rail axis that traverses the central parts of Johannesburg. This is a prominent axis that is poorly exploited in the Jeppestown region.



The methodological approach followed in this study is a conventional approach: theory, analysis, concept, and design proposal. This methodology aims to systematically unpack the Jeppe Precinct and in so doing, finding ways to answer the research question presented at the beginning of this study. The research question poses the simple idea that the capable design of the build environment surrounding a public transit station will improve access to the station and in so doing, it will improve patronage of the public transportation facility.

Attempts to answer the research question was approached in three primary ways. The first way of answering the research question involved reading current literature on Transit Oriented Development (TOD) (in a broad sense) to determine whether station precinct design impacted on access to and use of a public transit station. Once this was established, a second way of answering the research question was to determine the validity of the research question itself. This was done using the analysis of the Study Area to determine whether the current design of the Jeppe Precinct in any way hampered access to the Jeppe Station. The impact of the current precinct design on access to the station was re-enforced by casual observations of the Study Area. The third way of answering the research question involved the design of the station precinct. The design proposal deliberately explored practical ways of enhancing the station environment to improve access to the public transportation facility, thereby increasing the use of the facility.

METHODOLOGY



LOCALITY

Ellis Park Stadium

Image source: LizardTech, MrSID. (2009). Retrieved May 4, 2012.



Carlton Centre

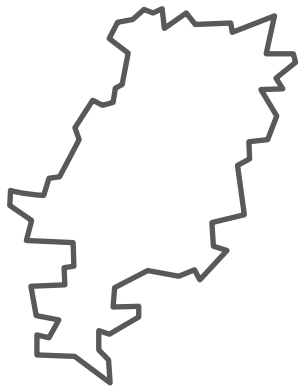
STUDY AREA CONTEXT

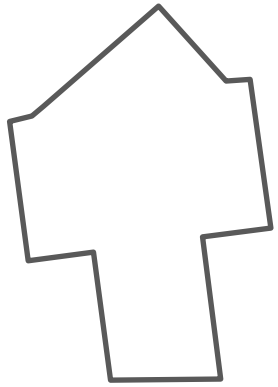
Image source: LizardTech, MrSID. (2009). Retrieved May 4, 2012.



STUDY AREA





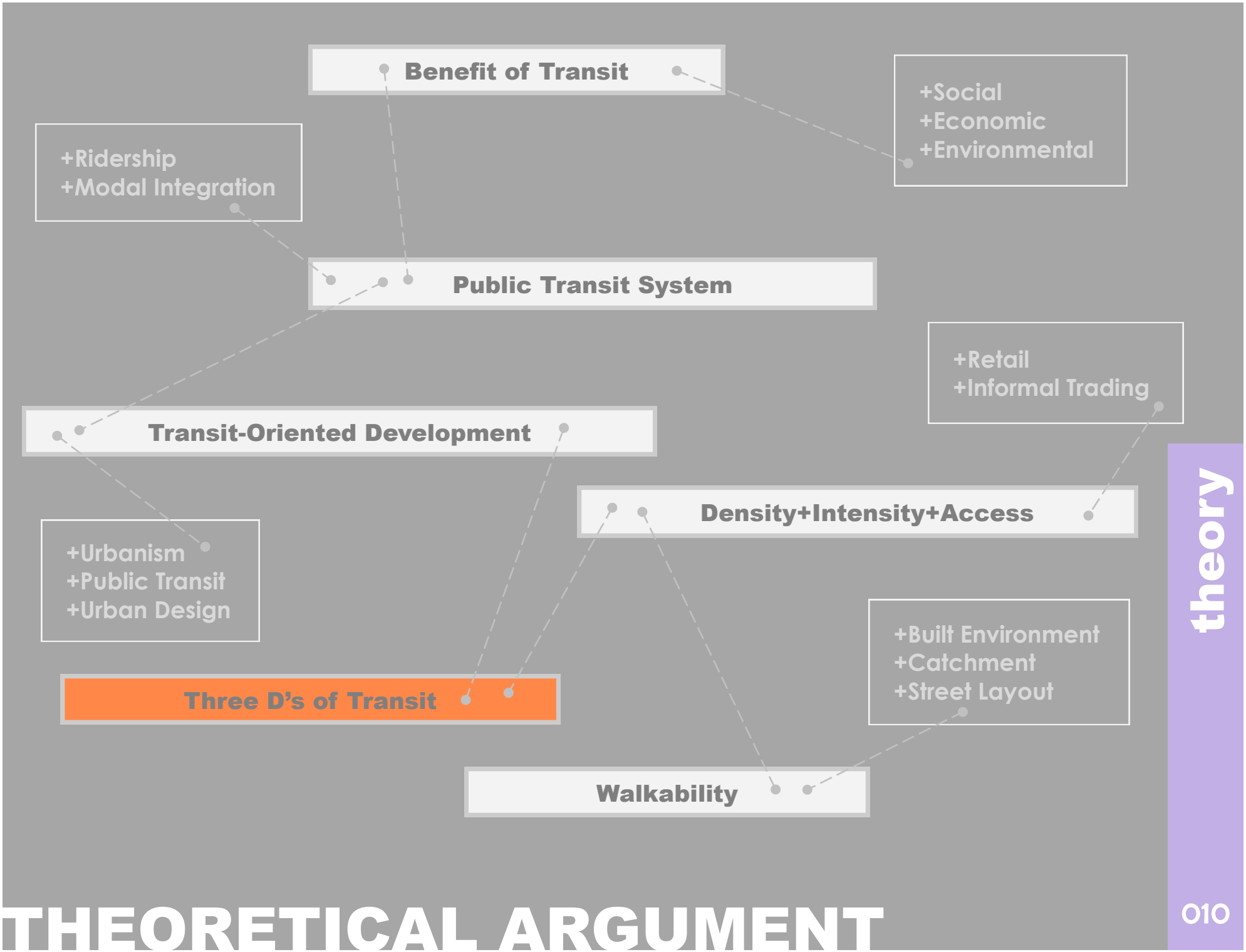


	9,720,474 people make up the population	3,397,928 people make up the population	1,531 people make up the population
	5.3% of the population use trains	5.0% of the population use trains	8.9% of the population use trains
	1.9ha of open space per 1000 people	0.7ha of open space per 1000 people	0.6ha of open space per 1000 people

FACTS+STATISTICS

Sources: Projected from SA Census 2001 figures

theory



THEORETICAL ARGUMENT

Given extreme income inequality in many developing countries, including South Africa, it is necessary to provide public transportation in the major cities of developing countries, because public transportation tends to provide a high level of accessibility to all city residents. Realizing this basic goal enables cities to overcome income differences and improve the lives of the poor. Such a public transportation thus needs to provide access to urban activities throughout a city to enable residents to reach essential services and economic opportunities throughout the city. Providing access to public transit stations is an important part of providing public transportation, without which the system provided will not operate optimally. The latter has to do with pedestrian access and walking distances (Delmelle and Casas, 2012, p.36-7).

Murray et al (1998, p.319) contends that 'the well-being of growing and expanding urban metropolitan regions is intimately connected to the provision of adequate and appropriate public transportation'. The primary reason for this is that an urban population requires access to business activities, education, employment and recreational opportunities.

According to Murray et al (1998, p.319), the location of the public transportation infrastructure has a significant influence on maintaining socially acceptable levels of quality of life. An important element of public transportation provision is also to ensure that a range of modes of public transport are available for use. This is necessary to provide commuter with travel alternatives in terms of destination and cost (Murray et al, 1998, p.320). This relates to the development of a multi-modal public transportation system and enabling modal interchange. Without an integrated multi-modal public transportation system, modal choice is not possible.

Taking into account the above, it is evident that public transportation impacts on the greater concept of sustainability. Sustainability is generally defined to include social, economic and environmental factors. In developing countries, the primary focus of sustainability is often on the promotion of economic growth and social equity, rather than on the broader implementation of sustainable development. According to (Murray et al, 1998, p.320) 'public transportation systems form the basis by which economic development can occur and the means by which a society interacts'. The opposite thus also holds true, that an ineffective transport system will limit economic development and access to social opportunities.

In a sense, the above relates to inclusion and using transport as a means to overcoming exclusion. According to Madanipour et al (1998, p.158) there are 3 types of exclusion: (a) economic exclusion, which occurs when people are excluded from employment opportunities, (b) political exclusion, which is when people are denied political power or full political representation, and (c) cultural exclusion, when people are marginalized from the symbols, meanings, rituals and discourse of the dominant culture in society. According to Madanipour et al, economic exclusion is considered to be the most painful form of exclusion, but the most acute form of exclusion occurs when there is simultaneous economic, political and social exclusion. According to Madanipour et al (1998, p.165), 'revisiting spatial barriers and promoting accessibility and more spatial freedom is a way that spatial planning (and urban design) can contribute to promoting social (and economic) integration'.

Given the importance of achieving social equity, it makes sense to develop and promote public transportation in areas where the socio-economic and demographic characteristics of commuters require access to economic opportunities and social amenities, instead of promoting public transportation in areas where communities have the ability to access such opportunities on their own accord. Priority should thus be given to improving access to areas that contain a high proportion of residents that require public transport, such as low income earners and the elderly, or to areas where households have low private vehicle ownership, thus increasing the probability of public transport patronage. In other words, the above is an approach that seeks to improve public transportation access to areas within a city that have household profiles that would most likely use public transportation (Murray et al, 1998, p.326).

Public transportation tends to provide city residents with equitable access to a large number of economic opportunities, which makes public transportation a crucial aspect of economic growth and development. As a result, public transportation projects are often linked to larger urban revitalization initiatives, which are intended to foster economic growth and development (Delmelle and Casas, 2012, p.36). In fact, the development of public transit options in cities in recent years has promoted tremendous economic growth within cities that have implemented public transportation systems, most notably cities located in developing countries. Improving access to economic opportunities and providing different public transit options to access these economic opportunities, are key responses to enable household participation in urban economic activities. This applies in particularly to city households that are transportation disadvantaged, such as those who do not own private vehicles (Nkurunziza, 2012, p.12).

In contrast to the above, the under-utilization of existing public transit systems often points to a mismatch between economic development within urban areas and the alignment of public transportation networks. Such a mismatch occurs when land use mix and land use intensity is not encouraged near transit station, which is often caused when transportation planning and land use planning are not integrated at city government level. In turn, this aggravates economic inequality, which is heightened by higher transportation costs needed to access economic opportunities. Research has repeatedly shown that economic efficiencies are dependent upon public transit and land use integration. Also, the need to develop city economies in an increasingly competitive international city-region environment makes it imperative that public transit and land use planning take advantage of these interdependencies (Chakraborty and Mishra, 2013, p.468).

Commuter rail systems in particular can foster economic development. Kim et al (2007, p.512) points out that, although reducing traffic congestion is widely considered to be the most common reason for building new transit systems, the reason most cited for the development of rail-based public transit is economic development. For example, it was found that rail-based public transit is more effective than bus transit in promoting economic development, when linked to Transit-Oriented Development (TOD), which involves compact, mixed-use and pedestrian-friendly development around transit stations.

Apart from providing access to economic opportunities, another benefit of public transportation development is that it increases land values. For example, empirical evidence from studies of Beijing, China, shows that investments in public transit can have a significant impact on land development and land value. In fact, these studies found that land development associated with public transit is critical to expand and maximize the return on the investments made in public transit. Studies from other parts of the world also indicate that properties that have access to transit or are located along transit routes, tends to appreciate in value (Zhang and Wang, 2012, p.1, 9). In Gauteng, the introduction of the Gautrain has seen significant increases in construction activity and building densities in areas such as Sandton and Hatfield, which has occurred within the fairly short existence of this high-speed commuter rail system.

To a large extent, land value differentials across a city can be explained by transportation cost savings. Public transit increases access and therefore reduces transportation cost. In turn, the improved access encourages households and businesses to locate near transit stations. This results in competition for locations near transit station, which influences the value of land (with land located closer to a station being of higher value). In other words, public transit impacts on the value of land near transit stations, which in turn influences the development of land near transit stations, such as increasing development densities near stations. However, international example clearly show that the impact of transit investment on land development is unlikely to occur if site conditions are not suitable. Thus, the planning and design for land development near transit station are critical to maximize the return of transit investments (Zhang and Wang, 2012, p.2, 9).

According to the Gauteng Strategy for Sustainable Development (2006, p.2), there is a growing worldwide focus and emphasis on the intricate linkages between the natural environment, economic stability and social well-being. The concept of sustainable development integrates these inter-dependent components. In South Africa, the primary focus has been on the promotion of economic growth and social equity, rather than on the broader implementation of sustainable development. Such a biased approach is considered unsustainable, because it leads to intensified and an unsustainable demand for land, water and ecological resources resulting from urbanization and sprawl.

Regarding environmental or ecological sustainability, there are two kinds, which Puch (2000, p.73) refers to as the 'brown' and 'green' agenda of environmental sustainability. The brown agenda refers to sanitary health and deals with issues such as unsanitary living conditions, hazardous pollutants in the air and waterways, and the accumulation of solid waste. This is the preferred focus of urbanists and studies on this subject tend to fall heavily of lower-income groups. The green agenda is primarily promoted by environmentalists and refers to issues such as ecosystem destruction, resource depletion and climate change.

In many respects, the brown and green agendas have different goals which are often in conflict or undermine each other. In reality, both agendas are relevant and significant, but it would be local conditions that would determine which agenda is considered more important. As Puch (2000, p.76) points out, in some cities the brown agenda would deserve more attention, while in other cities the green agenda would be more relevant.

Zetter and White (2002, p.43-44, 52) point out that although there are very real differences between the proponents of the brown and green agendas, some environmental improvements serve both agendas. These are improvements that support the need of low-income groups for a healthier urban environment, while also achieving some of the objectives of the green agenda. In fact, Zetter and White believe that 'in any given city…, the overlap between brown and green concerns is likely to be substantial'.

When it comes to urbanization and transportation integration, there is a clear overlap between the brown and green agendas. Regarding the green agenda, there is the need to densify cities in order to curb urban sprawl, which in turn places pressure on natural ecosystems. Densifying cities is also a transportation objective, in particular when it concerns implementing public transportation system. However, urbanization and providing public transportation also affects the brown agenda and it does this regarding air pollution. Private vehicle transportation is notoriously connected to air pollution and this is a primary reason why public transportation is promoted in cities with extreme air pollution problems. For example, Cervero and Kockelman (1996, p.199) state that

> proponents of public transit aim to reduce private vehicle usage in the hope that it would lessen the negative consequences of a private vehicle-oriented city. These consequences, they say, are air pollution, fossil fuel consumption, and social segregation.

In recent years, there has also been a considerable interest in improving walking environments to encourage the use of non-motorized modes of transportation to reduce pollution emissions and to improve public health. The Transit-Oriented Development (TOD) model has become one of the primary ways of achieving this. According to Wey and Chiu (2012, p.1-2), a large number of studies have confirmed that a favorable walking environment is a necessary condition for promoting walking as a substitute to using private vehicles (Wey and Chiu, 2012, p.1-2).

Factors that determine public transit ridership can be divided into two categories: external factors and internal factors. External factors include population, economic conditions, private vehicle ownership levels, and urban density. Internal factors include the transit service level, the reliability of transit services, transit amenities, and the cost of transit (Chakraborty and Mishra, 2013, p.459). A number of studies focused on comparing the influences of external and internal factors on ridership. Many of these studies found that external factors are more important in explaining ridership than internal factors (Chakraborty and Mishra, 2013, p.459-60). In other words, factors related to the built environment are more important in explaining transit ridership than the transit system and service provided.

Studies by Chakraborty and Mishra (2013, p.468) found that land use characteristics, transit accessibility, income, and density are strongly significant in determining transit ridership. They also found that the impact of these variables vary across urban, suburban and rural areas, suggesting varying interventions on a locational bases.

Research by Cervero and Radisch (1996, p.140) found that transit trip volumes were sensitive to the number of private vehicles owned by households. Private vehicle availability has a strong negative effect on walking and transit travel, especially for non-work purposes. Also, they concluded that the relationship between private vehicle ownership and non-work travel is interrelated with neighbourhood type. Pedestrian-oriented, mixed-use neighbourhoods seemed to reduce the need to own a second or third family vehicle, which in turn could induce the use of non-motorised modes of travel for trips to shops and other neighbourhood facilities. Other studies have also confirmed that household vehicle ownership rates are relatively low in compact, mixed-use urban areas.

Compact, mixed-use and pedestrian-friendly urban developments can significantly influence the transportation modes people choose to travel. An analysis by Cervero (2002, p.265) tested the influences of the following variables on mode of travel: (a) travel time, travel cost and the demographic profile of commuters, (b) attitudinal and lifestyle preferences of commuters, and (c) built-environment factors. The analysis revealed that land use intensity and land use mix significantly influence decisions to drive-alone, share a ride, or use public transit. They found that greater land use intensity and mix encouraged substitution effects. Notably, the use of public transit and walking trips replaced some private vehicle trips in neighbourhoods that were compact, mixed-use and pedestrian-friendly. They found that the influence of urban design factors (such as sidewalk widths) have modest affects ridership (Cervero, 2002, p.268, 281).

According to Murray et al (1998, p.326-7), providing multimodal public transit options is a means of increasing public transportation coverage and patronage. It involves providing commuters with a range of price differentiated public transport options. For example, a commuter at a public transit stop would be able to choose between a mini-bus taxi, a bus or a train. The advantage of a multimodal public transit system is that it is able to provide commuters with choice and control, which makes public transit use more attractive to commuters. In turn, this increases patronage of public transit.

Increasing patronage of public transit by providing different modes of public transit is likely to benefit urban areas, both in terms of mobility and accessibility (Murray et al, 1998, p.322). While bus transit has been the most popular public transit system in cities across the world, with its flexibility and low capital and operating cost, rail transit has also received support from commuters for its high capacity, reliability and comfort (Kim et al, 2007, p.511-2).

Intermodal factors are important for the functioning of the public transit system as a whole. For example, a study by Loo et al (2010, p.211) showed that the number of bus stops within a rail station catchment area statistically relates to rail patronage, with a higher number of bus stops close to a railway station being associated with higher rail patronage. In turn, studies have shown that commuters who have a direct bus connection to a light rail station were more likely to use bus services (Kim et al, 2007, p.511).

According to Loo et al (2010, P.209), the above dispels the generally accepted notion that bus systems are major competitors of rail transit. In fact, bus services can be complementary to railway services by providing feeder services that help bring passengers to rail stations. The results of their study thus suggest that enhanced intermodal integration can help increase rail patronage. The study findings also indicates that the number and location of bus stops within a station catchment area is a critical factor in planning for an intermodal transit system.

According to Kim et al (2007, p.519-20), feeder bus services are vital for the success of rail systems. They found that the availability of bus services between residential areas and rail stations increases the propensity of using busses as a mode of transit. Kim et al (2007, p.518) also found that statistically, the directness of the bus routes serving a commuter rail station shows an increase in bus use. This factor relates to convenience, because commuters do not have to transfer between buses to connect to a rail system. Therefore, the authors conclude that when aiming to increase the use of rail stations, it is imperative to provide direct bus feeder systems that connect to rail stations. They also emphasise the need to develop commuter rail stations as focal points of multimodal integration .

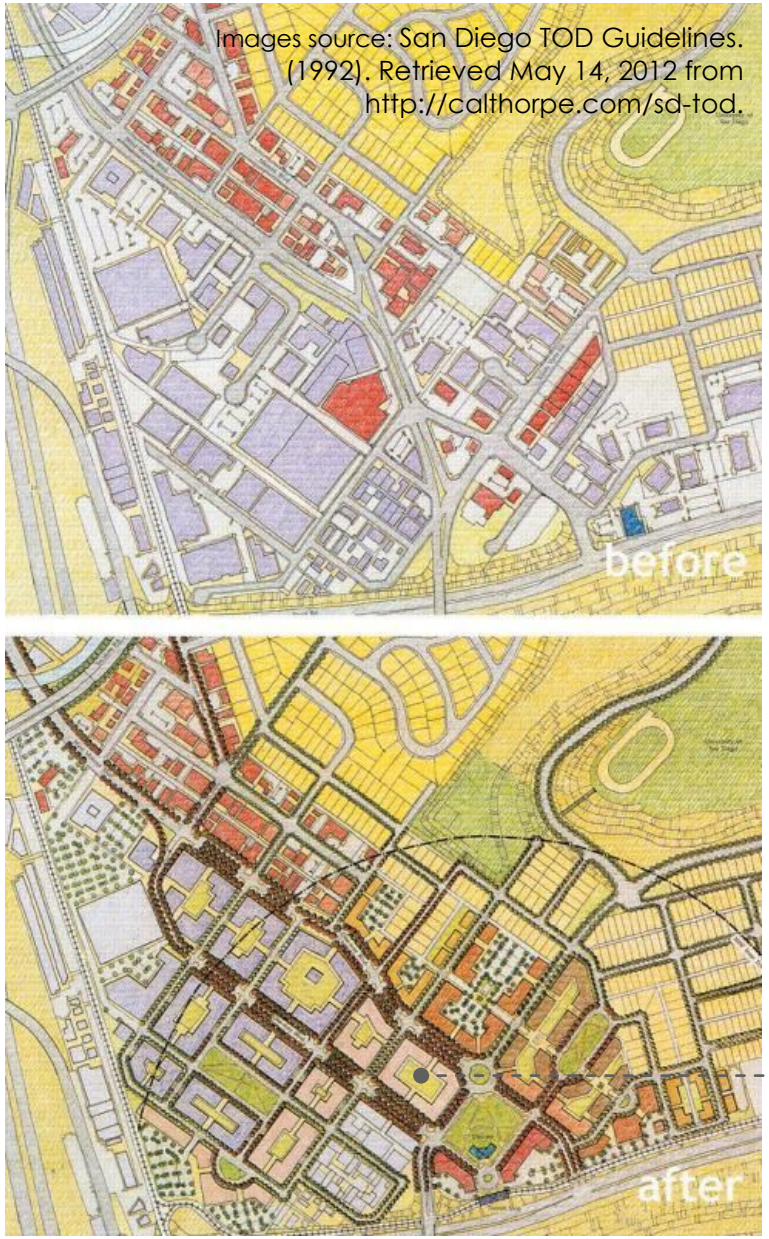
Based on the above, literature proposes that the quality and quantity for intermodal possibilities between bus and rail transit within rail station catchment areas should be focused upon to create transit-oriented cities. For example, easy access to bus stops and rail stations, as represented by the number of bus stops and rail station location, not only increases transit ridership, but it also has a positive impact on transfers between rail and bus transit service. In turn, better connectivity between bus and rail transit enables transit synergies, which attracts higher commuter numbers. According to Sung and Oh (2011, p.81) a number of studies found that pedestrian accessibility between different modes of public transit and the transfer convenience between different modes of public transit are significant factors in promoting transit ridership. This implies that designing for easy transfer between bus and rail service within rail station catchment areas could provide a highly effective design tool to increase transit ridership within urban areas (Sung and Oh, 2011, p.80-1).

Transit-Oriented Development or TOD basically involves the idea of reducing private vehicle dependency and improving the viability and use of public transportation by creating a high-density, mixed-use, pedestrian-friendly environment within walking distance of a transit station or stop.

The modern-day Transit-Oriented Development (TOD) was originally proposed by Peter Calthrope in this book: 'The Next American Metropolis' (Calthorpe, 1993). This idea has since gained much attention internationally and is being implemented in cities in the United States and development countries alike. Many American cities, such as San Francisco and Atlanta have incorporated TOD concepts. Recently, Asian cities in Taiwan and China have also begun to examine the possibility of implementing the TOD concept to address urban problems related to traffic congestion and the disconnect between urban development and the provision of public transportation (Sung and Oh, 2011, p.70). Cities in South Africa, such as Johannesburg, have also investigated the TOD concept and have started to implement TOD principles at existing and planned transit stations to coincide with the implementation of their public transportation initiatives.

TOD is closely associated with a movement that has developed in recent years, named 'New Urbanism'. This movement, which is essentially an American movement, calls for a fundamental change in how American communities are designed and built. New Urbanism embraces many of the design principles of late nineteenth- and early twentieth century American towns. Among these adoptions are compact urban form, a mixture of land uses and housing typologies, introducing a grid-like street pattern that promotes walking as a primary mode of transport, and the creation of prominent public spaces. All these adoptions (to a more or lesser degree) are also objectives of TOD. A central premise of New Urbanism is that by designing American communities based on the principles of historical towns, where walking was the dominant mode of transport, will reduce the usage of private vehicles by making public transit and walking attractive alternatives (Cervero and Radisch, 1996, p.127).

Two aspects of Transit Oriented Development need to be kept in mind. Firstly, the basic idea of Transit Oriented-Development in itself is not a new idea, but rather the revival of an older spatial pattern of a century ago: highly walkable, mixed-use communities that existed around most streetcar and interurban rail lines, both in the United States and Europe (Cervero et al, 2004, p.7). Secondly, an important point to consider is the generic nature of TOD. Although the concept is essentially an American (or Western) urban development concept, TOD planning has been shown to play a significant role in inducing public transportation patronage when applied to transit station areas in cities throughout the world, both as redevelopment initiatives and as new-town developments (Sung and Oh, 2011, p.81).



Images source: San Diego TOD Guidelines. (1992). Retrieved May 14, 2012 from http://calthorpe.com/sd-tod.

Calthrope's vision of redeveloping a node in San Diego, California, into and Transit Oriented Development

As mentioned previously, Transit-Oriented Development or TOD basically involves the idea of reducing private vehicle dependency and improving the viability and use of public transportation by creating a high-density, mixed-use, pedestrian-friendly environment within walking distance of a transit station or stop.

A number of urban design principles, related to Transit-Oriented Development and New Urbanism, have been established as a way of shaping travel demand. All these principles share three common transportation objectives: (a) reduce the number of private vehicle trips, (b) of the trips that are made, increase the share that is non-motorized (e.g. by foot or bicycle), and (c) encourage more travel by transit. The expected outcome of these objectives is to reduce the negative consequences of a private vehicle-oriented society, such as air pollution, fossil fuel consumption, and social segregation (Cervero and Kockelman, 1996, p.199).

A large body of research has shown that the TOD concept works. Research has shown that residents living in TOD areas tend to use transit more frequently than people living elsewhere, even if they have similar socio-economic characteristics (Loo et al, 2010, P.202, Sung and Oh, 2011, p.75). Research findings by Cervero and Kockelman (1996, p.216) also lend credibility to the claims of TOD proponents and New Urbanists that compact, mixed-use, pedestrian-friendly designs can reduce vehicle trips and encourage the use of public transportation and non-motorized travel. Research by Cervero et al (2004, p.S-6) showed that 'residents living near stations are five to six times more likely to commute via transit than are other residents in a region'. In an earlier study, Cervero and Radisch (1996, p.140) found that residents of transit-oriented developments are more likely to walk to a shop, a nearby restaurant, or local park than their counterparts living in more spacious, private vehicle-oriented developments. Transit-oriented developments have also been correlated with significantly higher numbers of walking trips to transit stations.

A study by Cervero and Radisch (1996, p.127, 140) deliberately compared transit-oriented developments to private vehicle-orientated developments. The study found that the transit-oriented developments on average achieved a higher share of trips by public transit than did the private vehicle-orientated developments, controlling for factors such as income and the levels of transit services. The greatest differences between the two development types were for short shopping trips. Residents of transit -oriented developments averaged a substantially higher number of walk trips, which was matched by lower private vehicle trips, suggesting that walking substitutes for private vehicle usage at relatively short commute distances. It thus showed the transit-oriented development design practices exerted its greatest influence on local non-works trips (such as shopping, personal business, and other non-work purposes) as opposed to longer-distance work trips. Regarding work trips, compact, mixed-use, and pedestrian-oriented development (TOD) was shown to have the strongest effect on inducing walking trips to access transit stations.

The Cervero and Radisch (1996, p.140) study also found that, apart from the built environment, longer work trips are strongly influenced by regional development characteristics and travel times among competing modes of transportation. This reinforces the notion the accessibility does not only involve access to a transit station, but it also involves the mode of transit used, the cost of the transit trip and the efficiency with which the mode of transit gets a commuter to his or her ultimate destination. Of course, in this research report the primary concern is with the former, which is connecting the commuter to the transit station.

Finally, it has to be pointed out that, although the TOD concept is essentially an American (or Western) urban development concept, it has been shown to play a significant role in reducing private vehicle use and inducing public transportation patronage when applied to transit station areas throughout the world, both in developed and developing countries (Sung and Oh, 2011, p.81). It is therefore, also a urban development concept suitable for South African cities.

Increased interest in Transit-Oriented Development and New Urbanism has resulted in a large body of literature that investigated the ways in which urban form, neighbourhood design, and the overall physical make-up of cities shape how people move within a city (Cervero, 2002, p.265-6). As Katz (1994, p.31) puts it, 'TOD… exploits the basic relationship between transportation and land use: Put more origin and destination points within and easy walk of a transit stop and more people will use transit'.

Successful TOD design usually embraces a number of factors, including land use density and diversity, station characteristics, the socio-economic and demographic characteristics of the resident population, and inter-modal facilities. These factors in combination account for variability of transit ridership (Loo et al, 2010, P.202). In addition, Loo et al (2010, P.202) found that often place-specific elements are also important factors influencing transit patronage.

Most definitions of TOD, emphasize higher-density development, mixed land uses and a high-quality pedestrian environment within walking distance of a transit station (Cervero et al, 2004, p.7). These are all element of the built environment surrounding a transit station. Of the TOD factors mentioned above, Loo et al (2010, P.211) found that station characteristics (which in this case implies the built environment surrounding a station) appeared to be more important than other factors affecting transit patronage. In other words, his research illustrated the value of the TOD concept in generating transit patronage.

Pedestrian access and the overall quality of the pedestrian environment are critical to the success of TODs. For example, the walk between the station and neighbouring land uses needs to be safe, direct and attractive for TODs to be successful. Research has found a marked decrease in pedestrian activity in TODs that contain physical and psychological barriers for pedestrians, such as wide and busy roads and incomplete sidewalk networks (Cervero et al, 2004, p.S-4, S-12).

The walking environment does, however, comprise more than the design of pedestrian routes. It also contains a mix of uses that create a vibrant urban environment. Katz (1994, p.31), a New Urbanist, explains that a 'TOD would be a dense, tightly woven community that mixes stores, housing and offices in a compact, walkable area surrounding a transit station… Closest to the station would be space for retail and service businesses, professional offices, restaurants, health clubs, cultural facilities and public uses – making jobs, goods, entertainment and services easily accessible to TOD residents and transit riders'. Cervero et al (2004, p.S-10) points out that 'successful TODs emphasize place-making: creating attractive, memorable, human-scale environs with and accent on quality-of-life and civic spaces'. Such places are vibrant and interesting and usually comprise a mix of restaurants, entertainment venues, shops, public plazas and civic spaces. It is thus evident from the above, that although TOD development does strive to increase densities near transit stations, this does not come at the expense of creating quality urban spaces near these transit stations.

Based on the above, it is evident that successful TOD development relies on the implementation of all the factors of transit-oriented development and the synergy that results from this. Thus, rather than focusing only on one factor, such as increasing development density, is not sufficient. Instead, other factors should also be included and part of a TOD strategy, such as creating a land-use mix, restructuring the street network to encourage walking, and using urban design to create a more pedestrian friendly environment around transit stations. (Sung and Oh, 2011, p.70). Loo et al (2010, P.211) also proposes that TOD employs a mix of factors, such as land use density, land use mix, walkable station characteristics, and inter-modal connectivity to promoting transit ridership and reduce private vehicle dependency in cities.

In the early 1990s, a movement to return to transit-oriented development patterns began to get recognition as a way to address urban sprawl and the social and environmental costs associated with it (Sung and Oh, 2011, p.70). A major focus of this movement has been on increasing development density (density), mixing land uses (diversity) and creating pedestrian-friendly urban areas (design) near transit stations. This has become known as the 3-Ds (density, diversity and design) of transit-oriented development; a term that was first coined by Cervero and Kockelman from the University of California in the 1990's. After exploring a number of empirical studies of TOD planning in American cities, Cervero and Kockelman realized that the application of the 3-Ds reduced private vehicle trips and increased the use of public transit. Since then, the application of the 3-Ds have become one of key planning methods to manage urban growth in the United States, as well as in other cities in other countries around the world (Sung and Oh, 2011, p.71, Lee and Moudon, 2006, p.204).

Density>Density
Diversity>Intensity
Design>Access

In this research report the 3-Ds are named density, intensity and access, as this is more descriptive of the project objectives pursued in this particular study. Diversity is replaced by intensity, which refers to Dewar and Uytenbogaardt's description of land use diversity. Design is replaced by access, because the literature research shows that enabling access to transit station by applying good urban design is most probably the primary design objective regarding transit-oriented development. It needs to be noted that this is largely a semantic change and it does therefore not significantly alter the basic observation made by Cervero and Kockelman.

The impact of density on travel demand has long been acknowledged, but the effects of diversity and design have only been acknowledged in recent years (Cervero and Kockelman, 1996, p.199). During the past decade, a considerable amount of research has been carried out to confirm the impact of all three factors (density, diversity and design) on transit patronage. In fact, numerous studies confirmed the impact of the 3-D's on transit and have become a validation for movements like New Urbanism and Transit-Oriented Development (TOD).

Cervero and Kockelman (1996, p.205-6) identified a number of variables that are related to density, land-use diversity and urban design. These variables can effectively be used to help design transit-oriented neighbourhoods. Variables related to density include population density, employment density, and compactness of land uses. Variables related to diversity (or intensity) include the proportion of dissimilar land uses, the proportion of land-use categories, vertical land use mix, intensities of land uses, and commercial intensities. Variables related to design (or access) include the proportion of street intersections, number of street blocks and block length, street widths, sidewalk width and topography.

Understanding the 3-Ds requires understanding the significance of the synergies that exist when all 3-Ds are employed. In other words, higher densities, diverse land uses, and pedestrian-friendly designs must co-exist if meaningful transportation benefits are to be obtained. Focusing only on design; providing pleasant sidewalks, attractive landscaping, and other pedestrian amenities in a low-density, low-intensity environment is unlikely to prompt residents to walk to public transit, or access amenities and employment opportunities on foot. Only by combining all 3-Ds near a public transit station are appreciable impacts on public transit patronage likely to be achieved (Cervero and Kockelman, 1996, p.217).

Linked to the idea of creating economic growth and development is the need for equitable access to economic opportunities. In particular, this involves the travel distances required to access economic opportunities, which in turn is a cost issue that largely affects the urban poor. According to Dewar and Uytenbogaardt (1991, p.17), 'the primary physical barrier to ease of access is the cost of overcoming the friction of distance. The best situation obtains when people can gain access to most necessary daily activities on foot... Movement on foot, therefore, should define the primary scale of urban development'. Where distances are too great for walking as a means of access, public transportation must be provided to enable the poor to access economic opportunities.

A spatial mismatch between employment opportunities and residential locations, housing options, and public transportation are all issues and problems for the urban poor that are tied to accessibility. A number of solutions have been proposed in the past to overcome spatial separation. One solution, for example, has been to disperse affordable housing options, moving residents closer to job opportunities. Other solutions claim that residential dispersion is unlikely to be effective and that a transportation solution would be a better option in linking people with economic opportunities. Thus, the latter option focuses on providing access to transportation systems from population centers (Delmelle and Casas, 2012, p.37).

Interwoven with the concept of accessibility is the identification of population groups with limited access to economic opportunities, public transportation, or both. It therefore deals with social exclusion; a term referring to the notion that individuals are unable to participate in everyday activities (including employment) due to a lack of transportation access. Social exclusion may be caused if individuals are unable to afford transportation, or due to poor public transportation coverage, or it may be cause by physical limitations, such as a lack of pedestrian walkways to transit stations (Delmelle and Casas, 2012, p.37).

Interrelated issues to be addressed in providing public transportation are access and accessibility to transit stations and stops. Access is the opportunity to use a public transportation system based on the proximity of the transit station. If the distances or barriers to access a transit station or stop are too great, then it is unlikely that the public transportation system will be accessed. Accessibility is the suitability of the mode of public transport to transport commuter to their destinations, thus having to do with modal choice and modal interchange. Access and accessibility are dependent upon each other if the public transport system is to be successfully supported (Murray et al, 1998, p.320).

Regarding access to a transit station; the pedestrian or walking environment to a public transit station or stop has a major impact on total travel time, which influences potential patronage of the transit station. For example, the results of a study by Jiang et al (2012, p.1) suggest that people walk further to transit stations when the walking environment has certain features, such as shaded, busy and interesting walkways. A study by Cervero and Kockelman (1996, p.217) also found that the quality of the pedestrian environment was associated with transit patronage. Several design elements of the pedestrian environment influenced transit patronage. Notably, transit areas with high number of intersections averaged less vehicular travel and a greater use of public transportation. This result supports the use of grid street patterns in transit areas.

Sprawling urban settlement patterns in modern-day cities have resulted in increasing social costs, traffic congestion, environmental degradation, and reduced spatial integration. In the early 1990s, the application of higher densities as a way of addressing these urban problems was pursued. This approach included high-density development near transit centers, such as rail stations (Wey and Chiu, 2012, p.2).

Compact, higher-density neighborhoods can reduce private vehicle trips and encourage public transport and non-motorized travel in several ways. More compact cities enable travel origin and destination points to be closer together spatially, which in turn provides more opportunities for walking or cycling to a destination. Also, compact neighbourhoods tend to have better quality transit services and a larger share of households that depend upon transit to access urban opportunities. In turn, these are all factors that encourage the use of transit and reduce the use of private vehicles (Cervero and Kockelman, 1996, p.200-1).

Numerous studies found a connection between urban densities and an increase in public transit patronage. To mention a few; a study by Kim et al (2007, p.512) indicated clearly that when residential and commercial densities are increased at transit stations, it increases transit ridership. A recent study by Sung and Oh (2011, p.80) showed that transit station areas with a higher development density tend to show a higher transit ridership. A study by Cervero (1995, p.375-6) showed that higher densities tends to reduce vehicle ownership rates and is associated with shorter commutes, even when controlling for factors such as household income.

According to Dewar and Uytenbogaardt (1991, p.43, 45-6), compacting the urban form is a pre-condition for achieving a high-performance urban environment that works well at a pedestrian level. There are a number of reasons for this, but the primary reasons for this is to allow a greater range of economic opportunities and services to be provided and to allow viable public transportation services to be provided. Regarding the latter, they say the 'real' need is to increase accessibility and the way to do this is to reduce travel distances, which in turn requires greater urban densities.

Transit is often used as a catalyst to focus higher-densities development within a city. Known as Transit-Orientated Development or TOD, the concept's application of higher densities can be associated with better accessibility to transit stations. In turn, better accessibility to transit is associated with making public transportation more viable and providing better transit services (Chakraborty and Mishra, 2013, p.458). In particular, the location of specific housing types that increase densities near public transit stations can dramatically improve access to public transport. These include higher-density public housing developments, which could benefit from localities that provide good access to public transport (Murray et al, 1998, p.322-3). Accordingly, attempts have been made to encourage higher densities at transit station through land use policy and the use of urban design principles (Chakraborty and Mishra, 2013, p.458).

Studies in the United States that compared private vehicle-oriented developments and transit-oriented developments clearly demonstrated that the latter, which employs higher densities, generates about 30% fewer private vehicle trips than the former (Wey and Chiu, 2012, p.2). Another study found that the number of private vehicles per household in the United States fell by one-quarter as densities doubled, even if controlling for factors such as household income (Cervero and Radisch, 1996, p.128). As the empirical evidence mounted regarding the link between urban density and the use of public transit, the TOD concept has become a key planning method to manage urban growth within cities.

According to Sung and Oh (2011, p.76), transit station areas with a high land-use mix that includes residential and commercial land uses, significantly increases public transportation ridership. In fact, mixed land use development in an urban environment may be as effective in enhancing transit patronage as providing higher-densities near stations (Loo et al, 2010, P.210). The study by Sung and Oh (2011, p.81) also showed that a mixed land-use pattern at a transit station has a similar impact on increasing transit ridership as high-density development has on increasing transit ridership. This implies that land-use mix and diversity needs to be emphasized as much as providing high-density development near transit stations.

According to Cervero (1995, p.361-2), mixed land-uses yield a number of transportation benefits. The more land uses are mixed, such as offices, shops, restaurants, and banks, the less likely people are to drive and the more likely people are to walk to destinations. This is often reflected in lower vehicular trips and higher non-motorized (e.g. walking) trips. Another benefit of mixed-use areas is that trips tend to be spread more evenly throughout the day. Whereas most trips to and from places of work occur during morning and evening commute hours; if such places also contain a mix of other uses, such as shops and restaurants, trips to these land uses will typically occur during non-peak hours, when more capacity is readily available on the transit system. Cervero (1995, p.376) found that mixed-use environments have a significant impact on non-work travel, such as trips to shop.

Murray et al (1998, p.327) confirms the above. They explain that travel patterns, using public transit, typically involves a trip from home to work or work to home, which may include numerous stops along the way to accomplish personal or work related tasks, such as going to the bank or shopping for groceries. This is known as trip chaining. Where individuals go during their travel is an important factor for public transport use and should be accounted for as best possible by diversifying land use development at stations in order to increase the demand for public transport.

Taking into account the above, it can be concluded that the degree of land use intensity has an influence on transit ridership, with a greater mix having a greater influence on increasing transit ridership (Sung and Oh, 2011, p.79). The one-stop-shop principle thus applies: the greater the land use mix, the greater the number of reasons to disembark at the transit station and therefore use that particular station.

Land use mix also relates to walking as a mode of transport, especially mixed land use development located within residential locations. A study by Lee and Moudon (2006, p.213-4) clearly shows that walkability increases with the proximity of land uses providing daily food supply and basic domestic necessities in residential neighbourhoods. Interestingly, Sung and Oh (2011, p.81) determined that the mixture of residential and non-residential uses near stations has a greater impact on promoting transit ridership than merely mixing non-residential land uses. Thus, having a more self-contained TOD unit has a greater impact on transit usage than creating TODs that are, for example, exclusively employment destinations or exclusively residential destinations.

In recent years, the focus of many studies dealing with TOD started to examine the issue of causality between the built environment and travel behavior. In other words, these studies tried to determine whether travel behavior is affected by the built environment – for example, successful TOD development encourages people to reduce the use of private vehicles and to use public transportation instead (Loo et al, 2010, P.203). Proving a causal relationship between the built environment and travel behavior is necessary to justify TOD policies and the promotion of transport-oriented development in general. Up to recently, the correlation between the built environment and the use of public transportation has been acknowledged, but the causality of this correlation has not been proven, making it a subject of debate in recent literature (Guo, 2009, p.343).

A key element that links the built environment to the use of public transportation is pedestrian access, because commuters mostly access public transportation stations and stops on foot. Many international studies have investigated the impact of the built environment of pedestrian access with varying results. For example, a study examining pedestrian access to BART rail stations in San Francisco found that pedestrian movement to the stations are primarily influenced by individual characteristics, with urban design and station area characteristics only playing a modest role. On the other hand, a study of rail transit access in Singapore found that, besides walking distance, the number of ascending steps, the number of road crossings, and traffic volumes within station catchment areas tend to reduce walking as a means to access transit stations (Jiang et al, 2012, p.3).

Other studies found that urban form features and station context may influence commuters to walk to public transit stations. One study concluded that commuters were prepared to walk longer distances to public transit stations when the walking environment had certain features, such as shaded pedestrian walkways and walkways that were busy and interesting (Jiang et al, 2012, p.13). In contrast to this study, a study by Cervero and Kockelman (1996, p.218) showed that most micro-elements of the built environment, like sidewalk widths and the presence of street trees had little bearing on pedestrian movement once more basic reason, such as land-use diversity and demographic attributes, were accounted for.

On the whole, research studies have however found that built environment can significantly effect a commuter's walking experience and in this way encourage walking to a transit station (Guo, 2009, p.343).

Accepting that the built environment can encourage walking to a transit station has important implications for transit and pedestrian planning, especially from an urban design perspective. For example, a well-designed built environment can attract more commuters to public transit and it can encourage the use of non-motorized modes of transportation, like walking. When walking as a mode of transit increases, the willingness to walk longer distances also increases, which increases the length and frequency of walking. In turn, this enlarges the catchment area of a transit station or stop (Guo, 2009, p.351).

A station catchment area can be defined as the geographical area that is served by a transit station or stop. This geographical area is usually empirically determined by a maximum walk distance whereby the majority of commuters arrive at the station on foot. The catchment areas may differ substantially in size from station to station, depending on the mode of public transportation provided and the position the station holds within the transportation hierarchy. Also, the catchment areas may be affected by locality. For example, catchment areas of inner city transit stations (as opposed to suburban stations) may differ, because walking is typically the primary mode of access to inner city stations.

Because walking behavior is effected by the built environment, the built environment should also exert some influence on a transit station's catchment area. For example, the street and pedestrian network can impact walking distances and walking times by determining the directness of pedestrian routes, the number of stops and pedestrian crossings, and other interferences found within the built environment. Other aspects of the built environment can also affect catchment area size, such as density and land use diversity, or simply the overall walking experience that the built environment provides (Jiang et al, 2012, p.1-2). Jiang et al (2012, p.13) found in their research that if a transit station was not located close to a road intersection, it could reduce the catchment area size significantly due to walking detour effects.

Demographics is also a factor that determines the catchment area of a public transit station. For example, income level may affect people's willingness to walk, all else equal (Jiang et al, 2012, p.11). A study by Jiang et al (2012, p.12) found that lower income people in China walk 165m further on average compared to higher income people. Other socio-demographic factors that could potentially influence walking and walking distance include gender, age and occupation.

Knowing the size of a station catchment area is important for public transportation planning, but also for the urban design of station catchment areas, because catchment area size largely determines the number of commuters that will access the station and use the public transportation system. As mentioned, each station catchment area may vary due to physical characteristics and the design of the built environment. Despite this, it can be accepted (as research has shown) that highly walkable station areas will, all else equal, increase the distance that people will walk to access the station by reducing the time it takes to access the station. Thus, knowing the relationship between a station's catchment area and its built environment could improve patronage of the public transportation system and it can inform how design changes to the built environment could increase the catchment area and walkability to the station. This suggests a mutually reinforcing relationship between urban design and transit demand when developing station catchment areas or Transit-Oriented Development (TOD) areas as they are commonly known (Jiang et al, 2012, p.2).

Due to the fact that station catchment areas are often determined by a number of variable, such as the mode of public transportation that is accessed, the order-size of the station, the characteristics of the built environment and other factors, it is not surprising that no consensus exists regarding a uniform standard for a transit station catchment area size. For example, the walking distance to a light rail station in Canada ranges between 300–900m, compared to 400 –800m in the United States. Although a 400m walking distance is usually considered applicable for bus stops, a study of the BRT system in Los Angles used a 800m walking distance. In a similar study focusing on the BRT system of Bogota, Colombia, a 250m walking distance was used to determine catchment area (Jiang et al, 2012, p.2-3).

As is evident from the above, the literature and research findings differ greatly on what constitutes average walking distances. Kim et al (2007, p.513) concludes that walking distances generally range between 400m and 800m, with an average walking distance of 400m being quoted most frequently for all modes of transport.

In recent years, much attention has been given to improving walking environments to encourage the use of non-motorized modes of transportation. Transit-Oriented Development (TOD) has become one of the most effective solutions to improve walking environments. TOD planning uses urban design and pedestrian-friendly design factors to reduce private vehicle use and enhance pedestrian access to transit stations (Wey and Chiu, 2012, p.1). In the past, vehicle-orientated land use policies have made walking less feasible, less convenient, and more dangerous. Literature studies on the impact of TOD planning on improving walking environments have repeatedly shown that TOD design can reduce private vehicle use and enhance pedestrian accessibility (Wey and Chiu, 2012, p.1).

Walking is a means of experiencing and interacting with the local environment and society in a manner that is not possible when using private vehicle modes of transport. By the same token, placing a strong emphasis on walking is a means of improving the urban environment and promoting investment in the public realm. In fact, a large body of research has confirmed that a favorable walking environment is a necessary condition for promoting walking and enabling community interaction. For example, research in the United States has shown that residents of compact, mixed use neighbourhoods are three times more likely to walk to local amenities than those living in more vehicle-oriented neighbourhoods (Wey and Chiu, 2012, p.1-2).

A number of built environment factors influence walking as a means of accessing public transit. A study on how land use patterns and the built environment influence pedestrian access to transit stations found a statistically significant association between the number of accesses to a station and walking. Another study found that pedestrian friendly infrastructure, such as sidewalk and grid street network, increase people's propensity to walk to transit stations (Kim et al, 2007, p.513).

Jiang et al (2012, p.12) found that the location of a transit station in a city has an impact of walking distance. They found that stations located further from the inner city have longer walking distances. According to them this is a reasonable deduction, presuming the inner city represents the point of highest accessibility in the city. The further away a station is located from the inner city, the lower the relative accessibility of the station location and therefore the more likely pedestrians are willing to walk to access the station. This finding has a direct bearing on Jeppe Station, which can be considered an inner city station location.

Access to alternative modes of public transit may also have an influence on walking, with some people having no choice but to walk longer distances to access public transit. Those with an alternative modes of public transit available may show less propensity to walk longer distances (Jiang et al, 2012, p.11).

According to Jiang et al (2012, p.8, 13) particular attention should be paid to improving the enjoyment factor, because this has an impact on walking and walking distance. Enjoyment refers to pedestrian route aesthetic, the presence of activities along the route, and relief from the elements, such as shading from the sun. Thus, the effects of design treatments along pedestrian walkways, such as planting trees along sidewalks to provide shade, can have an impact on walking as a mode of travel. In a sense, providing an enjoyable walking environment rewards pedestrians and commuters for using walking as a mode of travel. For some, such design interventions are more than amenities or rewards, but basic provisions. It is providing pedestrians and commuters with the same level of facilities provided to motorists, thus in a sense 'leveling the playing field' (Cervero and Kockelman, 1996, p.201).

As claimed by TOD and New Urbanism proponents, density and land use mix also impacts on the use of walking as a mode of travel. More compact, higher-density urban areas reduce walking distances, which in turn provide more opportunities for walking to a transit station (Cervero and Kockelman, 1996, p.200-1). Land use mix also correlates of walking, especially mixed land use intensity in proximity of origin (residential) locations. A study by Lee and Moudon (2006, p.213-4) found that walkability tended to increase when land uses providing daily food supply and basic domestic necessities were located near residential locations.

Dewar and Uytenbogaardt (1991, p.48) are of the view that a relatively continuous urban fabric, as expressed in its street network, is a pre-condition for the viable and efficient provision of public transportation. This view is supported by other literature on the subject. For example, Sung and Oh (2011, p.77) found that a grid street pattern can increase access to a transit station and increase transit ridership. In contrast, neighbourhoods with poor street connectivity, such as those typically found in most suburban areas, tend to have low accessibility (Delmelle and Casas, 2012, p.42).

New Urbanists also consider the grid street network an essential spatial characteristic. They argue that street networks with frequent connections ease traffic congestion by providing a wide variety of route options, while at the same time calming traffic by making vehicles stop frequently. By the same token, a grid street network makes pedestrian movement easier by slowing vehicular traffic and by making pedestrian routes shorter than a hierarchal street network would. New Urbanists also point out that the intersections of a grid system, which are located at regular intervals, creates a sense of scale and order, which improve pedestrian orientation and legibility. According to New Urbanists, this does not mean that all streets of a grid system needs to be designed similarly. Streets of the grid network can be designed differently to reflect the location of the street and the use of the street. This difference in design is encapsulated in the street dimensions, sidewalk widths, tree planting, on-street parking and pedestrian crossings (Katz, 1994, p.32).

A key reason why a grid street pattern increases access to a transit station is the number of four-way intersections it contains compared to other street patterns. The high number of intersections make a grid street pattern highly permeable for pedestrian, compared to other street patterns. For example Sung and Oh (2011, p.81) found that designing a grid-type street pattern with an appropriate number of intersections would promote transit ridership. They found that a high four-way intersection density, which is combined with a pedestrian-friendly environment, has a statistically significant influence on transit patronage (Sung and Oh, 2011, p.80-81).

Cervero and Kockelman (1996, p.199) also found the above to be true. While they found the quality of the walking environment was only moderately related to transit use, they found that grid street designs have a significant impact on reducing private vehicle usage and increasing transit patronage. A study of the Portland, Oregon region in the 1990's is one of the most ambitious effort to determine the travel impacts of 'pedestrian-friendliness'. In the study, neighbourhoods were subjectively rated in terms of ease of street crossings, sidewalk continuity, local street characteristics (grid versus cul-de-sac patterns), and topography. The study showed that neighbourhoods with highly-rated pedestrian environments typically comprising grid-like street patterns and averaged more transit trips than neighbourhood that did not have these pedestrian-oriented environments (Cervero and Radisch, 1996, p.129).

Apart from the grid layout, the street block sizes also affect pedestrian permeability. In neighbourhoods where block sizes are large (even if comprising a grid layout) permeability becomes more difficult if pedestrians are discouraged from walking along a path that leads around a large street block. This is particularly a problem in South African cities, because street block properties are usually fenced off; not allowing pedestrians to pass across the street block. When large street blocks are necessitated, Sung and Oh (2011, p.81) proposes that the street block be oriented in such a way that it does not severely block or lengthen pedestrian movement.

Sung and Oh (2011, p.81) points out that, although the street network typology and related urban design factors are important approaches in promoting transit ridership, its application needs to be cautiously implemented. For example, Jiang et al (2012, p.3) emphasize the socio-cultural underpinnings of pedestrian behavior and the varying roles and importance that street space use occupies in different cultures and societies.

Retail development is a key land use of the land use mix present in transit-oriented developments. A study by Kim et al (2007, p.520) found that in areas where retail was a dominant land use, the propensity to walk to transit stations was increased. This was consistent with the findings of Cervero and Kockelman (1996, p.217), who found that having retail activities within neighbourhoods was closely associated with mode choice used for trips. They found that the presence of convenience shops and retail outlets within station catchment areas was associated with the use of the public transit station and non-motorized modes of transport.

Specifically, Cervero (1995, p.361) found that having retail outlets located within 500m of residences was found to encourage walking and commuting by public transit, controlling for factors such as residential densities and vehicle ownership levels. When retail outlets are located beyond 500m of residences, they tend to encourage private vehicle-commuting due to the ability to efficiently link work and shop trips by car.

Mixing retail uses with other uses in TOD areas, such as mixing retail with office uses, was also found to significantly reduce private vehicle travel and increase commuting by public transit. Cervero (1995, p.362) found that for every 10% increase in floor space devoted to retail uses within office areas, there was an associated 3% increase in the use of public transit. Another follow-up study confirmed that the existence of a retail component within an office building can reduce vehicle-trips by about 8%. This follow-up study also confirmed that buildings with mixed uses averaged 3% more commutes by public transit than buildings exclusively containing office uses.

Cervero (1995, p.362) also found that the type of urban area determines where public transit and non-motorised modes of transit are used to access retail facilities. By comparing the shopping trips of residents living in transit-orientated neighbourhood to the shopping trips of residents living in private vehicle-orientated neighbourhoods, he found that the former induces two to four more walking trips per week to neighbourhood retail stores than did those living in private vehicle-oriented neighbourhoods served by strip retail facilities. In another study, Cervero and Radisch (1996, p.140) mentioned that they found this result somewhat surprising, as conventional wisdom holds that consumer shopping is heavily private vehicle-oriented, requiring large and convenient parking areas.

Cervero and Radisch (1996, p.140) took their research a step further to determine whether higher rates of short, within-neighbourhood shopping trips using non-motorised modes of transport actually replaced longer, out-of-neighbourhood private vehicle trips. For example, did residents of transit-oriented neighbourhood make fewer trips to large, regional shopping malls and big-box retailers; relying on local shops for most of their purchases? Or was walk trips in transit-oriented neighbourhoods simply supplementing private vehicle trips? In their study, they found that transit-oriented neighbourhoods have lower private vehicle trip numbers, as well as averaged shorter trips. This led them to infer that walk trips were substitutes to private vehicle trips in transit-oriented neighbourhoods; not supplements to private vehicle trips.

Creating retail activities near stations within cities of developing countries will need to take into account the socio-economic conditions found within those cities. Dewar and Uytenbogaardt (1991, p.16) express the need to enable opportunities for small-scale, self-generated economic activity in developing countries, simply because the formal economies of these countries do not have the capacity to absorb all new entrance into the job market. They specifically refer to promoting the informal sector as a means of job creation. This implies creating more diverse and intensive urban environments that provide opportunities for all city residents. Dewar and Uytenbogaardt (1991, p.17), say that real choice (and opportunity) is only offered when urban residents have access to high-intensity environments. Thus, they say, 'successfully preforming (urban) environments are necessarily complex (intense): they contain a variety of overlapping conditions and activities'. However, they do point out that this does not imply ubiquitous intensity, but rather ranges of intensity depending on locality, such as transit stations.

Brown (2006, p.4) explores the connection between public space and street trade, which is turn affects the livelihood of the urban poor. She examines how the urban poor use public space to support their livelihoods and how the urban poor access public space to support their livelihoods.

Brown (2006, p.9-10) points out the misguided notion of applying concepts of public space of cities in the north to cities in the south. The concept of public space in cities of the north tend to revolve around aesthetics and public order, which leads to public spaces being excessively controlled. This, Brown found, was in stark contrast to what happened to public spaces in cities of the south, where public space played an important role in the livelihoods of the urban poor. Brown says that few modern-day public space policies recognize the economic importance of public space to the urban poor.

The above prompted Brown (2006, p.12) to develop the concept of 'contested space'. These are spaces where street traders typically concentrate. They are areas with high pedestrian flows, such as transit stations, shopping centres and office locations. These are locations where street trading is typically barred and therefore constitute 'conflict zones'. Brown points to a paradox arising from the above. On the one hand, urban planners and managers aim to support poverty reduction though micro-enterprise development. On the other hand, these same planners and managers aim to clear the city from congestion caused by street trading. This results in a complex mix of persecution, tolerance, regulation and promotion.

Brown (2006, p.35) says: 'it must be recognized that street trading represents a commodification of the public realm, a social cost that restricts its uses for other activities. Recognition of those social costs could lead to a system whereby traders contribute to the wider society for the benefit they accrue. Although street trading in urban public space confers individual benefits, the collective potential for poverty reduction of the use of urban public space is more than a private survival strategy or activity – it is part of the wider urban economy'.

In their book 'Urban Markets: Developing Informal Retailing', Dewar and Watson (1990, p.28) provide design guidelines for the design of informal markets. They suggest that when designing informal markets, it is important that the market infrastructure be integrated with the surrounding urban areas to avoid it being visually disruptive or disruptive to pedestrian flows. They illustrate that most of these issues can be overcome through competent informal market design.

According to Dewar and Watson (1990, p.23), 'the location of (informal) markets is a critical factor in their success. Inappropriate location is often the reason for the failure of markets, where shelter and infrastructure is provided by governmental or other organizations'. A major factor affecting the location of informal markets is pedestrian movements. Dewar and Watson (1990, p.23) say that 'markets are extremely sensitive to flows and concentrations of pedestrians and traffic and the most successful locations are therefore in close proximity to larger generators of population movement', such as public transportation stations. Brown (2006, p.9) concurs with this, pointing out that 'locations with busy pedestrian flows, such as main thoroughfares and transport interchanges, are key sites for traders'.

Reading through the literature, it becomes evident that a large body of research has been constructed on the relationship between urban development (and design) and public transportation and that much of this research is empirically verified. This has largely to do with the original work done by Cervero during the 1990's, who set out to empirically verify the relationship between urban development and public transportation, which was at that stage postulated by proponents of Transit-Oriented Development and New Urbanism.

As empirical support for Transit-Oriented Development or TOD mounted; so the TOD concept became more influential as a blueprint for developing transit station environments. TOD involves the basic idea of increasing development density (density), mixing land uses (diversity), and creating pedestrian-friendly urban areas (design) near transit stations in order to reduce private vehicle dependency and improving the viability and use of public transportation. This has become known as the 3-Ds (density, diversity and design) of transit-oriented design, a term that was first coined by Cervero. In this research report, density is referred to as density, diversity is referred to as intensity, and design is referred to as access. Access to transit stations, the density of the built environment next to transit stations, and the intensity of the land use mix near transit stations have all been proven to reduce private vehicle trips and encourage the use of public transport and non-motorized forms of travel.

Regarding intensity (or land use mix and diversity) the literature had much to say about the location of retail near transit stations. Research has found significant evidence that the presence of convenience shops and retail outlets within station catchment areas was associated with the use of public transit and encouraged walking as a primary mode of travel. In turn, this was found to impact on informal trading, because informal markets were said to be extremely sensitive to flows and concentrations of pedestrians and pedestrian traffic, making public transportation stations suitable for this economic activity.

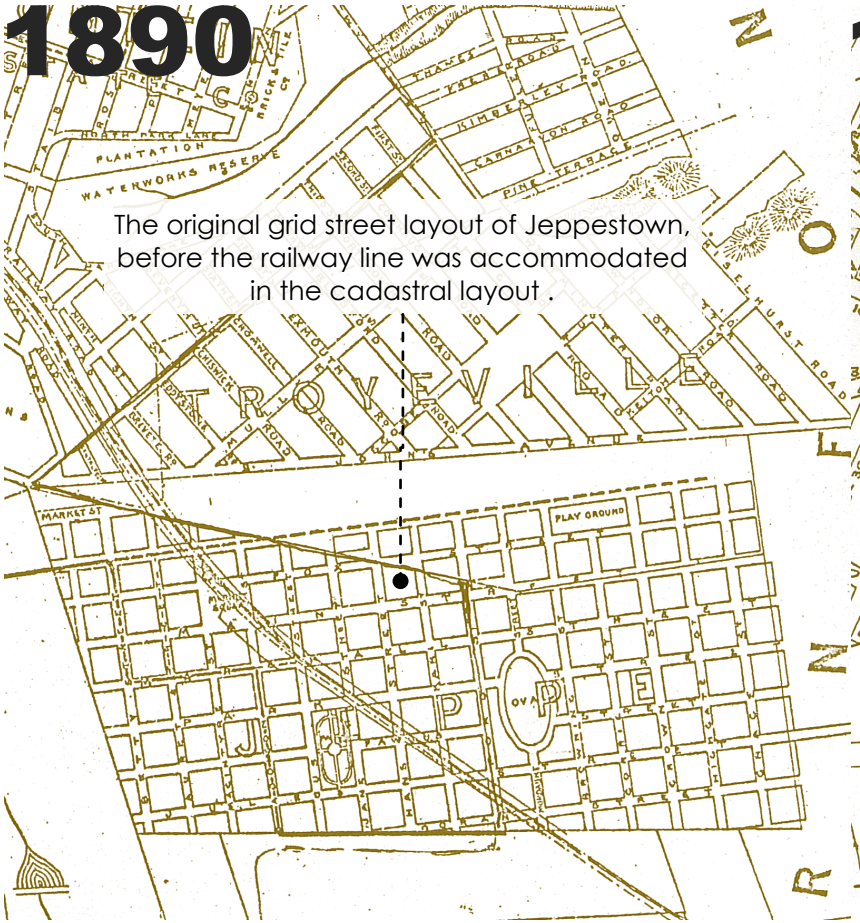
As can be deduced from the above, walking as a means of accessing transit stations is a key element of public transit patronage. It may be of value to point out at this stage that literature on the subject of public transit shows that access has two basic components. The first involves access between the point of origin (such as a commuter's home) and the station. Here density, land use intensity, and pedestrian access by design are of critical importance. The second involves the transit system itself and the efficiency (time and cost) with which the transit system can transport a commuter to his or her destination (such as an office). This research report concerns itself with the former and the way in which patronage of a rail transit station can be support and increased though the design of the built environment surrounding the station.

Returning to the subject of walking is a means of accessing a transit station. Literature shows that to encourage walking as a means of accessing public transit requires an understanding of a station's catchment area. It also requires an understanding of how design changes to the built environment within the catchment area could increase the catchment area size and walkability to the station. One element of this is walking distance. Internationally, 400m-800m is considered too be the average walking distances that commuters are prepared to walk to access transit stations. The street layout surrounding a station area was also deemed important. Studies found that grid street designs have a significant impact on increasing transit patronage, simply because the high number of street intersections made access more convenient and direct.

In conclusion, literature on the subject of public transit was explicit that there are many benefits that promote the use of public transit, which can be derived through the competent design on the built environment. There are social benefits, such as improving the well-being of a growing urban population, and environmental benefits, such as curbing an expanding urban footprint, which in turn is intimately connected to the provision of adequate and appropriate public transportation. The development of public transit options in cities has also been linked to the promotion of economic growth within the cities; most notably cities located in developing countries. Finally, the introduction of public transit has been proven to reduce private vehicle usage, which in turn lessens the negative consequences of private vehicle use, such as air pollution, fossil fuel consumption, and social segregation.

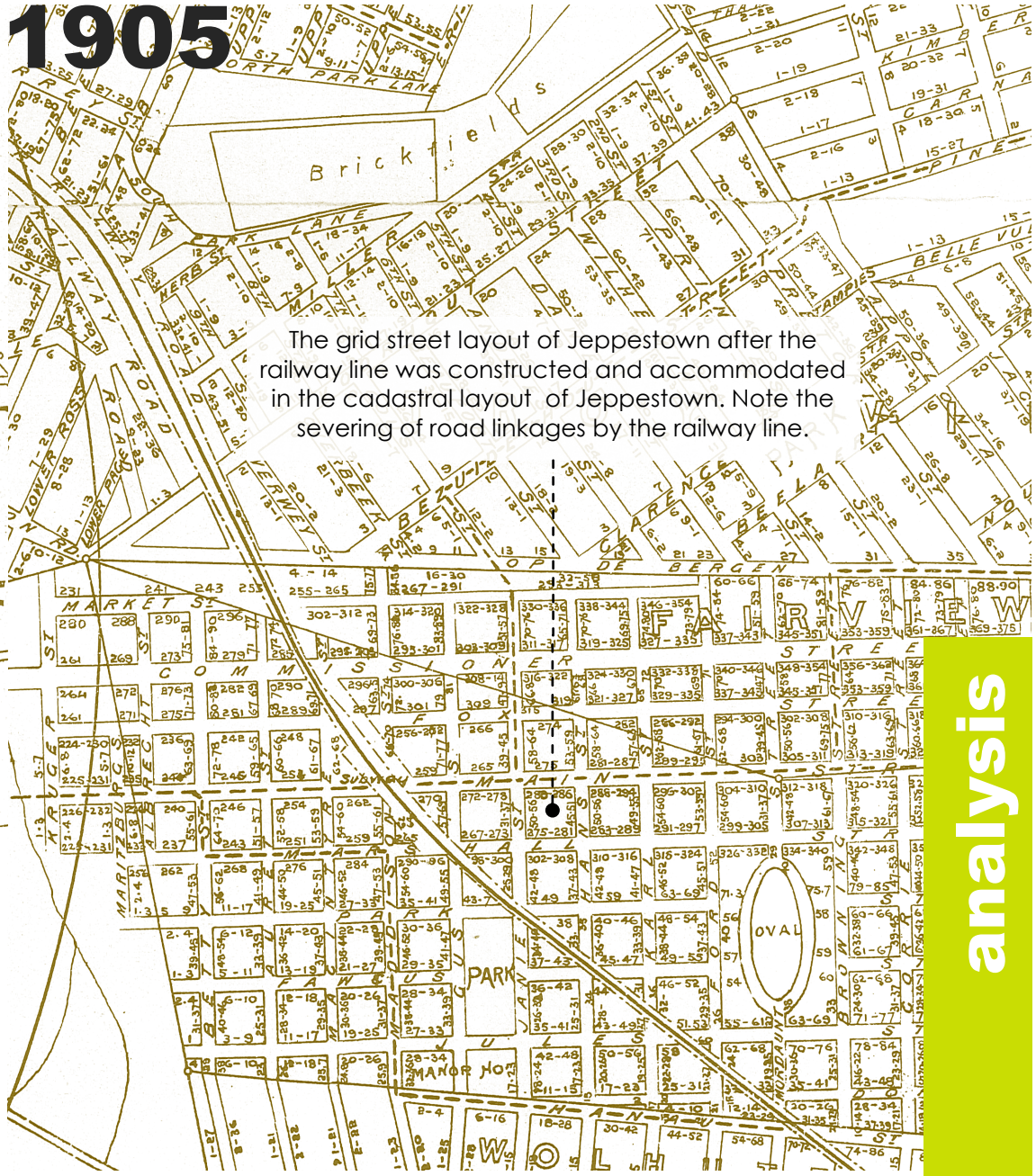
analysis

1890



The original grid street layout of Jeppestown, before the railway line was accommodated in the cadastral layout .

1905



The grid street layout of Jeppestown after the railway line was constructed and accommodated in the cadastral layout of Jeppestown. Note the severing of road linkages by the railway line.

Jeppestown was founded in 1886 by the Jeppe & Ford Estate Company, when it was expected that Johannesburg would grow east and west along the Gold Reef (myfundi.co.za). When a railway had to be built through the township, Julius Jeppe donated the land on condition that all trains were to stop for passengers at Jeppe Station. By 1894 the suburb comprised 421 buildings, two churches, a Masonic temple, St Mary's Collegiate for Girls, St Michael's School for Boys (now Jeppe High School for Boys), and a library (www.jda.co.za). The Julius Jeppe Oval (now Bertha Solomon Oval) existed initially as an open piece of land, which was formalised into a park by 1890. The St Mary's Anglican church on Park Street is the oldest place of worship in Johannesburg, having been built in 1889 (www.joburg.org.za).

Images source: City of Johannesburg. Museum Africa Archive. Retrieved September 11, 2012.

Images source: City of Johannesburg. Museum Africa Archive. Retrieved September 11, 2012.

1905



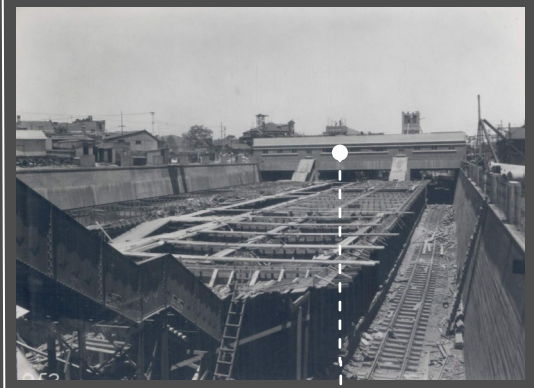
The original Jeppe Station building

1924



By 1904 the railway line had not been sunken below street level

1936

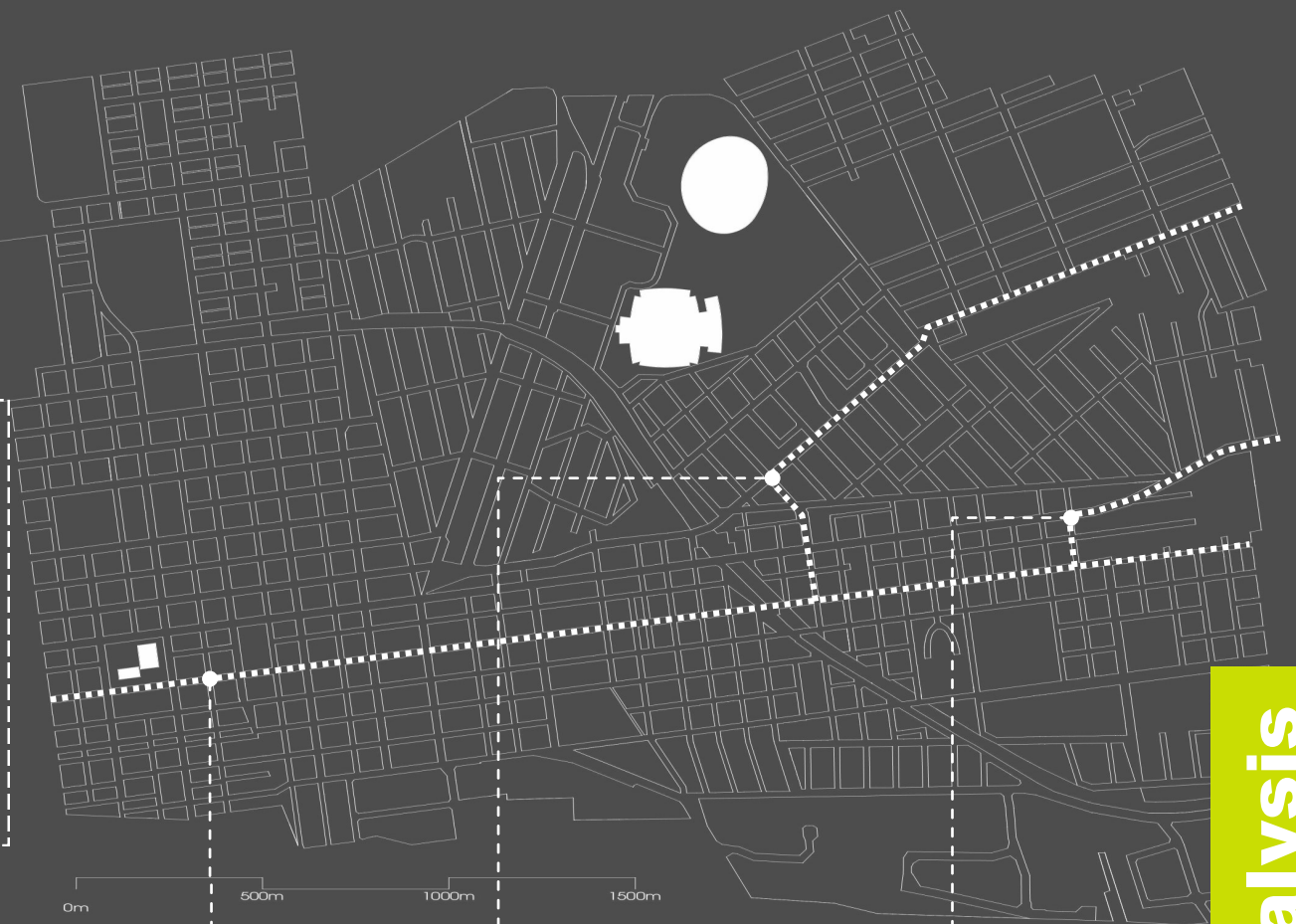


The railway line had been sunken below street level by 1936 and the original Jeppe Station was being replaced by a more modern station building — the one that exists to this day

JEPPE STATION HISTORY

1937





Main Street Tramline. This tramline was historically established on Main Street as a primary east-west axis. Electric tramways were operated between 1906 and 1961.

City Hall - Main St. - Jules St. - Malvern East

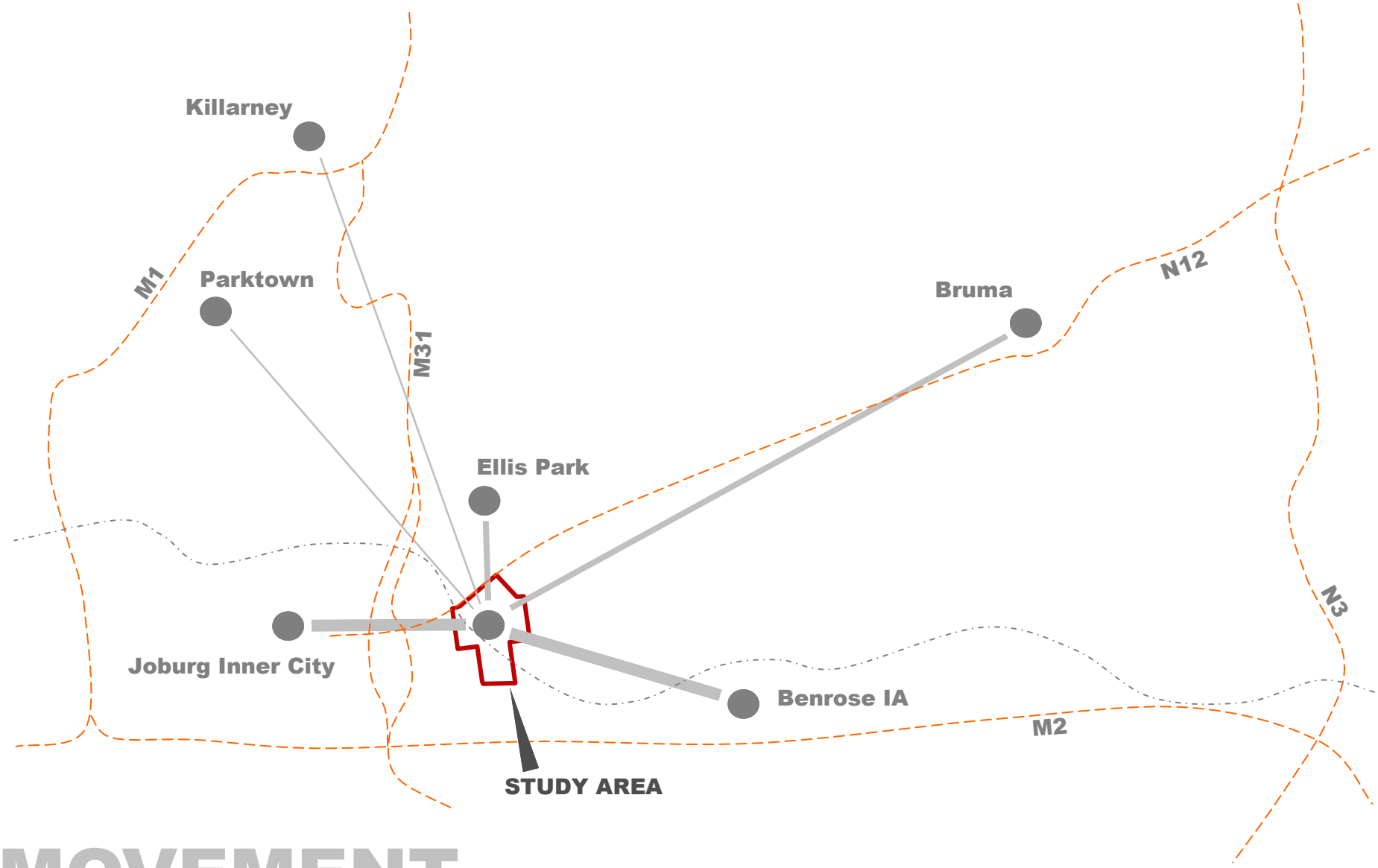
City Hall - Main St. - Kitchener Ave. - Bezuidenhoutsvallei

City Hall - Main St. - Roberts Ave. - Langerman Dr. – Kensington

Image source: City of Johannesburg. Museum Africa Archive. Retrieved September 11, 2012.
Text source: The GS Tram Site. (1998). Retrieved September 7, 2012 from http://www.tundria.com/trams/ZAF/Johannesburg-1935.shtml

JOHANNESBURG TRAM LINES

Movement patterns provide an understanding of how an area functions, because it illustrates the spatial relationships between settlements and core areas (employment, shopping and entertainment areas) and the linkages that exist between such spatial entities. Using a basic gravity model, which takes into account the size of core areas and the distance of core areas from settlement, the influence of each core area on movement between the core area and the settlement can be determined. The accompanying diagram depicts the movement of people between the Jeppe Study Area and the neighbouring core areas. It is evident from this diagram that most of the Study Area is located on a movement axis between the Johannesburg Inner City and Bruma core area. The Study Area has a stronger linkage with the Johannesburg Inner City due to its proximity and size. Strong movement is also assumed between the Study Area and the Benrose Industrial Area, with Jeppe Station functioning as one of the access point to this industrial area. Periodic movement is expected between the Study Area and the Ellis Park recreational precinct. Limited movement is expected between the Study Area and the Parktown and Killarney core areas due to the distance of these core areas and the geographical difficulty to reach these core areas.



MOVEMENT

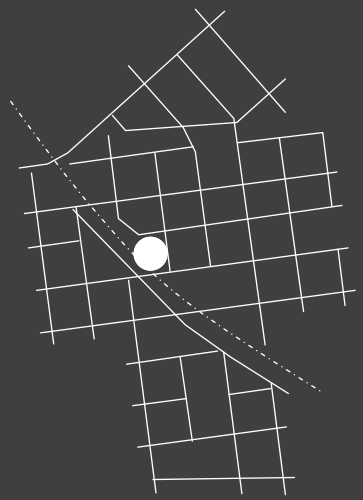
The Johannesburg-Germiston railway line is a public transportation spine traversing the central parts of Johannesburg and the Study Area. It basically follows the historical mining belt of Johannesburg. This commuter railway line has many stations serving the surrounding residential, industrial, recreation and business areas. Despite this, land use development near many of these stations do not display Transit Oriented Development characteristics, such as higher densities and mixed land use development. This provides opportunities for the redevelopment of many of the station precincts to better integrate land use and public transportation at these station.



METRORAIL NETWORK

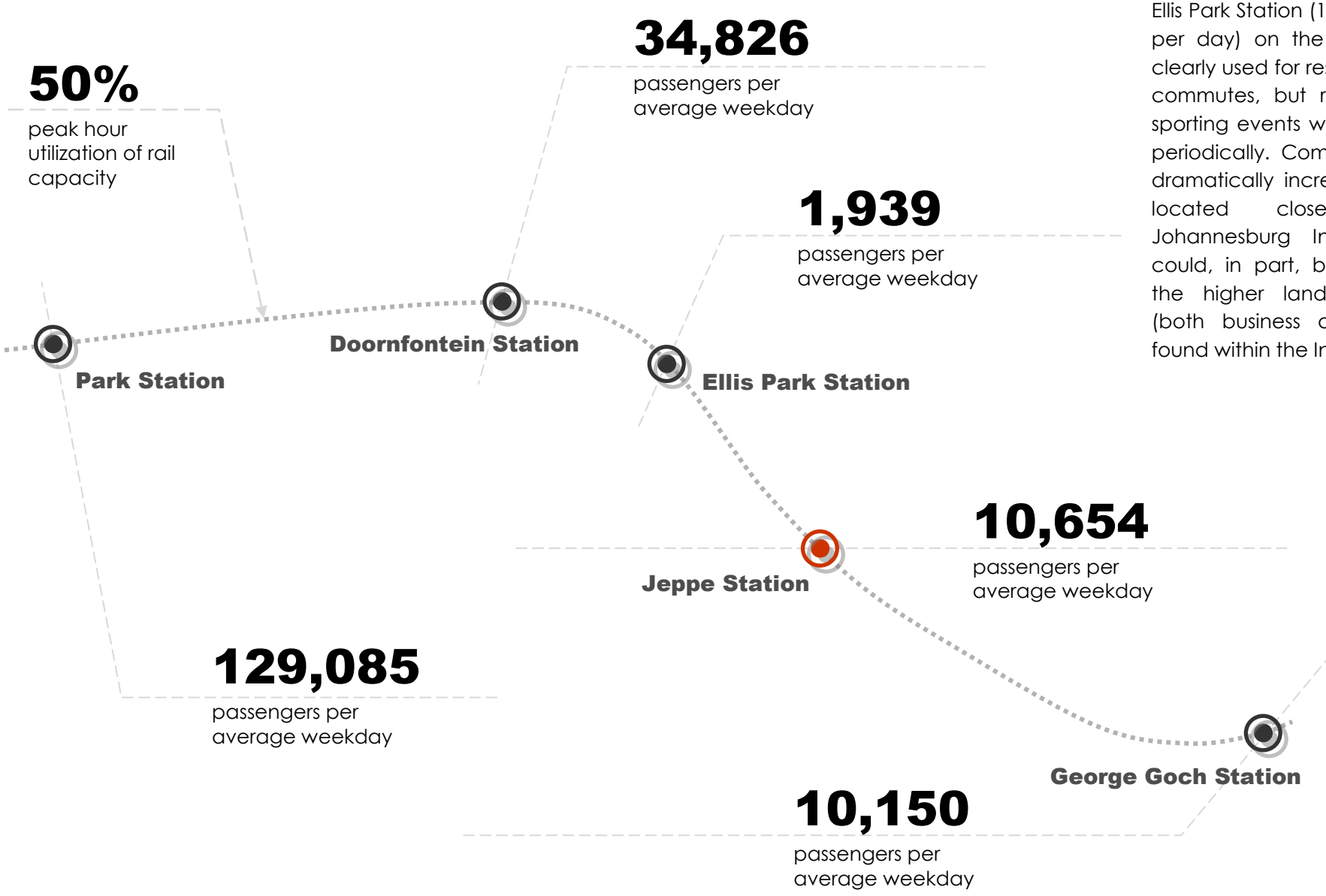


Image source: Personal photograph by author.
Photographed July 6, 2012.

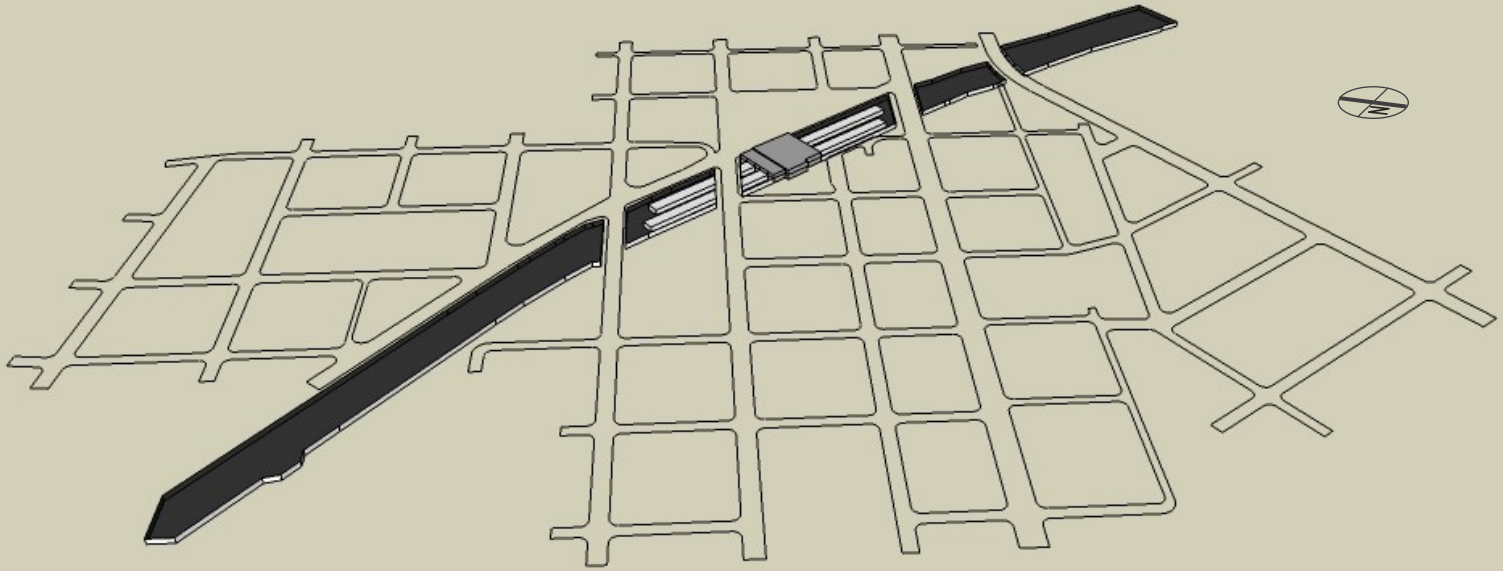


Jeppe Station and the public square situated in front of the station building. This public square is actively used. The station building is largely concealed behind walls and barriers and it is therefore not highly visible from the distance.

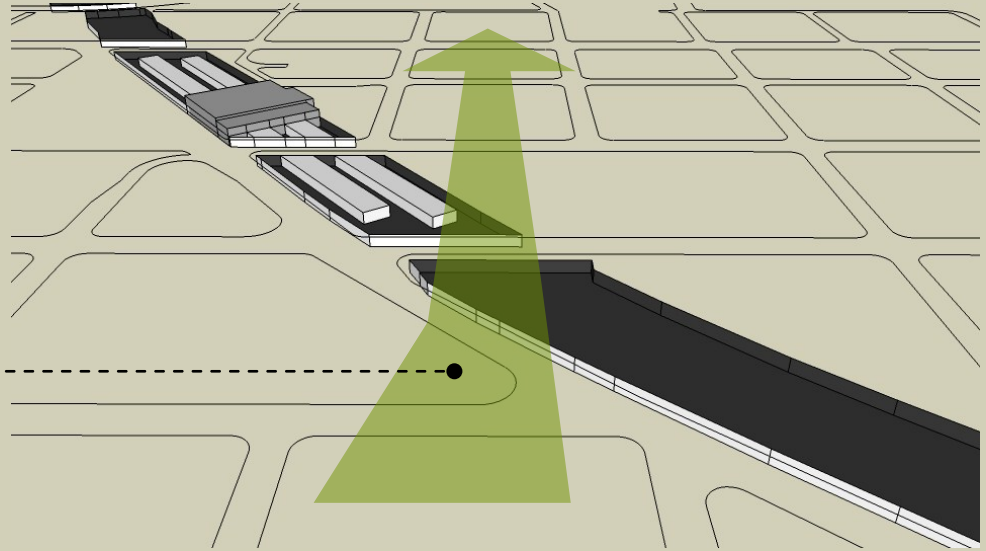
The figures presented below are representative of passenger movements for an average weekday through Jeppe Station and its neighbouring commuter railway stations (City of Johannesburg, 2003, p.175-177). It should further be noted that rail-to-rail transfers are included in these figures. This implies that passengers that transfer between rail services are counted twice: on arrival and on departure. This affects the Park Station number, which functions as a transfer stations. Roughly 10,000 passengers pass through Jeppe Station each day, indicating that the station is used as a residence-to-work transportation facility. The Ellis Park Station (1,900 passengers per day) on the other hand, is clearly used for residence-to-work commutes, but rather for large sporting events which only occur periodically. Commuter numbers dramatically increase at stations located closer to the Johannesburg Inner City. This could, in part, be attributed to the higher land use densities (both business and residential) found within the Inner City area.



PASSENGER VOLUMES

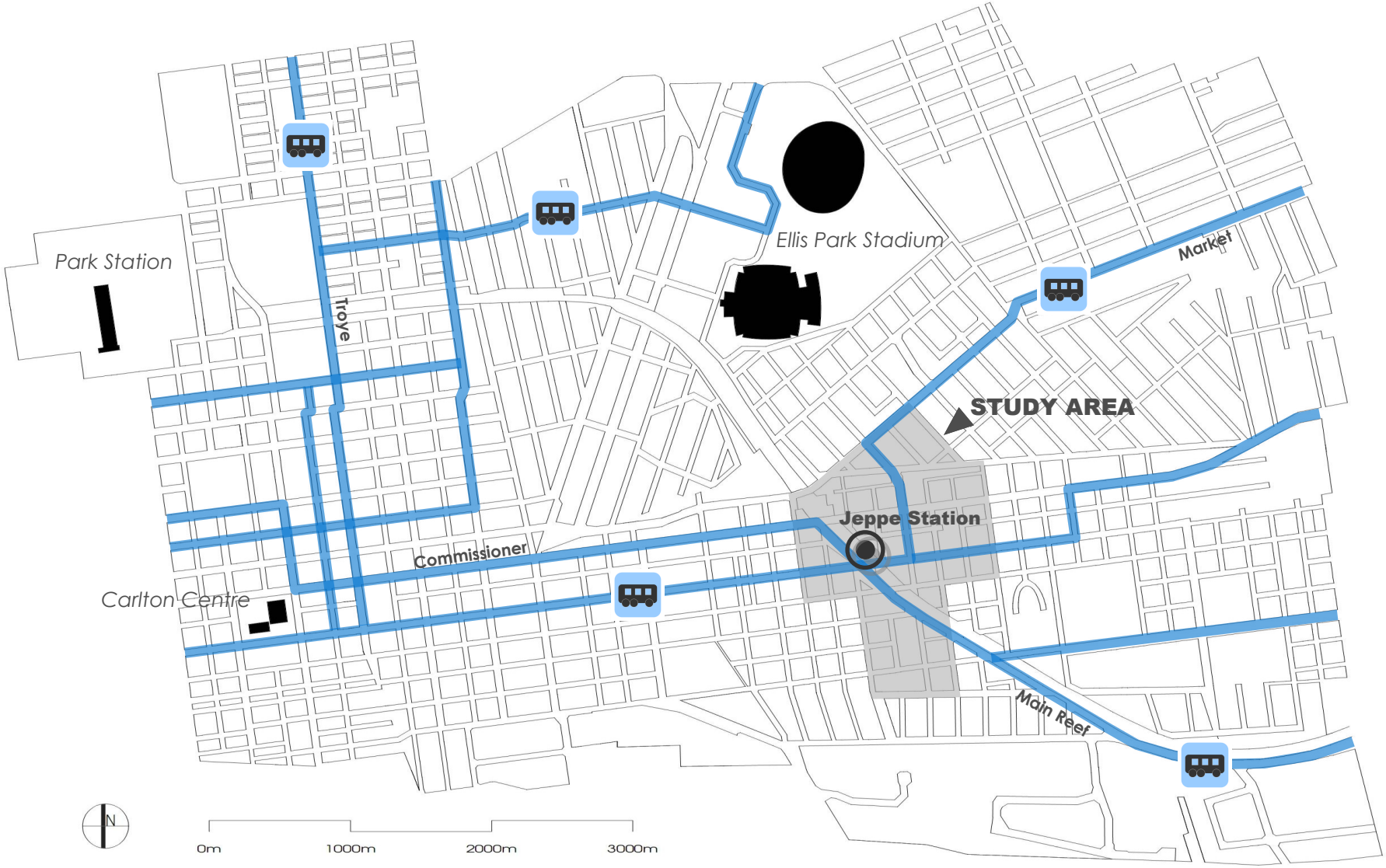


Because the rail line is sunken below ground level, the potential exists to cross the railway underpass at ground level. This allows pedestrian movement to remain on ground level, which has many pedestrian pathway integration advantages. The rail underpass also provides huge cost-saving; advantages, which would have been spend to resolve pedestrian integration issues, if the rail line was located on ground level.



RAIL UNDERPASS

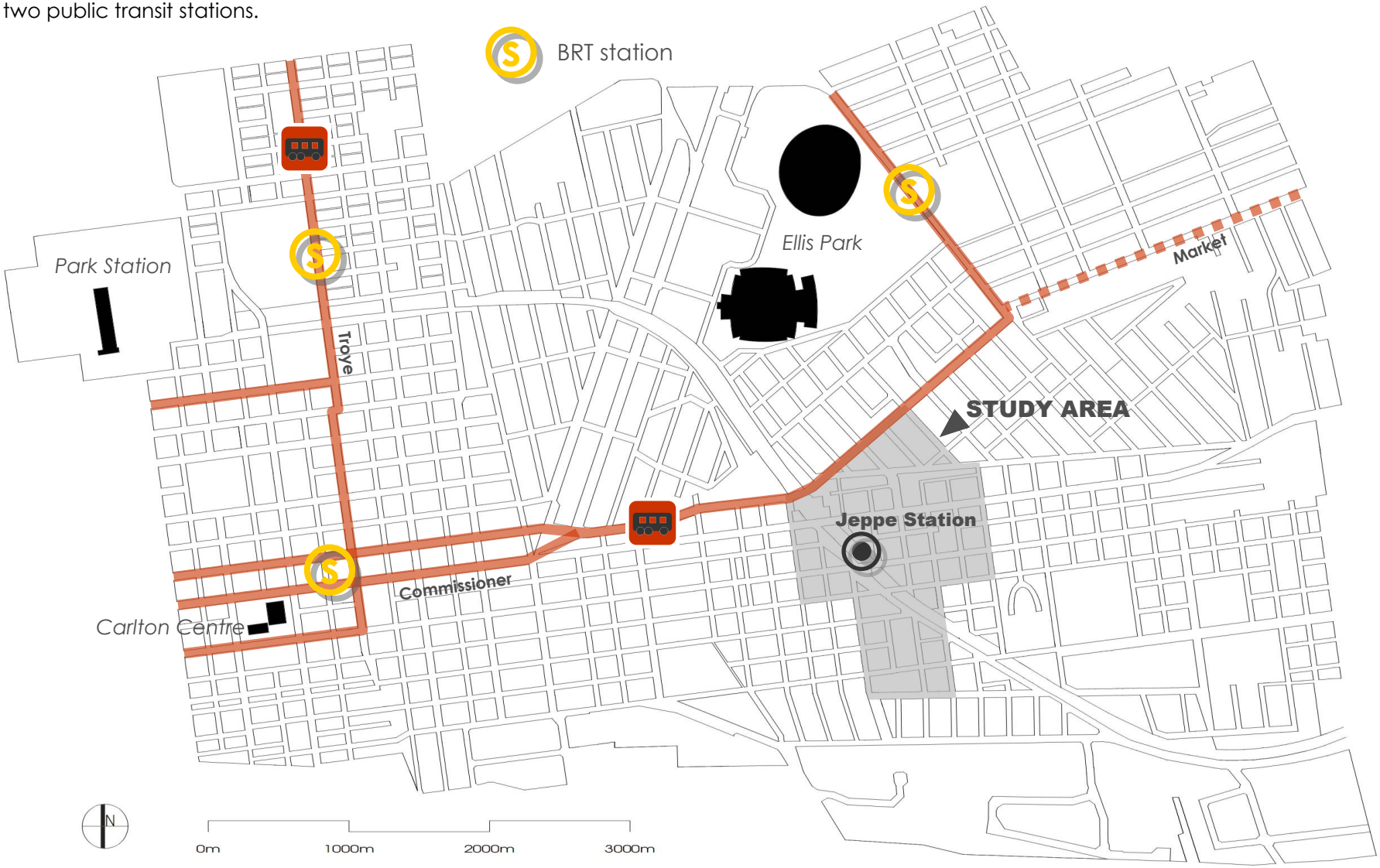
The Johannesburg metro bus network serves the Jeppe Precinct, linking the precinct to surrounding areas, such as the Johannesburg Inner City situated to the west of the precinct, and Bruma Lake, situated east of the precinct. Prominent routes used by the metro bus system, including Commissioner Street, Besuidenhout Street and Main Reef Road, converge on Jeppe Precinct and Jeppe Station in particular. This provides opportunities for modal interchange within the Jeppe Precinct, whereby the metro bus network functions as a feeder system to the commuter rail system.



METRO BUS NETWORK

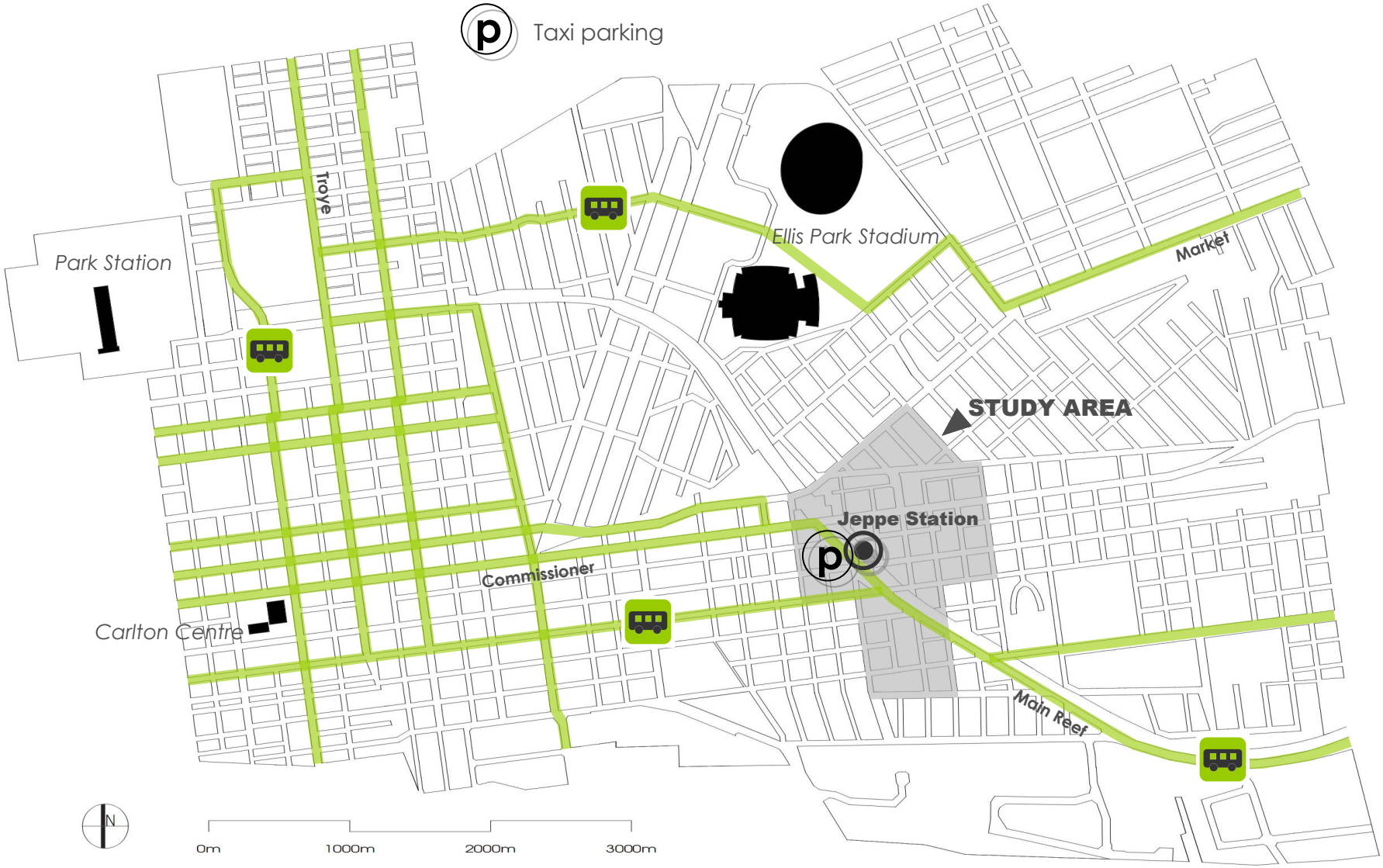
Bus Rapid Transit or BRT is a high-quality, bus-based transit system that delivers fast, comfortable, and cost-effective urban mobility through the provision of rapid and frequent operations. The key to achieving service this is through segregated, right-of-way, bus lanes, which enables rail-like performance using road-based public transport technology. Another key element is the BRT stations, which are aesthetically designed to enhance the attractiveness of the system. Stations are located approximately 700m apart. For the Johannesburg Inner City, the distances between stations were shortened because the Inner City is considered the primary trip attraction zone (LOGIT and ITDP, 2007).

The existing Johannesburg BRT network serving the Ellis Park Stadium, passes the northern boundary of the Jeppe Precinct on Market Street. Although this BRT route does not contain a BRT station near the precinct, it does provide the opportunity for the location of such a station on Market Street. This station would be located within walking distance of the Jeppe commuter railway station, potentially allowing for modal interchange between these two public transit stations.

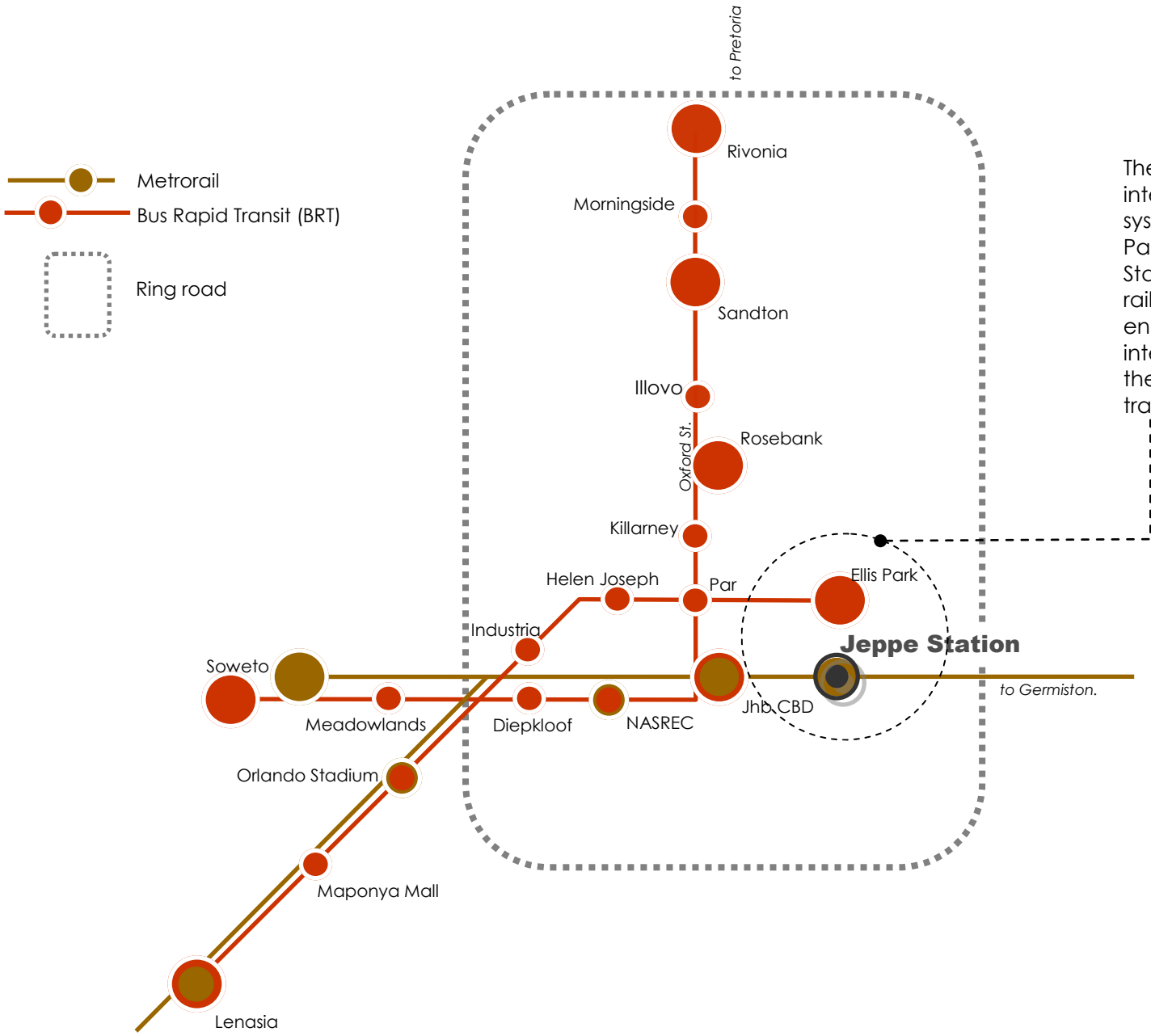


BRT NETWORK

The taxi network serves a greater number of streets within the Johannesburg Inner City than any of the other modes of public transportation. However, the taxi network does not serve the Jeppe Precinct as comprehensively as the other modes of public transportation. For example, the taxi network does not utilize the parts of Market that borders the Jeppe Precinct. However, the taxi network does follow Main Reef Road up to Commissioner Street, thus serving the Jeppe commuter railway station. Taxi parking areas opposite Jeppe Station confirms the linkage between the taxi system and the commuter railway system and the use of Jeppe Station as a multi-modal transfer facility.



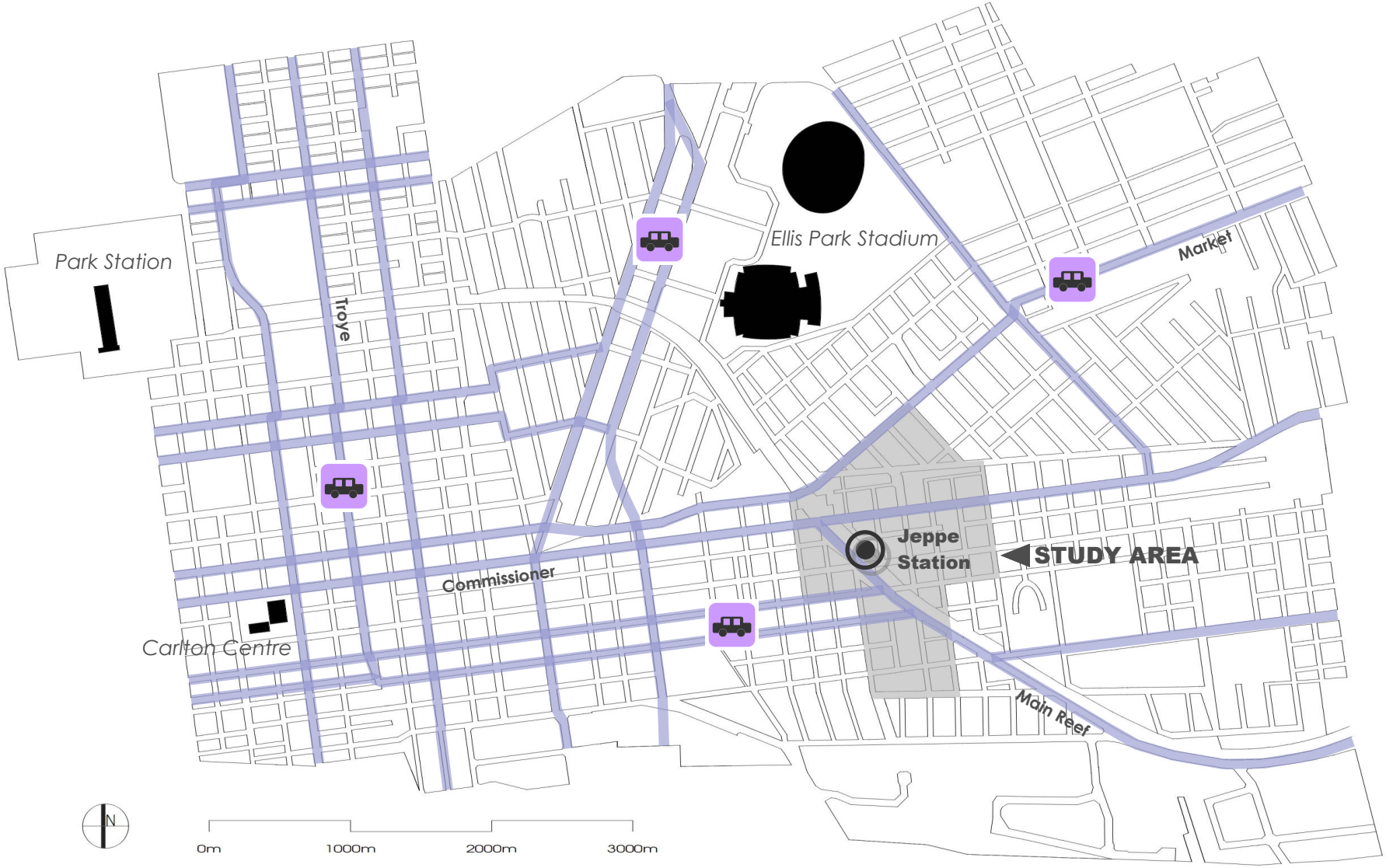
TAXI NETWORK



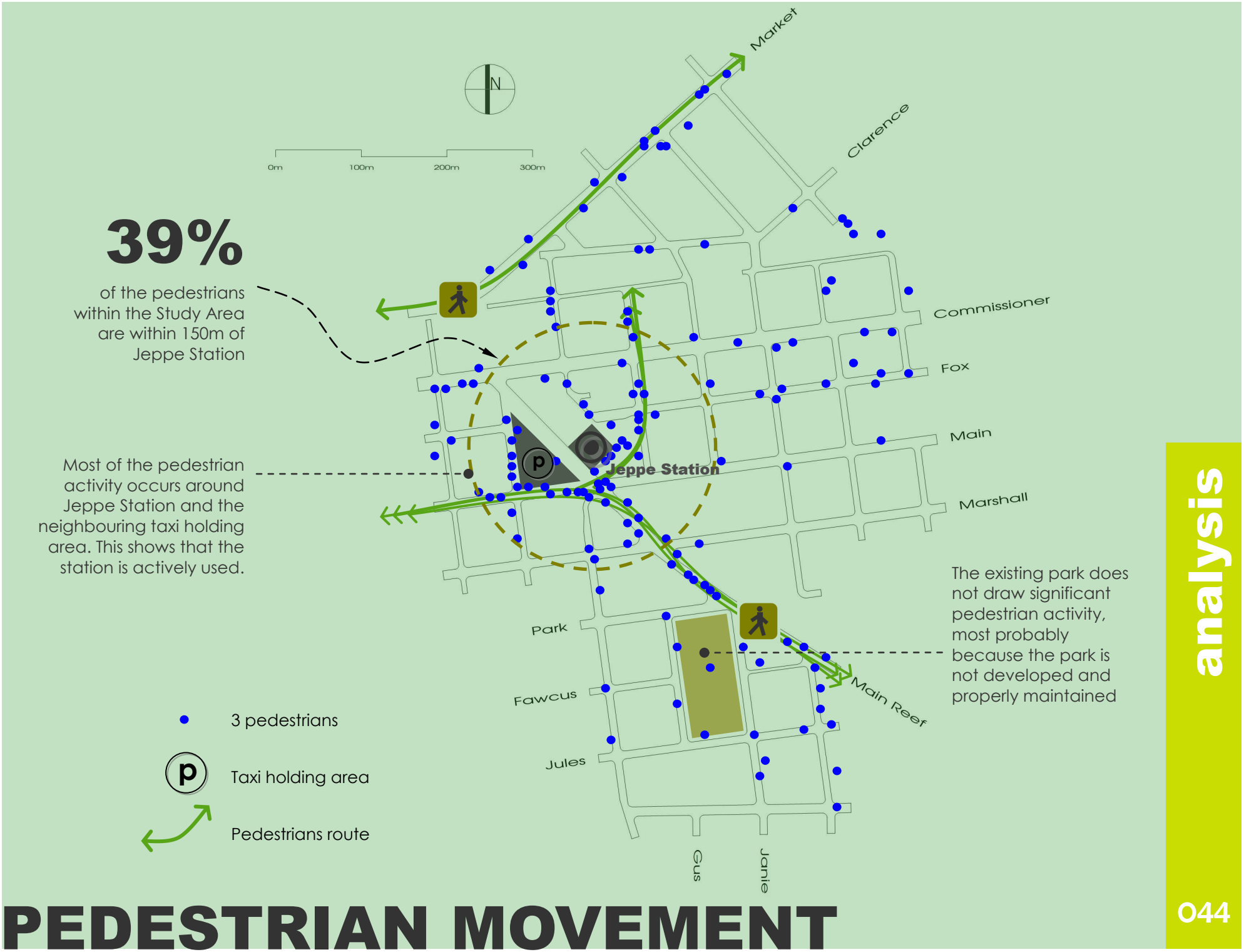
The potential exists to integrate the BRT system serving Ellis Park with the Jeppe Station and commuter railway line. This will enable modal interchange between these regional public transportation systems.

TRANSPORT INTEGRATION

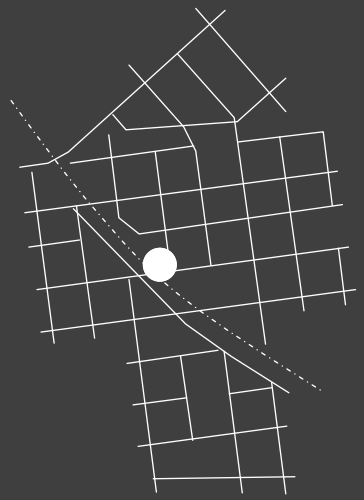
The Johannesburg Inner City and Jeppestown has a predominantly grid street layout. Within the grid street layout, some streets are considered main arterials connecting the Johannesburg Inner City to surrounding areas (such as Jeppestown) and the surrounding freeway network (notably the M2 freeway situated south of the Jeppe Precinct). Prominent main roads connecting the Jeppe Precinct to the Johannesburg Inner City and surrounding areas, include Commissioner Street, Market Street and Main Reef Road. In particular, Commissioner Street forms a central east-west spine traversing the Jeppe Precinct. Commissioner Street also directly passes the Jeppe commuter railway station, allowing drop-off opportunities.



MAIN ROAD NETWORK



PEDESTRIAN MOVEMENT



The pedestrian-only bridge across the railway line, situated next to Jeppe Station, is actively used



Image source: Personal photograph by author.
Photographed July 6, 2012.

Internationally, a 400m walking distance to a transit station, such as a commuter railway line, is accepted as the average walking distance commuters would be prepared to walk to access a public transit system. However, it is widely accepted that South Africans are prepared to walk greater distances to access public transit than, for example Europeans and Americans. This notion is reflected in the spacing of Metrorail stations, which are spaced up to 2km apart, which assumes a 1km walking distance to access a Metrorail station. The accompanying map shows both walking distances to Jeppe Station. It is evident that both the Ellis Park Stadium and the Benrose Industrial Park are located within walking distance of Jeppe Station, stressing the importance of linking the station northward and southwards. The Johannesburg Inner City, on the other hand, is located beyond walking distance of Jeppe Station, thus requiring public transport to connect to the Johannesburg Inner City.

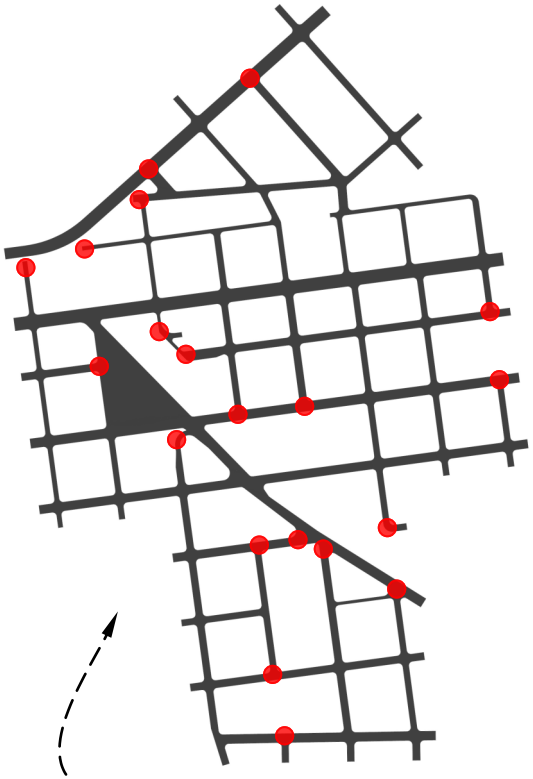


WALKING DISTANCE

Permeability can be determined by the length of routes (in addition to other variables): the longer a route the greater its permeability. On a regional level, it is evident that the Study Area road network allows for good east-west permeability along roads such as Commissioner, Main and Marshall Streets. This is mainly due to the need for regional traffic to cross the Study Area on route to the Johannesburg Inner City. North-south routes, on the other hand, do not have the same level of permeability. Limited permeability exists between the Ellis Park Stadium precinct and the Jeppe Precinct.

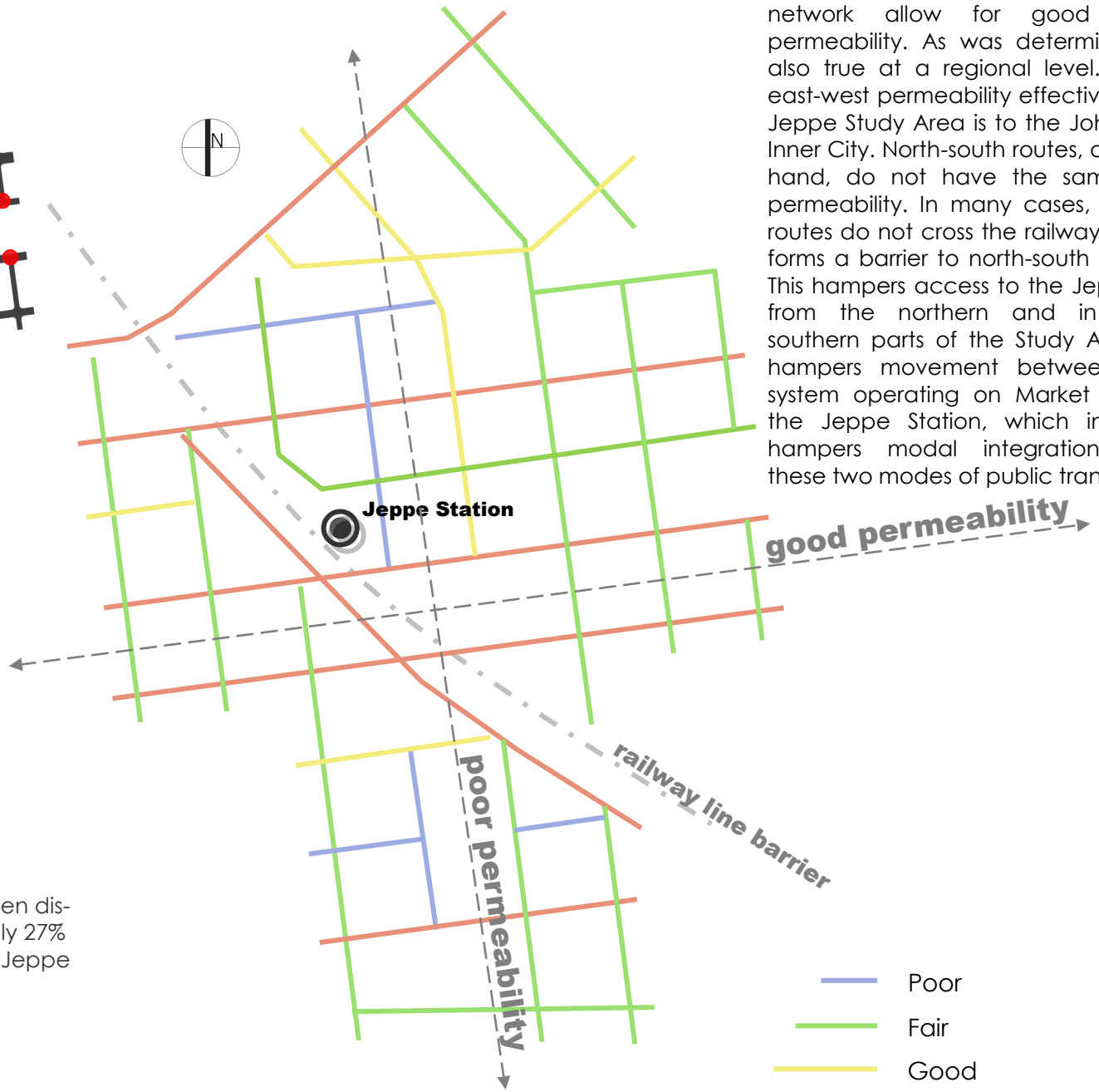


REGIONAL PERMEABILITY



73%

of north-south roads have been disconnected, compared to only 27% of east-west roads within the Jeppe Precinct.



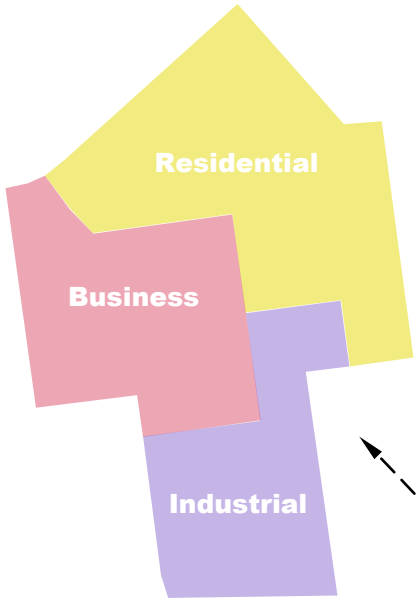
The accompanying diagram shows that, at a local level, the Study Area road network allow for good east-west permeability. As was determined, this is also true at a regional level. The good east-west permeability effectively links the Jeppe Study Area is to the Johannesburg Inner City. North-south routes, on the other hand, do not have the same level of permeability. In many cases, north-south routes do not cross the railway line, which forms a barrier to north-south movement. This hampers access to the Jeppe Station from the northern and in particular southern parts of the Study Area. It also hampers movement between the BRT system operating on Market Street and the Jeppe Station, which in turn also hampers modal integration between these two modes of public transportation.

LOCAL PERMEABILITY

When viewing the building coverage surrounding Jeppe Station, it is evident that buildings cover less land area to the east of this railway line than buildings to the west of the railway line. The part of Jeppe Precinct to the west of the railway line therefore reflects the character of the Johannesburg Inner City, whereas the area east of the railway line is more residential in nature. It appears as if the eastward expansion of the Johannesburg Inner City and its higher-density building fabric terminates at the railway line.



BUILT+COVERAGE



BROAD LAND USE ZONES



Residential
Flats
Church
Retail
Office
Industrial
Public Space
Vacant
Parking

The Jeppe Precinct is a mixed-use environment, comprising mostly retail, industrial and residential uses. Residential uses range from a number of detached housing units to a few high-rise residential buildings. A number of walk-ups comprising two to three storeys are prevalent within the Study Area. Considered broadly, a land use pattern emerges that is depicted on the accompanying diagram: a business zone that is centered on Jeppe Station, an industrial zone that is located in the southern parts of the precinct and a residential zone is situated in the northeastern parts of the precinct.

BUILDING LAND USE

It is evident from the Tables below that the eastern part of the Jeppe Precinct is predominantly residential in nature. As a consequence, the eastern part of the precinct lacks land use intensity. By contrast, the western part of the Jeppe Precinct contains a greater mix of land uses, largely because of the inclusion of office uses in the land use mix of the western part of the precinct. The provides the western part of the precinct a greater land use intensity. However, it should be pointed out that by comparison, the land use intensity of the eastern part of the precinct is far greater than one would find in most suburban areas of Johannesburg.



EAST PRECINCT

Land Use	Floor Area	%
Residential	34595	51.1
Retail	12610	18.6
Office	1919	2.8
Industrial	18589	27.5
Total	67713	100.0

WEST PRECINCT

Land Use	Floor Area	%
Residential	9856	10.1
Retail	16057	16.4
Office	30181	30.9
Industrial	41559	42.6
Total	97653	100.0

LAND USE INTENSITY

67%

of the retail floor area is located within a street block around Jeppe Station. The Study Area has

22,286m²

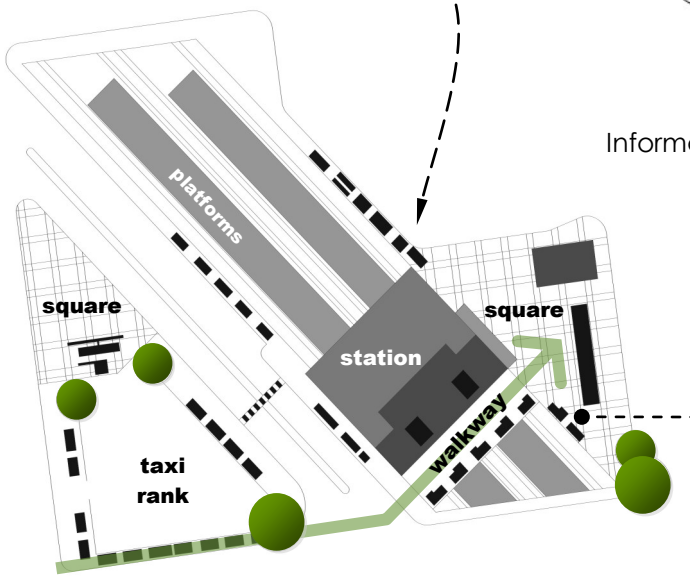
of retail space, which is equal to a suburban community shopping centre in size.

As mentioned, most of the retail floor area within the Study Area is located within a street block around Jeppe Station. This illustrates the link between retail and commuters, as was alluded to in the literature study. A retail spine exists along Main Street, situated on both sides of Jeppe Station.



Large parts of the Study Area has a fine building grain. This enables good edges where retail engages well with sidewalk pedestrian traffic.

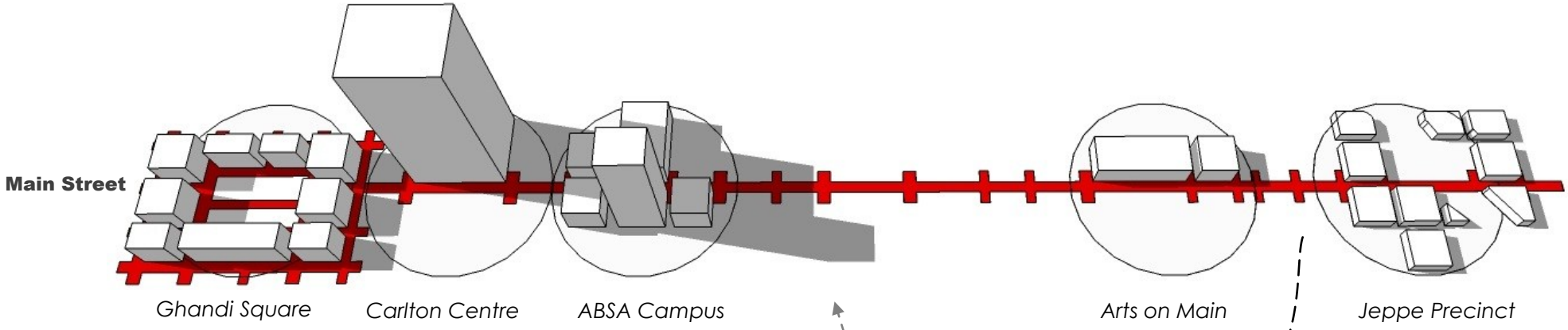




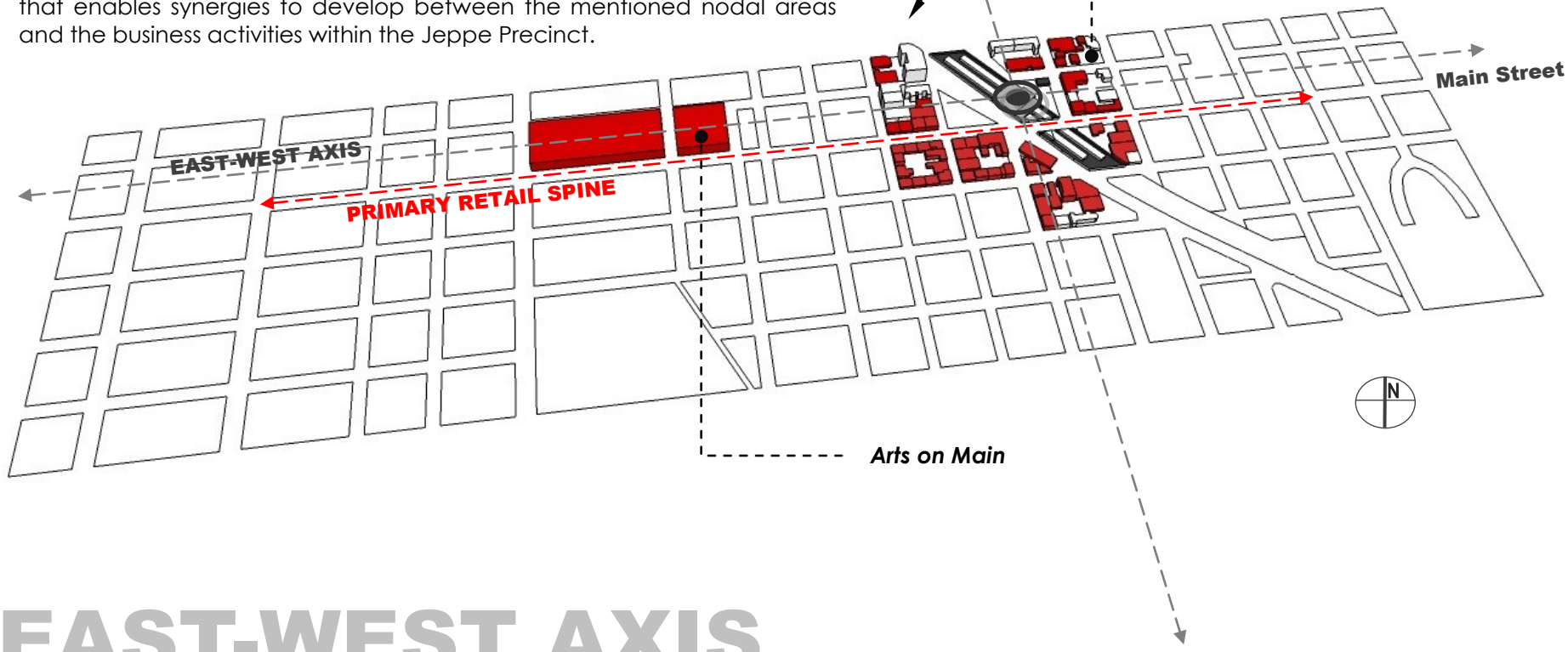
Informal trading stalls

INFORMAL TRADING AT STATION

ACTIVITY+EDGES



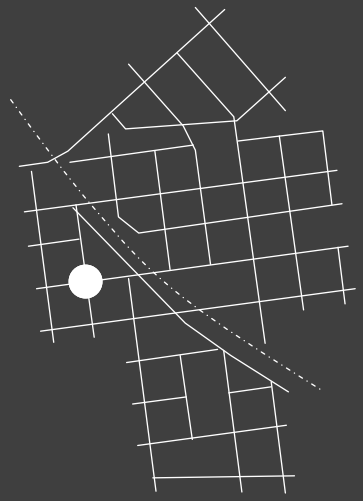
Main Street is a well-established east-west axis linking the Johannesburg Inner City and the Jeppes Precinct. This east-west axis was shown to have links to the tramline, which historically operated on Main Street. The east-west axis has a number of prominent nodal areas, including the Carlton Centre, the ABSA Campus and the Maboneng Precinct (Arts on Main). The Maboneng Precinct is a recent redevelopment of the eastern parts of the Johannesburg Inner City into an arts precinct. Main Street is the link that enables synergies to develop between the mentioned nodal areas and the business activities within the Jeppe Precinct.



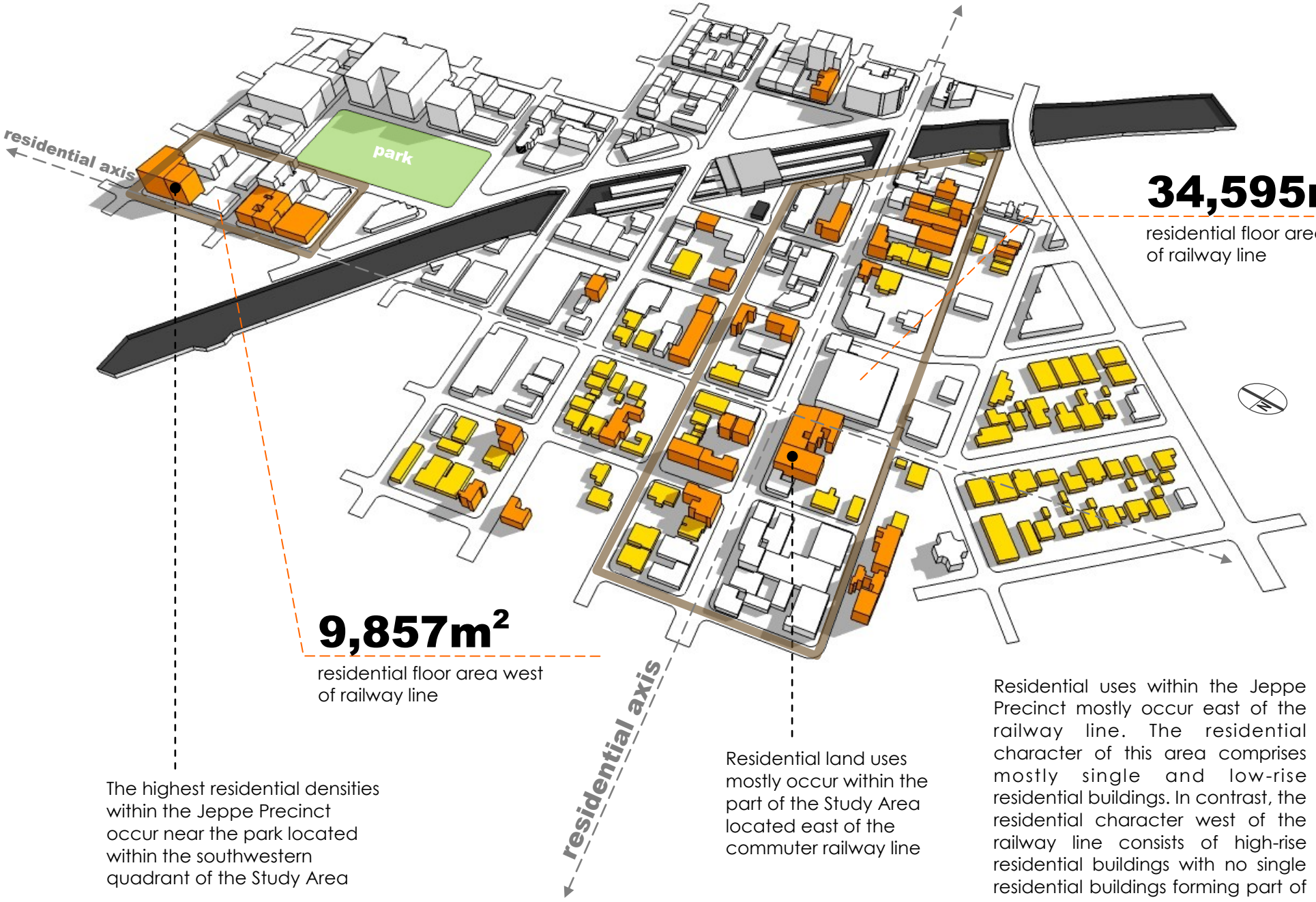
EAST-WEST AXIS



Image source: Personal photograph by author.
Photographed July 6, 2012.



Main Street is the primary retail spine within the Jeppe Study Area. It has a fine architectural character, which interacts well with the street network. According to the literature, this is a development pattern that support transit use and is is therefore a development pattern that could be furthered throughout the Jeppe Precinct.



Residential uses within the Jeppe Precinct mostly occur east of the railway line. The residential character of this area comprises mostly single and low-rise residential buildings. In contrast, the residential character west of the railway line consists of high-rise residential buildings with no single residential buildings forming part of the housing typology mix. The area west of the railway line thus reflects the residential character of the Johannesburg Inner City.

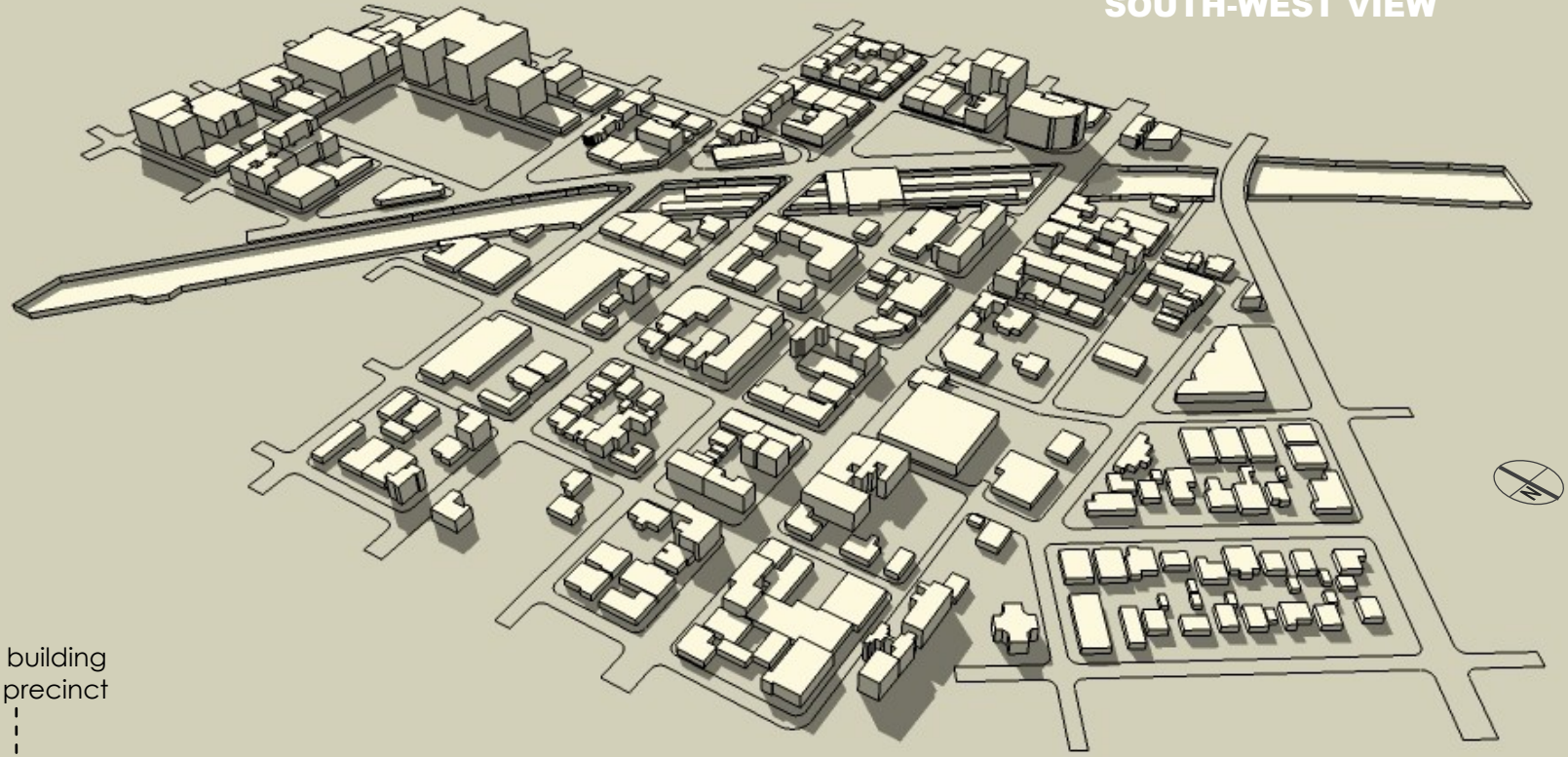
RESIDENTIAL DENSITY

Most of Jeppe Precinct consists of building between one and two storeys in height. Buildings that are more than two storeys in height is primarily concentrated around the existing park, situated in the southern part of the precinct, and northwest of Jeppe Station. When compared to land use, these taller buildings are mostly used for office of residential purposes. The highest building is located on the western boundary of the mentioned park. This building sets a benchmark on what height landmark buildings could be within the Jeppe Precinct. To an extent, the heights of the other buildings determine future height restrictions for neighbouring buildings, when allowing of appropriate building height interface.

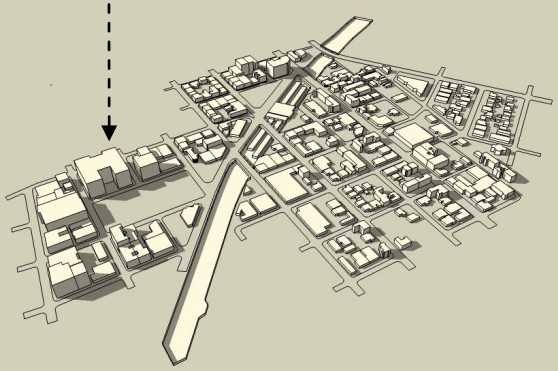


BUILDING HEIGHT

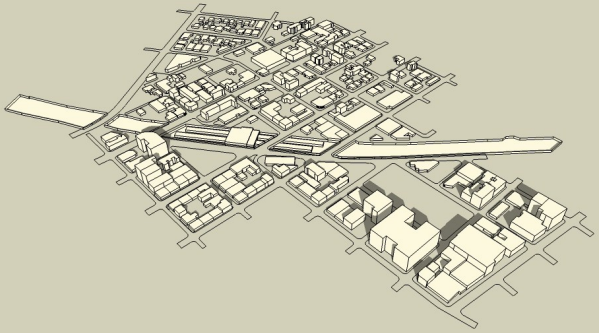
SOUTH-WEST VIEW



Tallest building
within precinct



NORTH-WEST VIEW



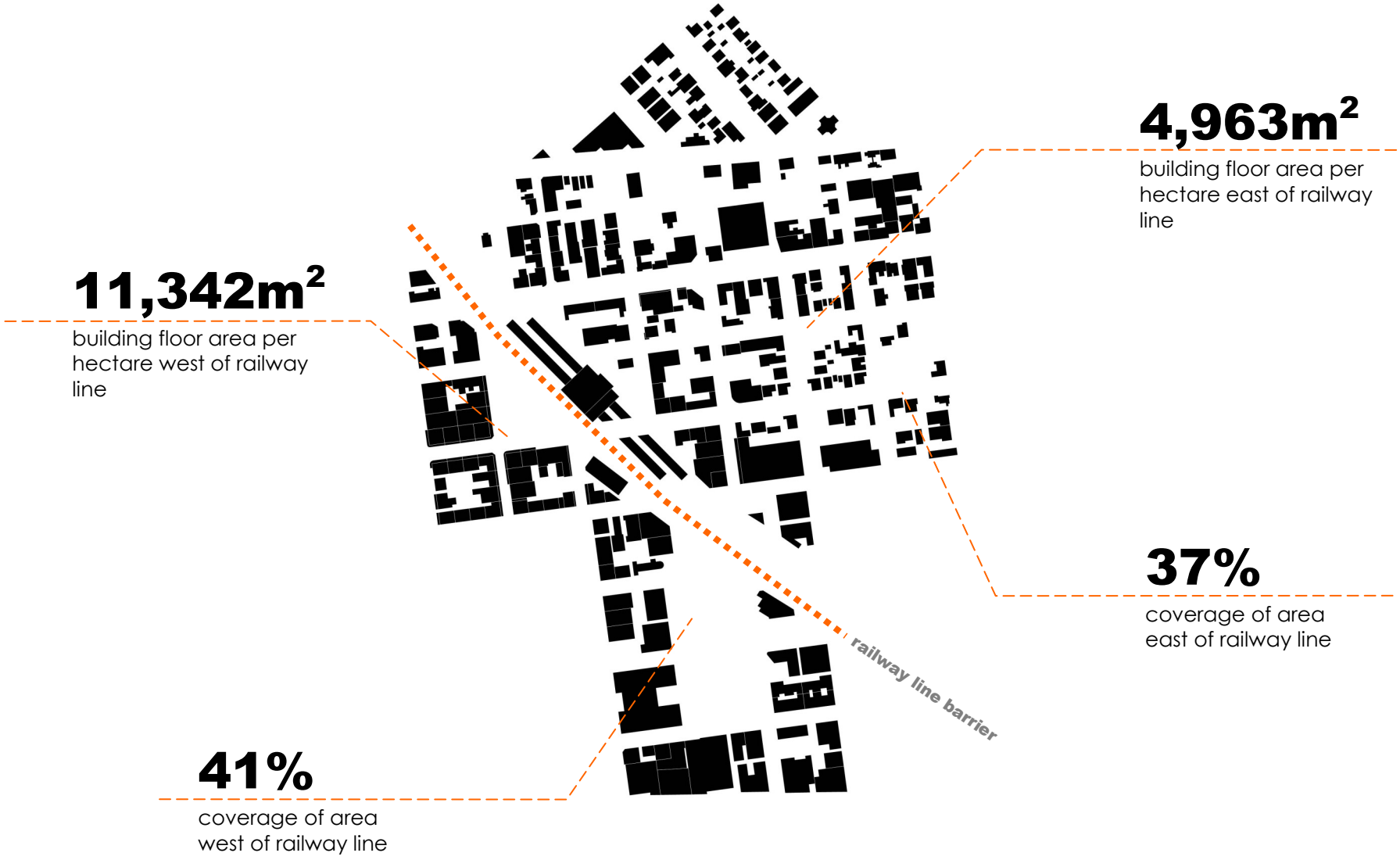
NORTH-EAST VIEW



SOUTH-EAST VIEW

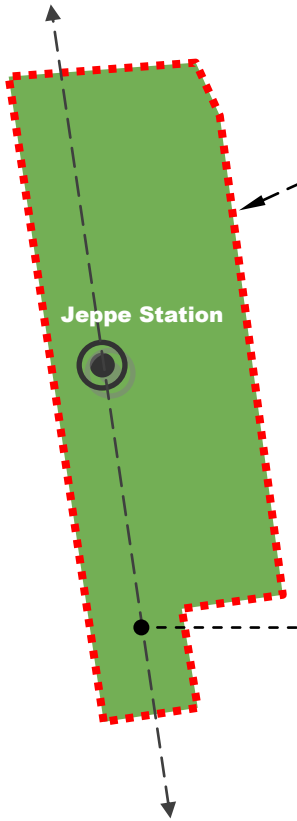
MASSING+HEIGHT

There is a marked difference between the areas east and west of the commuter railway line, which traverses the Jeppe Precinct. Higher densities occur to the west of the railway line, as though the eastward expansion of the Johannesburg Inner City stopped at the railway line 'barrier'. Whereas coverage on both sides of the railway line are similar (41% coverage west of the railway line and 37% coverage east of the railway line), there is a marked difference in floor area density east and west of the railway line. The precinct area west of the railway line has more than 11,000m2 of building floor area per hectare, while the precinct area east of the railway line has less than half that building floor area per hectare. This implies that lower urban densities do not support the Jeppe Station as well, east of the railway line.



BUILDING DENSITY

The Jeppe Precinct comprises a wide range of building qualities, ranging from buildings in good condition to buildings that have deteriorated to the point that they are most likely only suitable for demolition. The accompanying map show soft buildings within the Jeppe Precinct that could potentially be demolished if a better use is identified for the land on which these buildings are situated. Almost half of these 'soft' buildings are located in a north-south stretching band straddling Jeppe Station. This presents an opportunity to redevelop this axis north and south of Jeppe Station.



The location of soft buildings reinforces the development of a north-south axis centred on Jeppe Station

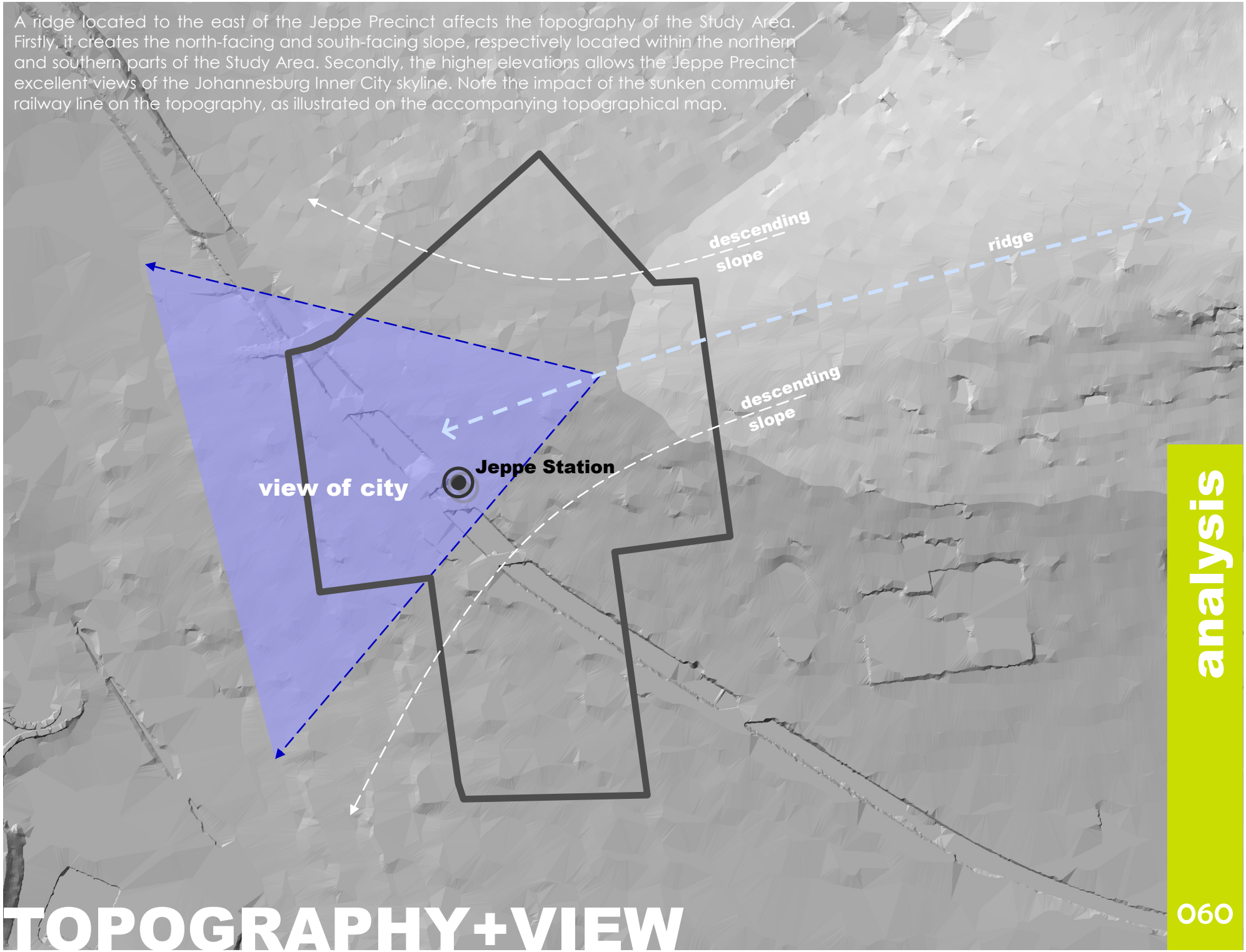


44%

of the soft buildings located within the Study Area are located within this north-south stretching band straddling Jeppe Station

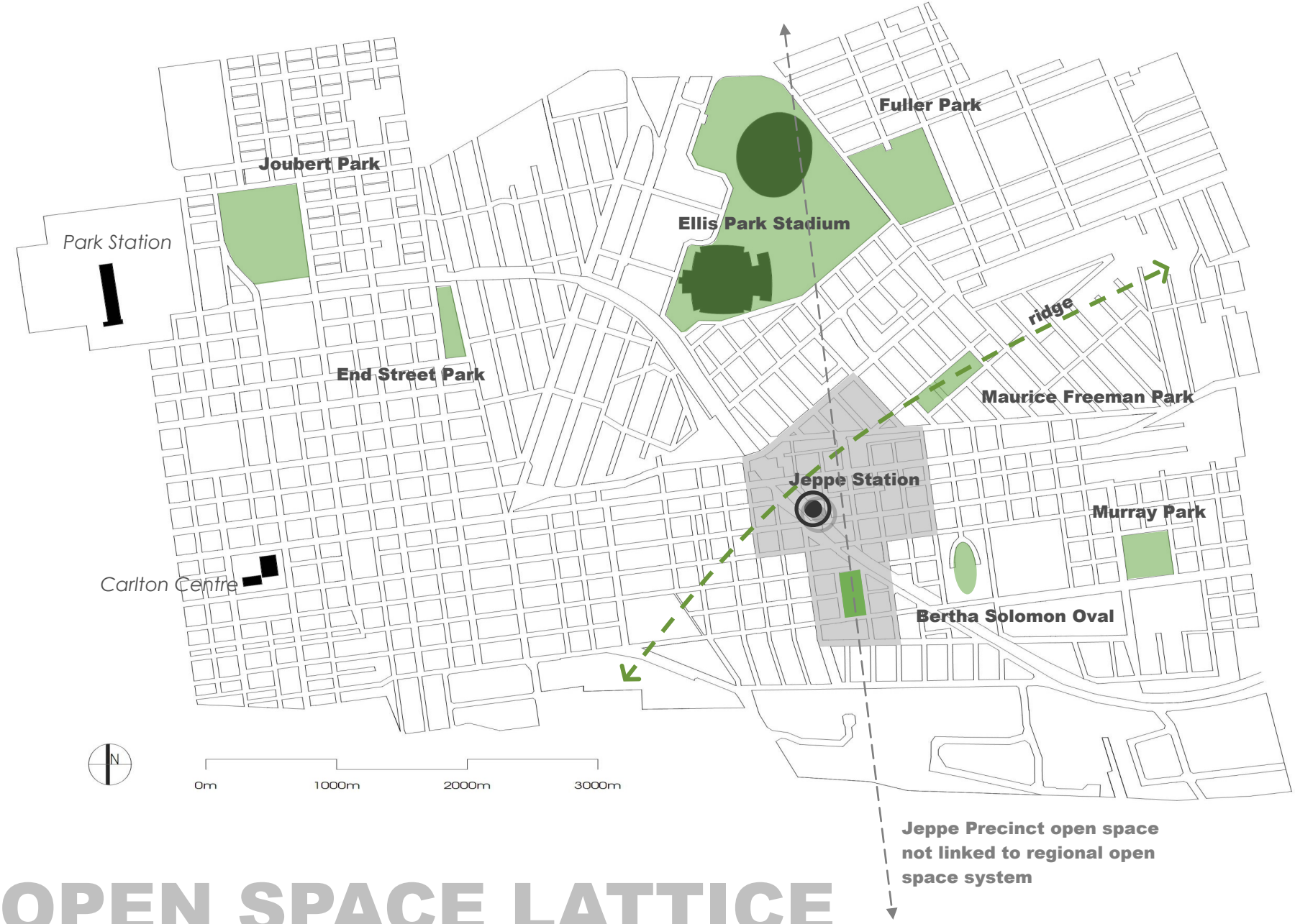
BUILDING QUALITY

A ridge located to the east of the Jeppe Precinct affects the topography of the Study Area. Firstly, it creates the north-facing and south-facing slope, respectively located within the northern and southern parts of the Study Area. Secondly, the higher elevations allows the Jeppe Precinct excellent views of the Johannesburg Inner City skyline. Note the impact of the sunken commuter railway line on the topography, as illustrated on the accompanying topographical map.



TOPOGRAPHY+VIEW

The Study Area and its region comprises a fairly dense urban environment. As a result, open space is limited within the Jeppe region. The largest open space is the Ellis Park Stadium, situated north of the Study Area. Joubert Park, situated near Park Station, is the largest formal open space or urban park within the region. Of concern is the fact that these open space elements are not linked to each other through a natural open space lattice, which uses and incorporates, for example, the ridge located northeast of the Study Area. However, many streets within the region have tree linings, which function as pedestrian walkways that links these open space elements to each other. This street function is reinforced by the grid pattern of the street network and can be further exploited to link these open space elements into an open space lattice.



OPEN SPACE LATTICE

The Jeppe Precinct is located within a fairly dense urban environment. Only 3% of the Study Area was set aside for open space and public space. The low open space and public space allocation is further aggravated by the fact that these spaces are poorly developed and maintained. Another drawback of the open space and public space that are provided is the fact that these spaces are not deliberately integrated through a public space lattice of the Study Area of the region; utilizing the street network to link these spaces.





3%

of the Study Area is dedicated open space or public space

PUBLIC SPACE+VEGETATION

The park situated south of Jeppe Station is undeveloped and poorly maintained. Despite this, the park appears to be actively used by local residents.

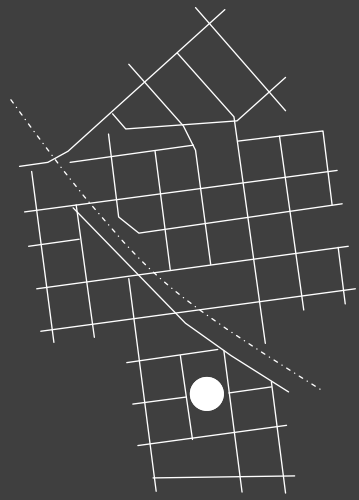




Image source: Personal photograph by author.
Photographed July 6, 2012.

As was mentioned, the Jeppe Precinct consists of a number of building that are of poor building quality. Over time, this appears to have resulted in a number of buildings being demolished, leaving a number of vacant land parcels within the Study Area. Most of the vacant land parcels are located to the east and to the north of Jeppe Station. Most of these vacant land parcels are located with the strips of land that are demarcated on the accompanying map. These vacant land parcels present an opportunity for redevelopment linked to Jeppe Station.



56%

of the vacant properties located within the Study Area are located within these strips centred on Jeppe Station

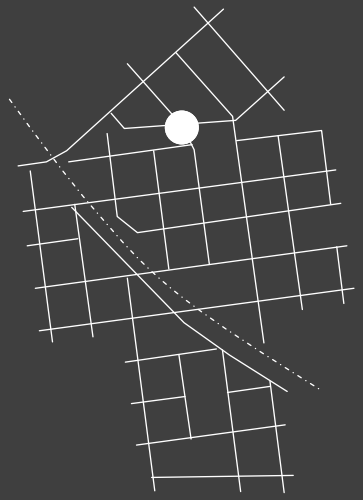
Location of vacant land parcels reinforces a cross-axis redevelopment of Study Area centred on Jeppe Station

VACANT LAND



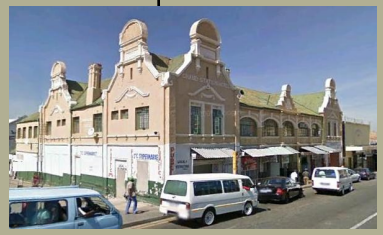
Image source: Personal photograph by author.
Photographed July 6, 2012.

Large parcels of land within the Study Area are vacant after the buildings located on these properties have been demolished.















LANDMARK BUILDINGS

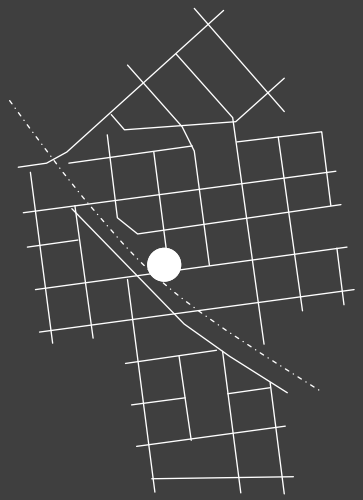


Image source: Personal photograph by author.
Photographed July 6, 2012.



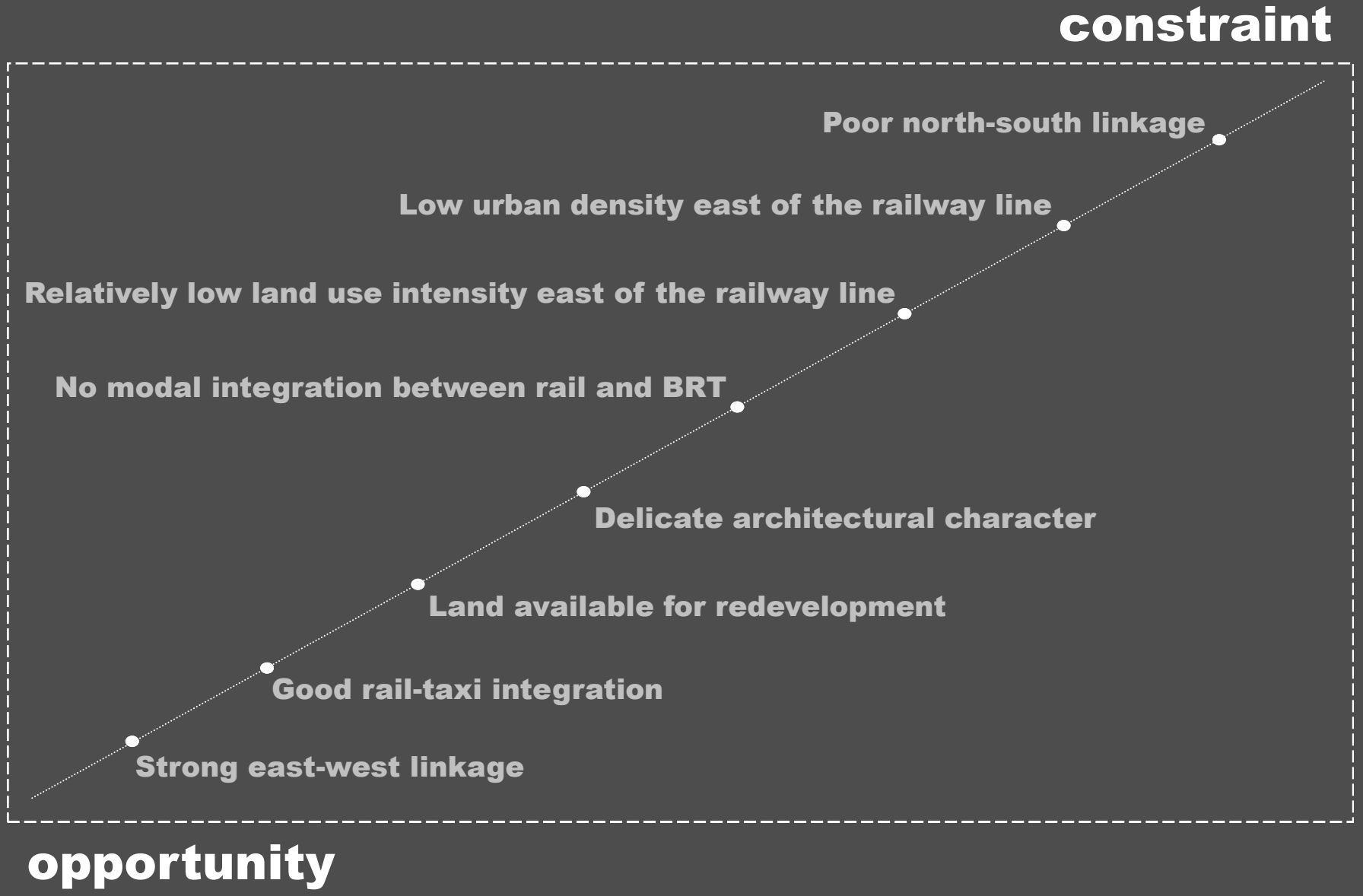
The Study Area has a number of landmark buildings of architectural value. As illustrated on the previous drawing, many of these buildings are located near Jeppe Station, such as this building located opposite the station.



The sunken railway line increases views of the landmark buildings; most of which straddle the railway line edge.

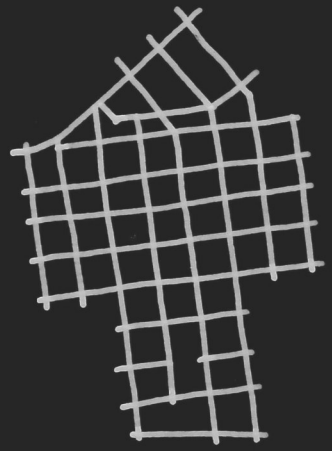
VIEWS OF LANDMARKS

A number of opportunities present the Jeppe Study Area with development potential. These opportunities can effectively be employed in the design proposal. However, it is the constraints that need to be dealt with in the design proposal in order the improve the Study Area environment. Three constraints in particular need to be addressed: the poor north-south linkages between the Ellis Park Stadium and the Benrose Industrial Area, low urban densities east of the railway line, and relatively low land use intensity east of the railway line. Addressing these constraints through the design interventions presented in the design proposal are all aimed at improving commuter patronage of the Jeppe Station.



OPPORTUNITIES+CONSTRAINTS

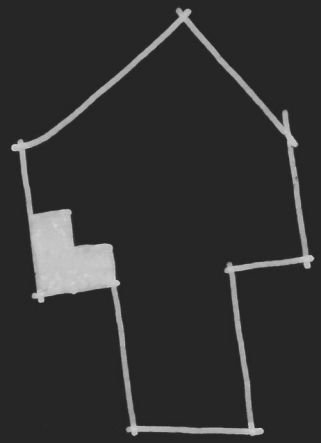
concept



1886 • stage 1

establishment

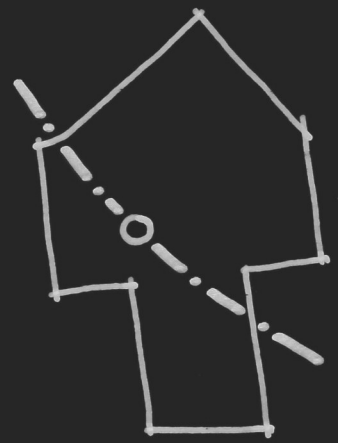
Jeppe Township is established as a grid residential suburb in the late 19th century



1906 • stage 2

concentration

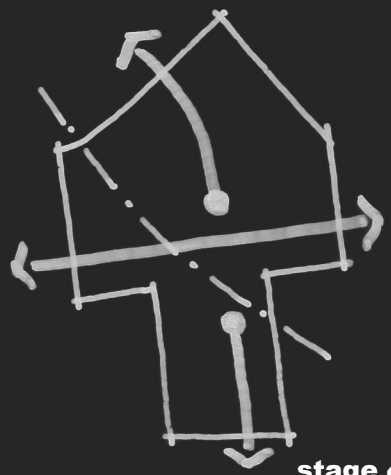
development of retail on Main Street, supported by electric tramway on Main Street



1936 • stage 3

separation

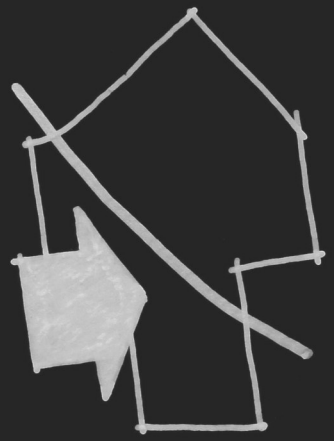
construction of the sunken railway line separates western and eastern parts of precinct



stage 4

disconnection

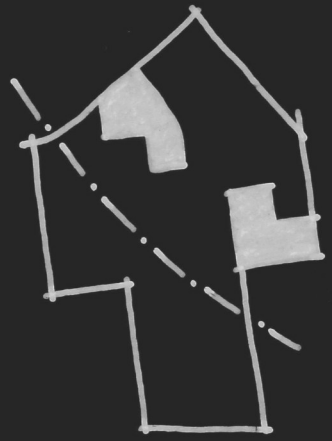
east-west routes are reconnected, but north-south routes remain disconnected



stage 5

densification

densification up to railway line through the western expansion of Joburg Inner City



stage 6

deterioration

recent deterioration of westerns part of Jeppe Precinct and associated demolition

HISTORICAL EVOLUTION

Analysis of the historic evolution of the Jeppe Precinct revealed that the precinct started out as a grid layout, but that this grid layout was disrupted by the construction of the commuter railway line traversing the precinct. Despite efforts to minimize the impact of the railway line by sinking the railway line below street level in the 1930's, the impact of the railway line on separating the grid street layout remained. Whereas east-west connection were re-established by constructing bridge crossing across the sunken railway line; north-south connections remained severed. By implication, this hampered access to the Jeppe Station; thus reducing the potential number of commuters that would be within walking distance of the station. In a sense what happed was ironic. Whereas the railway line impacted on the grid street layout, separating the northern and southern parts of the grid, the railway station was impacted by a reduction in the potential number of commuters that could have accessed the station if the grid street layout remained in tact.

Apart from serving the north-south connections and thereby impacting on potential commuter numbers, the construction of the commuter railway line appeared to have other impacts on the Jeppe Precinct as well. The railway line appears to have halted the westward expansion of the Johannesburg Inner City across the railway line, which could possibly have prevented the severe deterioration of the part of the precinct located east of the railway line. Thus, correcting the spatial deterioration experienced within the Jeppe Precinct requires the reconnection of the northern and southern parts of the street grid network across the commuter railway line and enabling the redevelopment of the eastern part of the precinct to better support and serve Jeppe Station, using Transit Orientated Development (TOD) principles. The following TOD principles apply:

+Connect

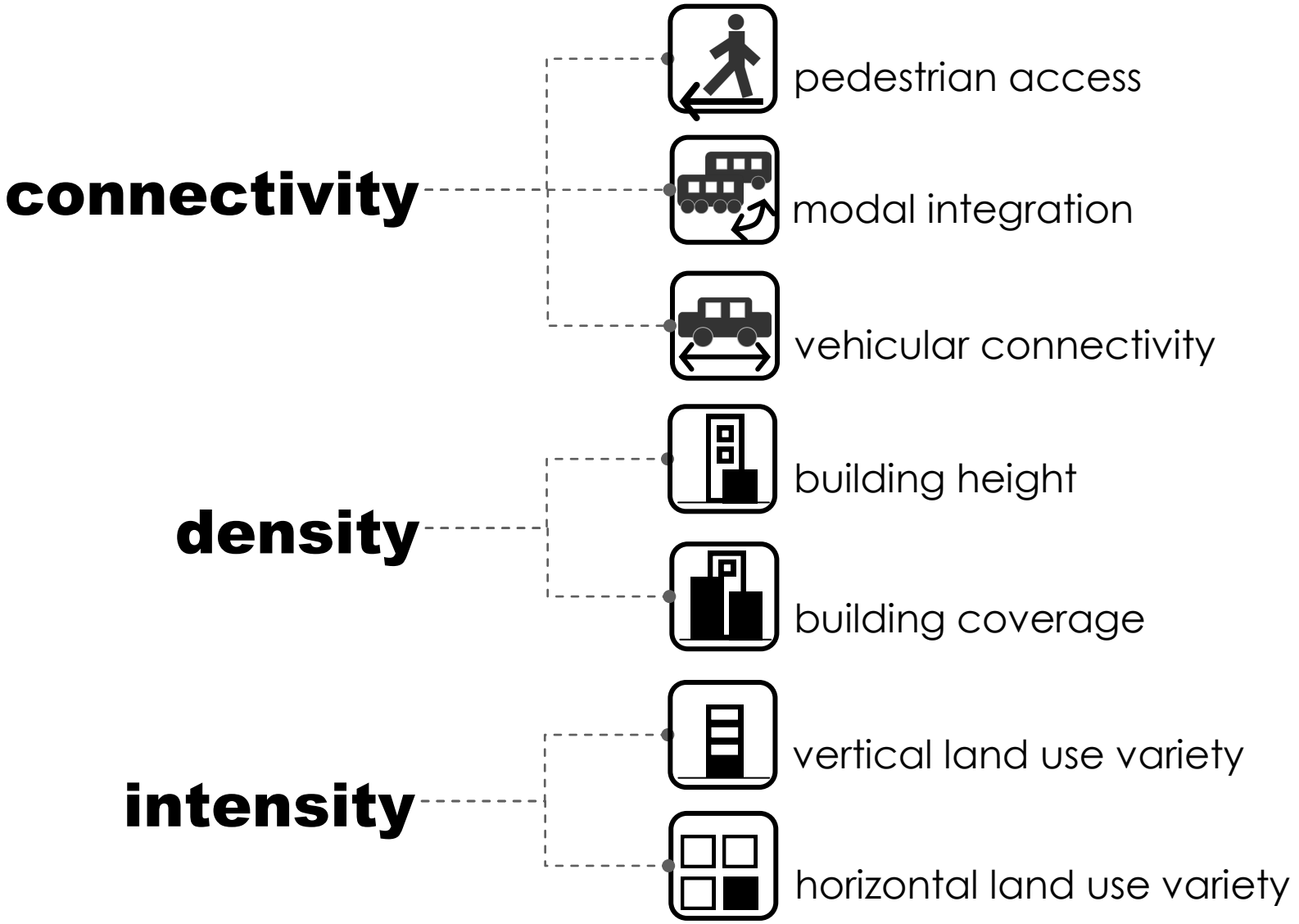
Re-establish the original grid layout pattern to re-connect the northern and southern parts of Jeppe Precinct. This will improve north-south connection and, in turn, it will improve access to Jeppe Station. Improved access to Jeppe Station should shorten walking distances to the station and, according the literature, this should increase commuter access to and use of Jeppe Station.

+Densify

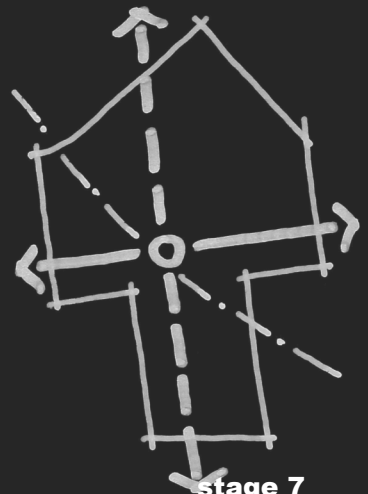
As established in the Analysis, the eastern part of Jeppe Precinct has not been densified to the extent that the western part of the precinct has, largely because the commuter railway line restricted the eastward expansion of the Johannesburg Inner City across the railway line. As a result, the eastern part of the precinct does not support the Jeppe Station with the necessary commuter densities. To correct this, the eastern part of the precinct needs to be densified by developing higher-density housing east of the railway line.

+Intensify

Currently, the western part of the Jeppe Precinct has a more intense and diversified land use structure than the eastern part of the precinct. According to literature, a more intense land use structure better supports public transport because it provide a 'one-stop-shop' that commuters can access. To improve support of the Jeppe Station, the eastern part of the precinct needs to be intensified by encouraging a greater variety of land uses to be established within this part of the precinct.



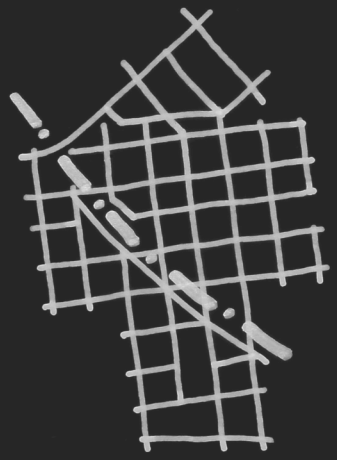
The Oxford Online Dictionary defines connectivity as to 'bring together or into contact so that a real or notional link is established' or as 'the state of being connected or interconnected'. In spatial terms, this can be understood as linking various modes of transport and linking these modes of transport to land uses.
The Oxford Online Dictionary defines density as 'the degree of compactness of a substance' or 'the quantity of people or things in a given area or space'. In spatial terms, this can be understood as increasing buildings coverage and building height.
The Oxford Online Dictionary defines intensity as 'of extreme force, degree, or strength' or as 'highly concentrated'. In spatial terms, this can be understood as increasing the variety and mix of land uses within a given geographical area.



stage 7

identification

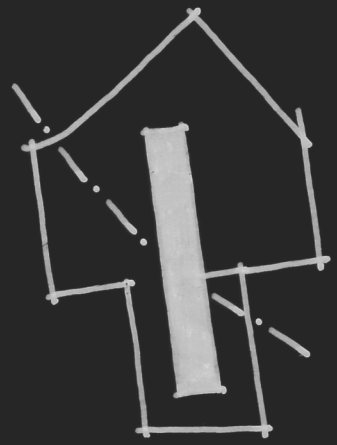
identifying the cross-shaped pattern of the original grid street pattern



stage 8

restoration

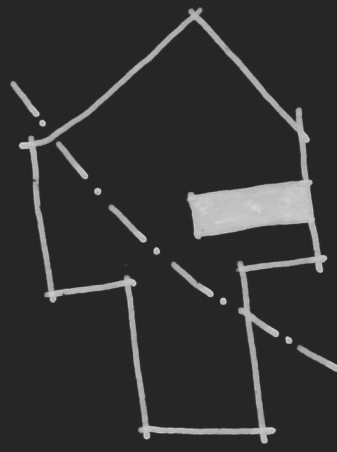
re-establishment of the original grid across the railway line to reconnect north and south



stage 9

re-enforcing

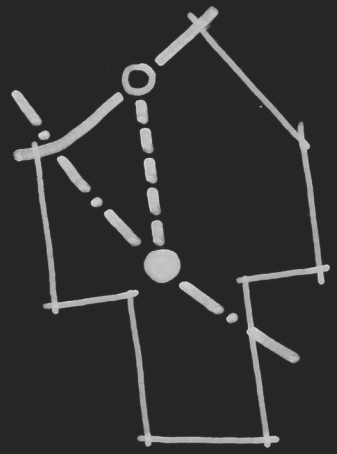
re-enforcing the north-south connection through land use intervention



stage 10

densification

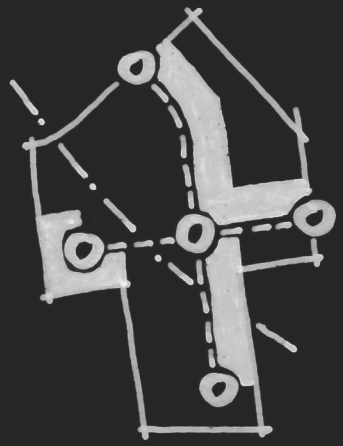
densifiying to boost commuter number within walking distance of the station



stage 11

connection

connecting Bus Rapid Transit (BRT) to Jeppe Station to enable modal interchange

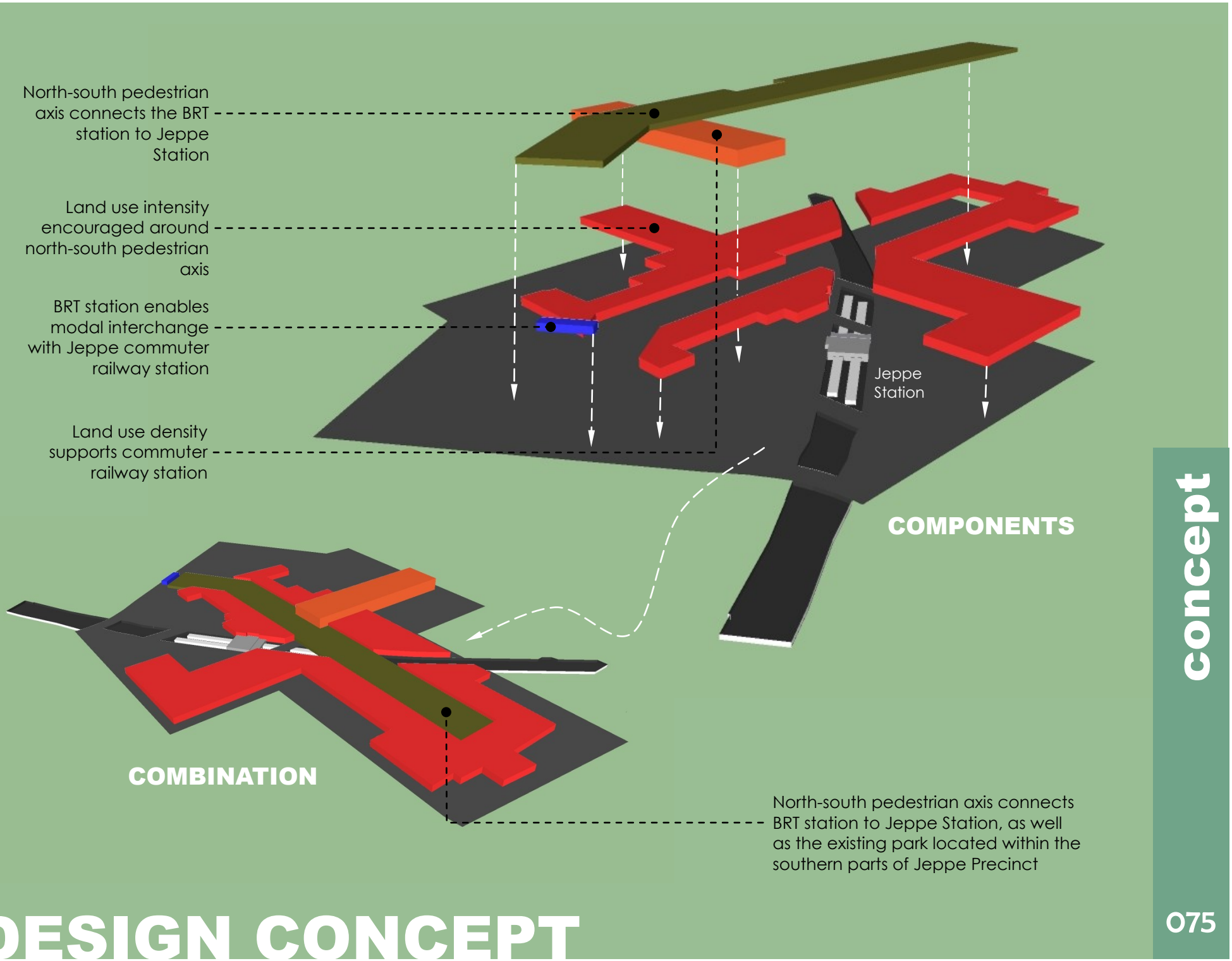


stage 12

intensification

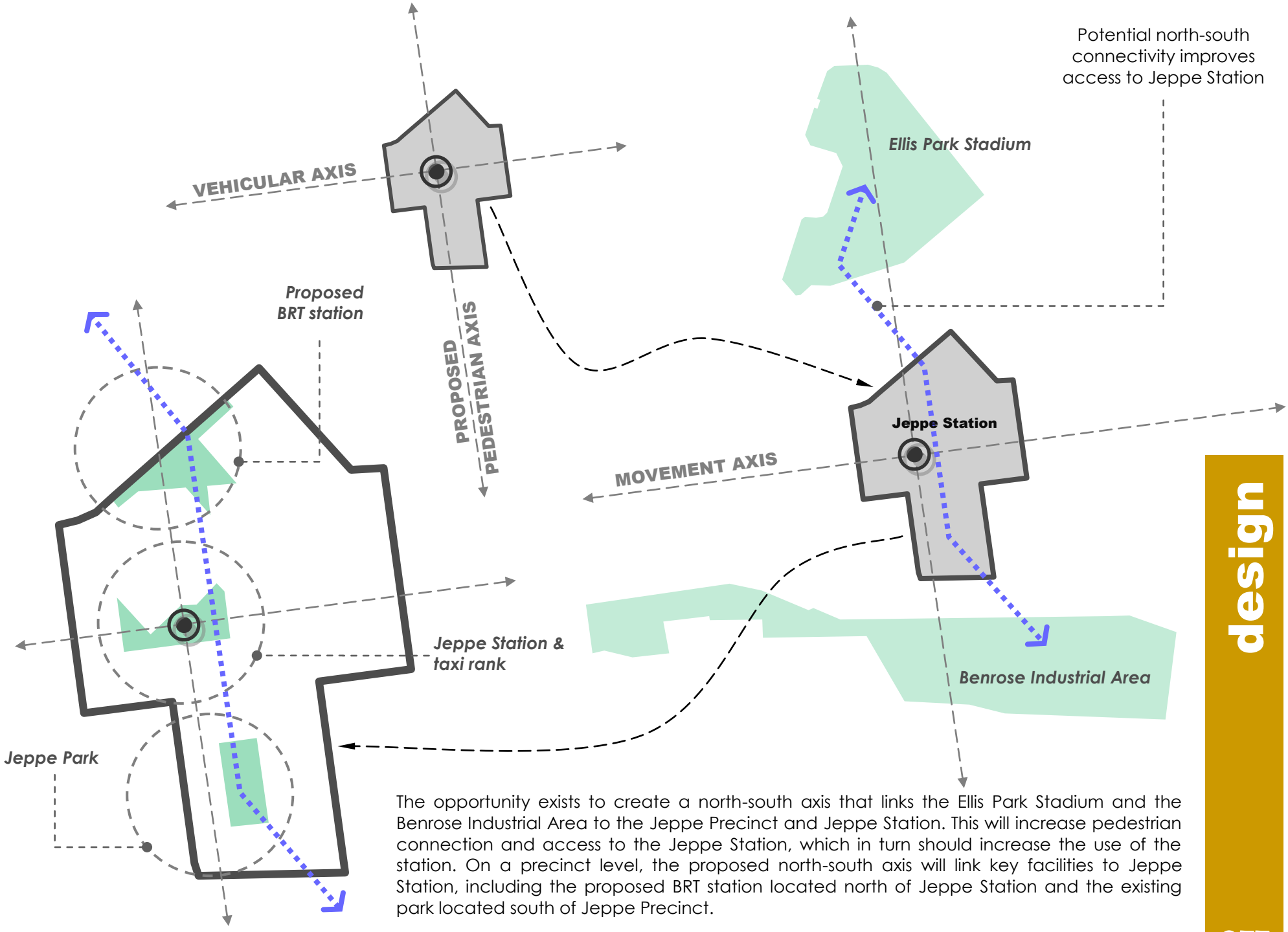
intensifying to increase land use variety and support the railway station

FUTURE EVOLUTION



DESIGN CONCEPT

design



The opportunity exists to create a north-south axis that links the Ellis Park Stadium and the Benrose Industrial Area to the Jeppe Precinct and Jeppe Station. This will increase pedestrian connection and access to the Jeppe Station, which in turn should increase the use of the station. On a precinct level, the proposed north-south axis will link key facilities to Jeppe Station, including the proposed BRT station located north of Jeppe Station and the existing park located south of Jeppe Precinct.

NORTH-SOUTH CONNECTIVITY



High Impact

Low Impact



Demolish
Retain
Not Applicable

As determined in the Analysis, the Jeppe Precinct comprises a wide range of building qualities, ranging from buildings in good condition to buildings that have deteriorated to the point that they are eligible for demolition. The accompanying maps show a low impact demolition scenario, whereby only soft buildings are demolished, as opposed to a scenario where both soft and a selected number of hard building are demolished to make way for the proposed pedestrian link between the proposed BRT station and Jeppe Station. Although the high impact scenario would provide a more axial pedestrian link, the low impact option was chosen because the high impact proposal was considered to be to destructive; demolishing valuable parts of the urban fabric.



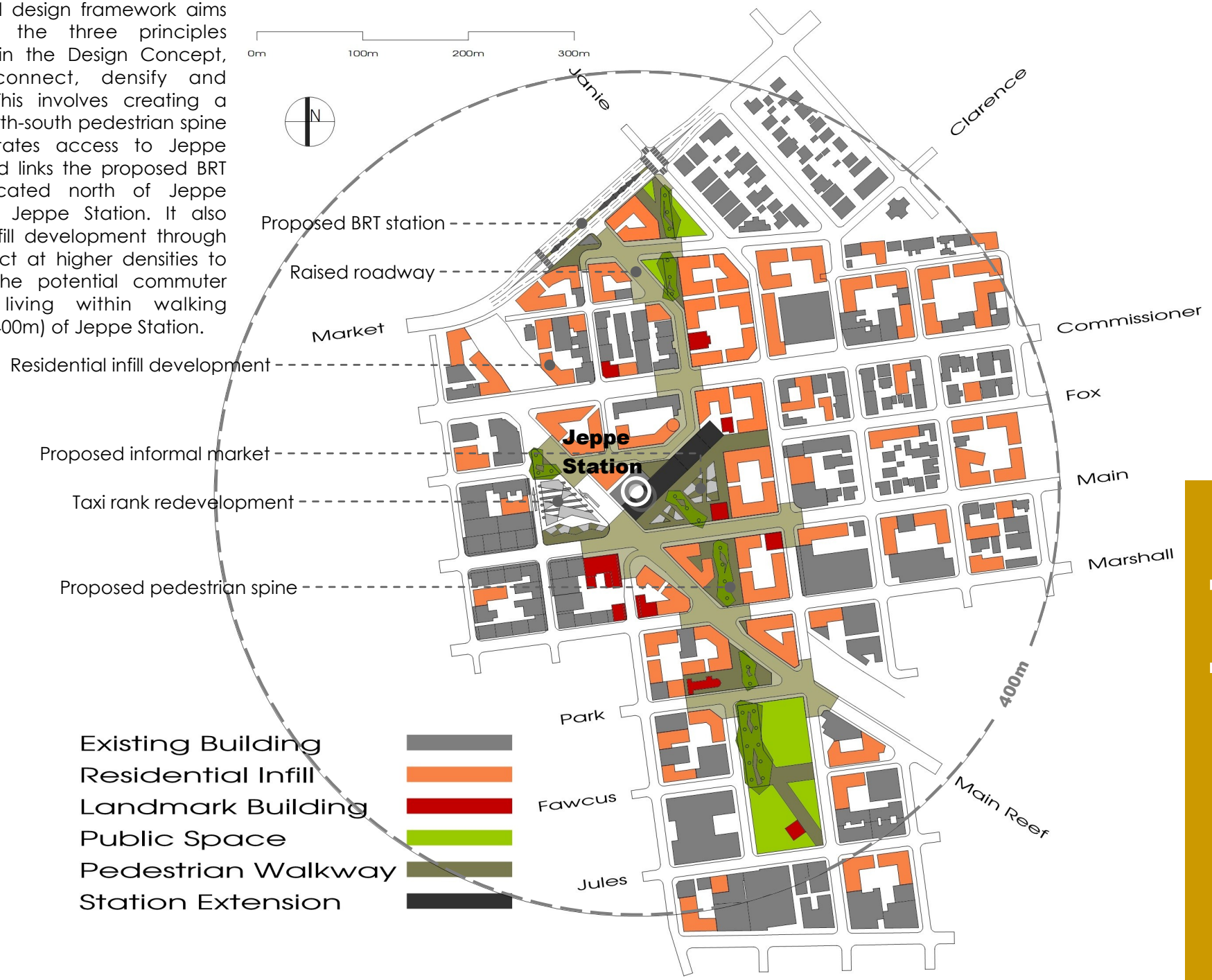


It is envisaged that most of the Jeppe Precinct will be redeveloped through private sector initiatives, whereby the private sector buys up properties and redevelops these properties as infill developments. However, it is proposed that the north-south spine be expropriated by (municipal or provincial) government for redevelopment. This will allow government to determine to outcome of this critical redevelopment section. Reconsolidated land parcels along this spine can be sold off to the private sector for development; subject to the guidelines and requirements of government. Also, air rights would need to be obtained for certain sections of the railway reserve in order to deck and develop the sections of the railway reserve.

Properties with soft buildings, as identified in the Analysis, have mostly been selected for redevelopment. As depicted on the accompanying map, there are a selected number of hard buildings that have also been selected, all of which are located along the north-south spine. These building were selected to establish the proposed north-south spine as envisaged.

EXPROPRIATION+DEMOLITION

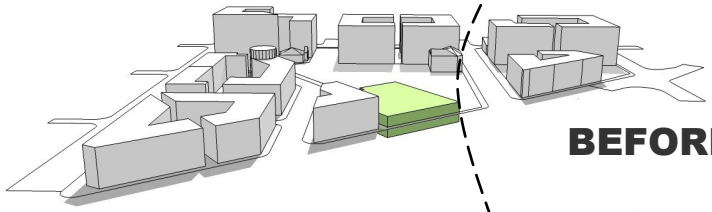
The overall design framework aims to apply the three principles identified in the Design Concept, namely connect, densify and intensify. This involves creating a central north-south pedestrian spine that facilitates access to Jeppe Station and links the proposed BRT station located north of Jeppe Station to Jeppe Station. It also involves infill development through the precinct at higher densities to increase the potential commuter numbers living within walking distance (400m) of Jeppe Station.



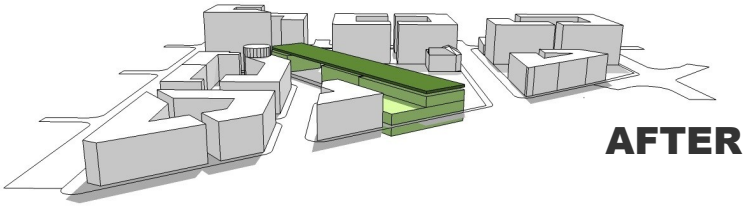
OVERALL DESIGN FRAMEWORK



Images source: Modern Architecture: Japanese School Made of Glass. (2007). Retrieved August 8, 2012 from http://www.mymodernmet.com/profiles/blogs/modern-architecture-japanese-1.

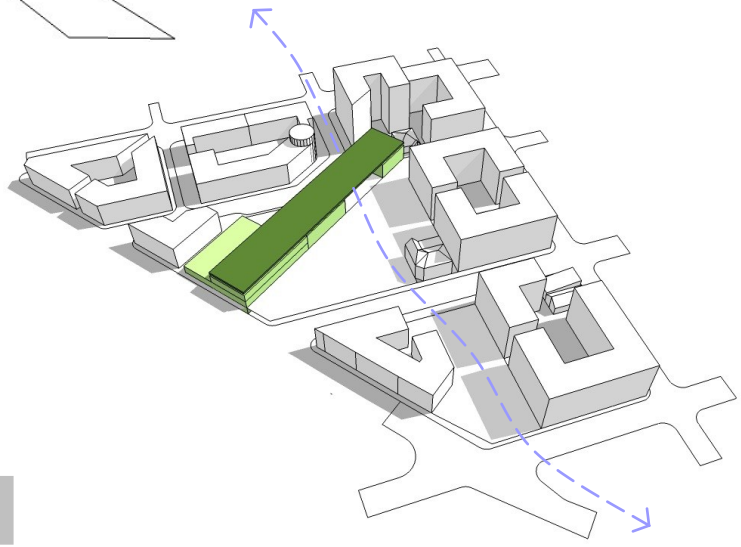


BEFORE



AFTER

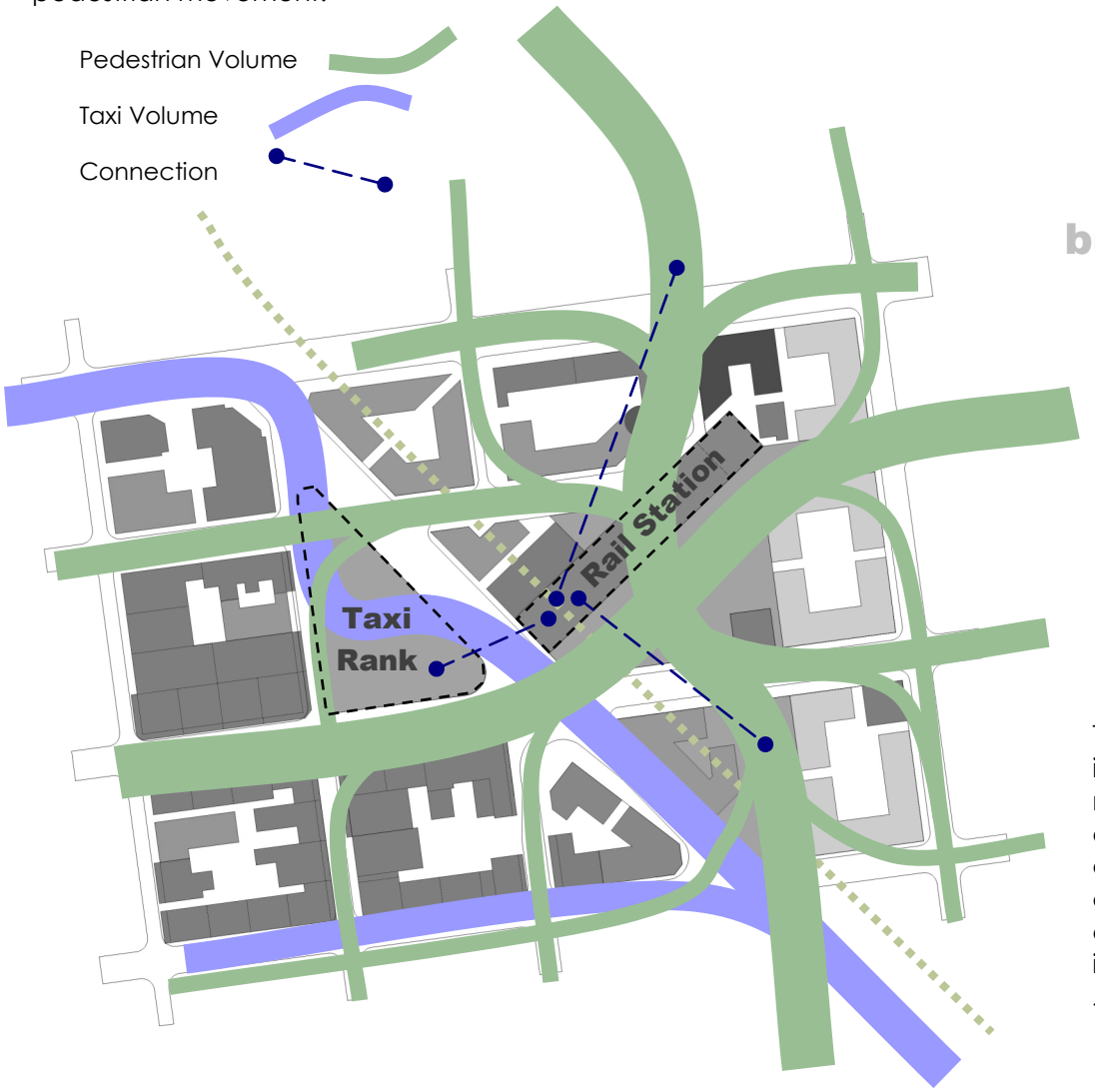


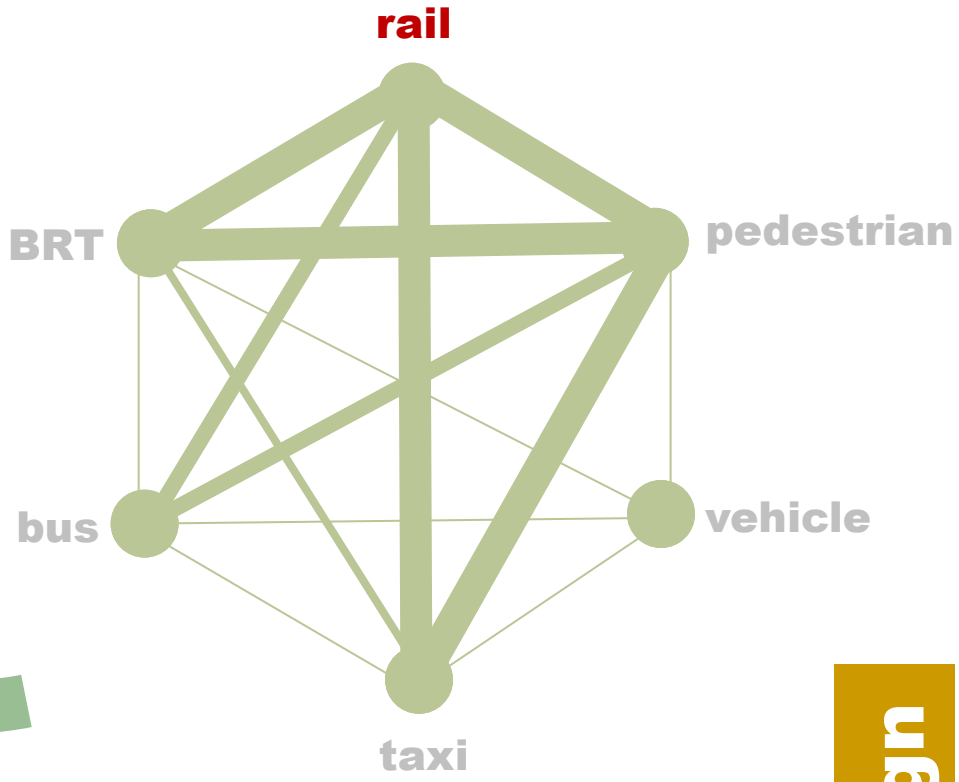


As mentioned in the Analysis, the station building is largely concealed behind walls and barriers and it is therefore not very visible. This is despite it being a key transit facility within the Study Area. Opening up the existing square in front of the station by incorporating the square into the proposed north-south pedestrian spine should increase its visibility. The visibility of the station can be further enhanced by extending the station across the proposed pedestrian spine. North-south pedestrian flows can be maintained by making the station building permeable. In addition, the station extension could be made of glass, allowing it to be transparent; revealing the urban fabric behind it.

STATION EXTENSION

The diagram below shows the anticipated pedestrian flow around Jeppe Station and the taxi rank. Strong pedestrian flows are expected in a north-south direction, which is generated by the introduction of the proposed north-south pedestrian spine. High volumes of east-west pedestrian traffic is also expected, between the taxi rank and Jeppe Station, as is currently the case. Apart from this, it is expected that the reconnected grid street network across the railway line will improve pedestrian permeability, which would provide alterative routes to access Jeppe Station. The position of the proposed Jeppe Station building extension is also expected to influence pedestrian movement.

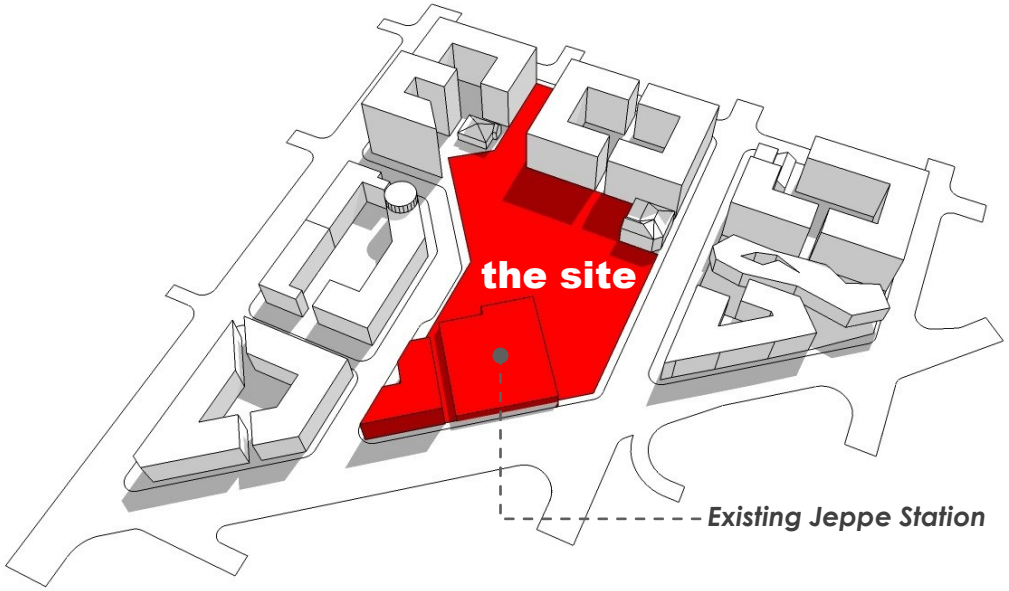




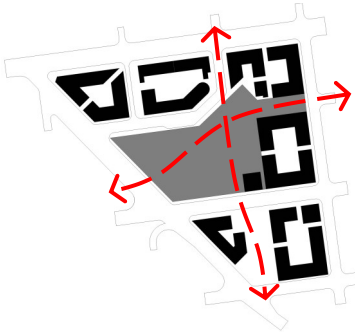
anticipated modal interchange

The diagram above illustrates the anticipated model interchange between Jeppe Station and the other modes of transport serving the Study Area. As illustrated, a strong interchange is expected between rail, BRT, taxi, and pedestrians. The strong interchange between rail and taxi is existing, but a strong interchange between rail and BRT is expected, facilitated by the proposed introduction of the BRT station located directly north of Jeppe Station.

STATION+MODAL INTEGRATION

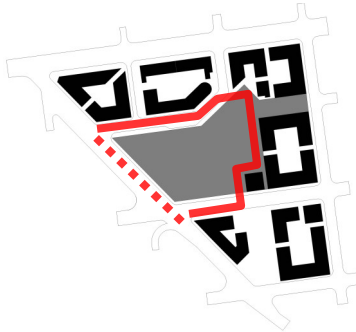


It is acknowledged that the design of the Jeppe Station extension is not an urban design function, but requires an architectural solution. In other words, the design of the station extension needs to be solved by an architect. Consequently, the ultimate design solution for this facility may differ substantially from the one proposed in this study. To ensure that this ultimate design solution adheres to the basic intentions of the overall urban design framework proposed; design principles have been proposed to guide the design of the station extension. These principles include maintaining connectivity, reinforcing proposed edges and the incorporation of informal trading. Importantly, the urban design framework envisages the station extension to be iconic in nature; drawing attention to the facility's location and function as a primary public transportation facility.



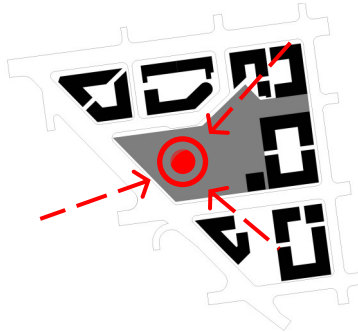
Maintain connectivity

The design of the station must not impede pedestrian movement. In particular, movement between Jeppe Station and the proposed BRT must be maintained.



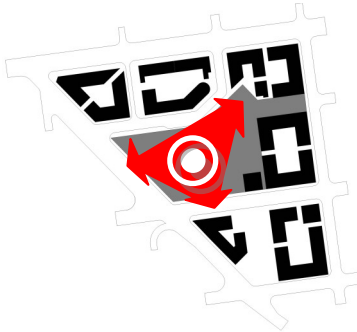
Establish edges and enclosure

The existing Jeppe Station is located on the western edge of an enclosure. The redesign of the station must maintain this edge function.



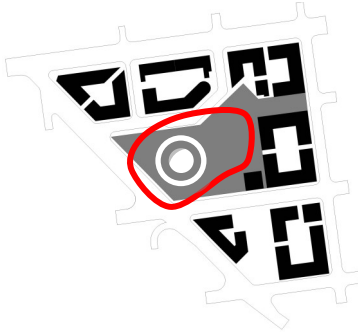
Create a more iconic structure

The Jeppe station redesign should be iconic to draw commuters and increase station usage. Visual exposure and sightlines of the structure are thus necessary.



Increase station capacity

The proposed BRT station and to redeveloped taxi rank will require Jeppe station to function as a modal interchange, require greater station capacity



Incorporate informal trading

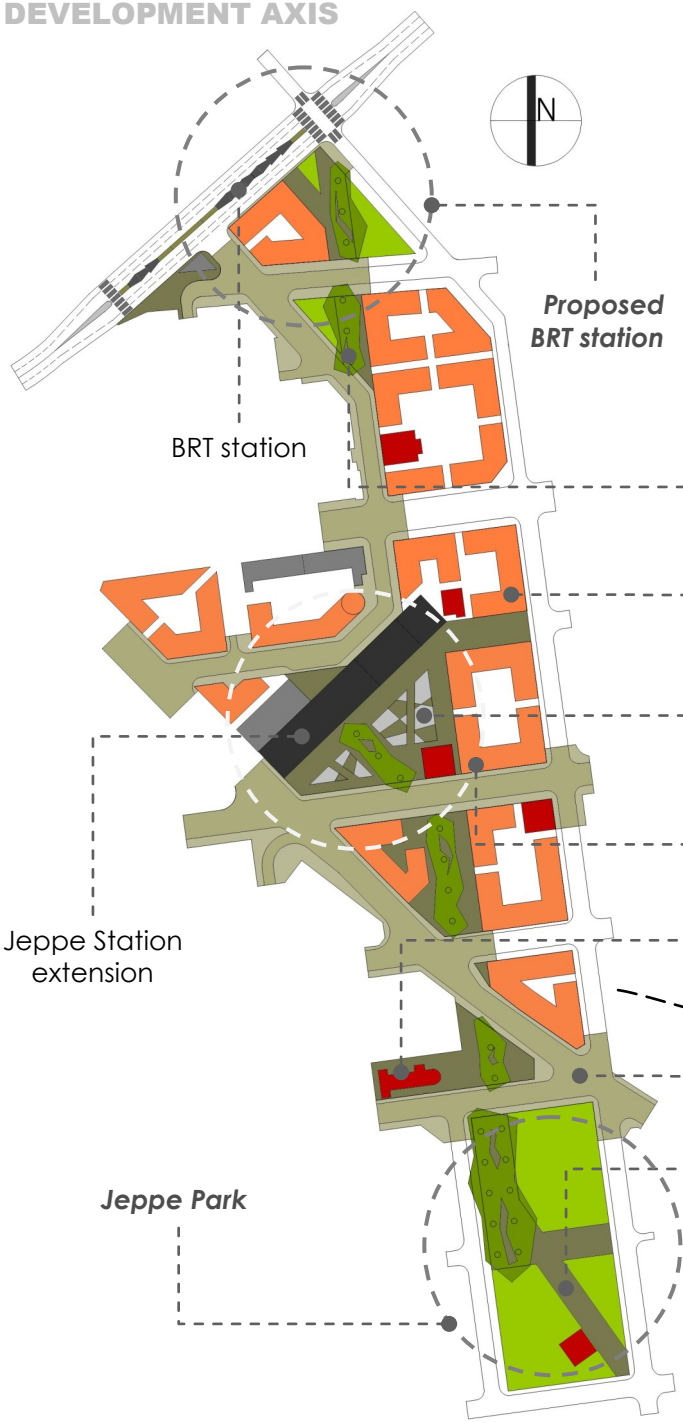
Informal trading is linked to movement and therefore pedestrian generators, such a transit stations. The design of the Jeppe Station must therefore incorporate the existing informal market.

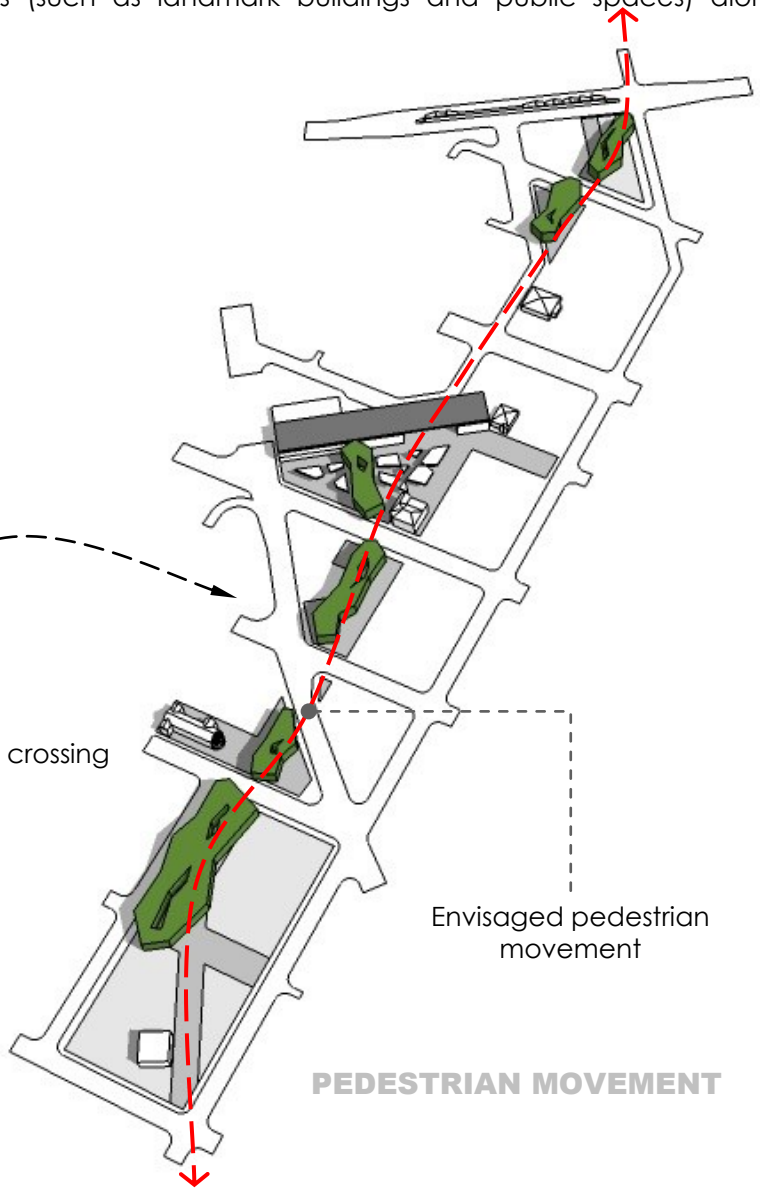
STATION DESIGN PRINCIPLES

NORTH-SOUTH AXIS

A key element of the Design Concept is creating a north-south axis through the centre of the Study Area. This access will connect Jeppe Park and the proposed BRT Station on Market Street to the Jeppe Station. In doing this, regional north-south connectively to Jeppe Station will be improved. It is envisaged that this development axis contains all three TOD principles: connectivity, higher-density development and greater land use intensity. An important aspect of the north-south axis is pedestrian connectivity and in particular connectivity between the proposed BRT station and Jeppe Station. The placing of pedestrian walkways and facilities along this north-south axis will influence pedestrian connectivity. Therefore, attempts were made to follow the shortest routes to the abovementioned pedestrian destinations and to located pedestrian facilities (such as landmark buildings and public spaces) along these pedestrian routes.

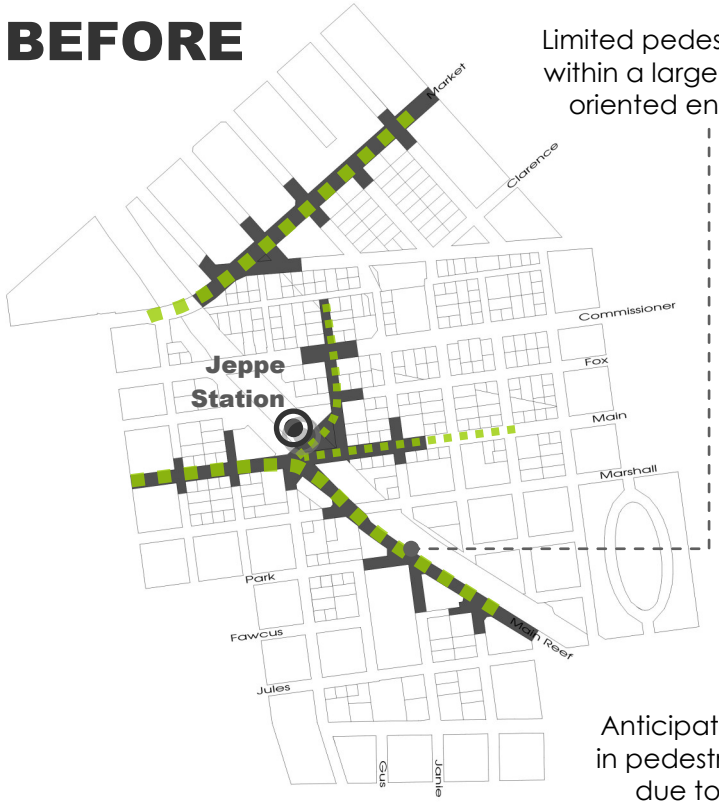
DEVELOPMENT AXIS





PEDESTRIAN MOVEMENT

BEFORE



Limited pedestrian space, within a largely a vehicle-oriented environment

AFTER

36%

Increase in pedestrian space after introduction of pedestrian spine



Anticipated increase in pedestrian volumes due to increase pedestrian space and movement

Pedestrian Area

High Pedestrian Volume

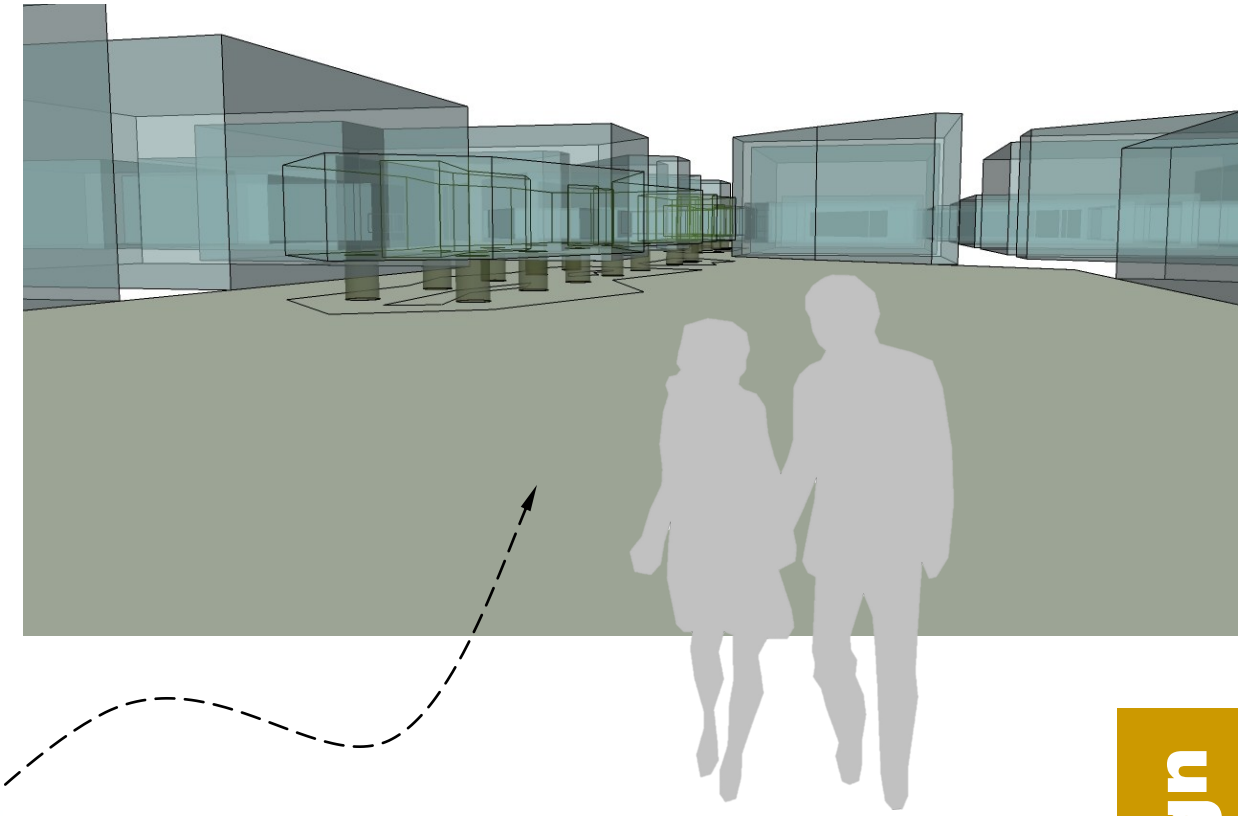
Medium Pedestrian Volume

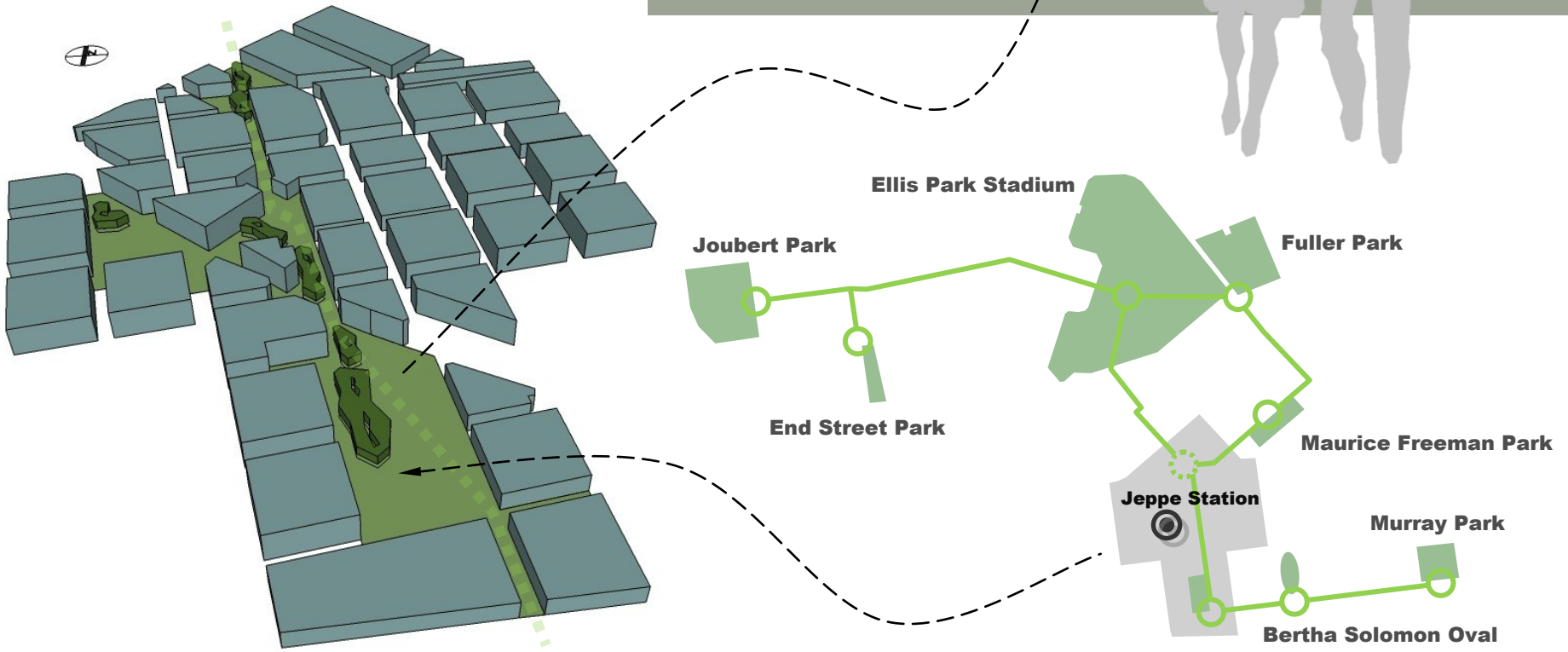
Low Pedestrian Volume

The primary objective of the Design Concept was to improve north-south connectively and, in so doing, make Jeppe Station more accessible. To this end, the north-south pedestrian spine was proposed, which would connect the proposed BRT station on Market Street to the Jeppe Station. It will also connect the park, which is located south of Jeppe Station, to Jeppe Station. The result is a dramatic increase in pedestrian space and a potential increase in pedestrian volumes, which is related to the increase in pedestrian space. In addition, the larger north-south pedestrian spine should allow for a greater variety of pedestrian route options to access Jeppe Station.

PEDESTRIAN MOVEMENT

It is proposed that trees are planted along the north-south pedestrian spine that leads to Jeppe Station. This will not only provide rich edge conditions, but it will also reinforce movement towards Jeppe Station. The latter implies using trees to provide spatial legibility to help pedestrians find the station. Trees also provide shade within the walking environment, which the literature suggest encourages people to walk further to access transit stations. Also, planting trees along the north-south pedestrian spine will help define a regional open space lattice; using streets to connect the open spaces located within the region of the Study Area. This open space lattice is depicted by the diagram below, right.





MOVEMENT+LANDSCAPING

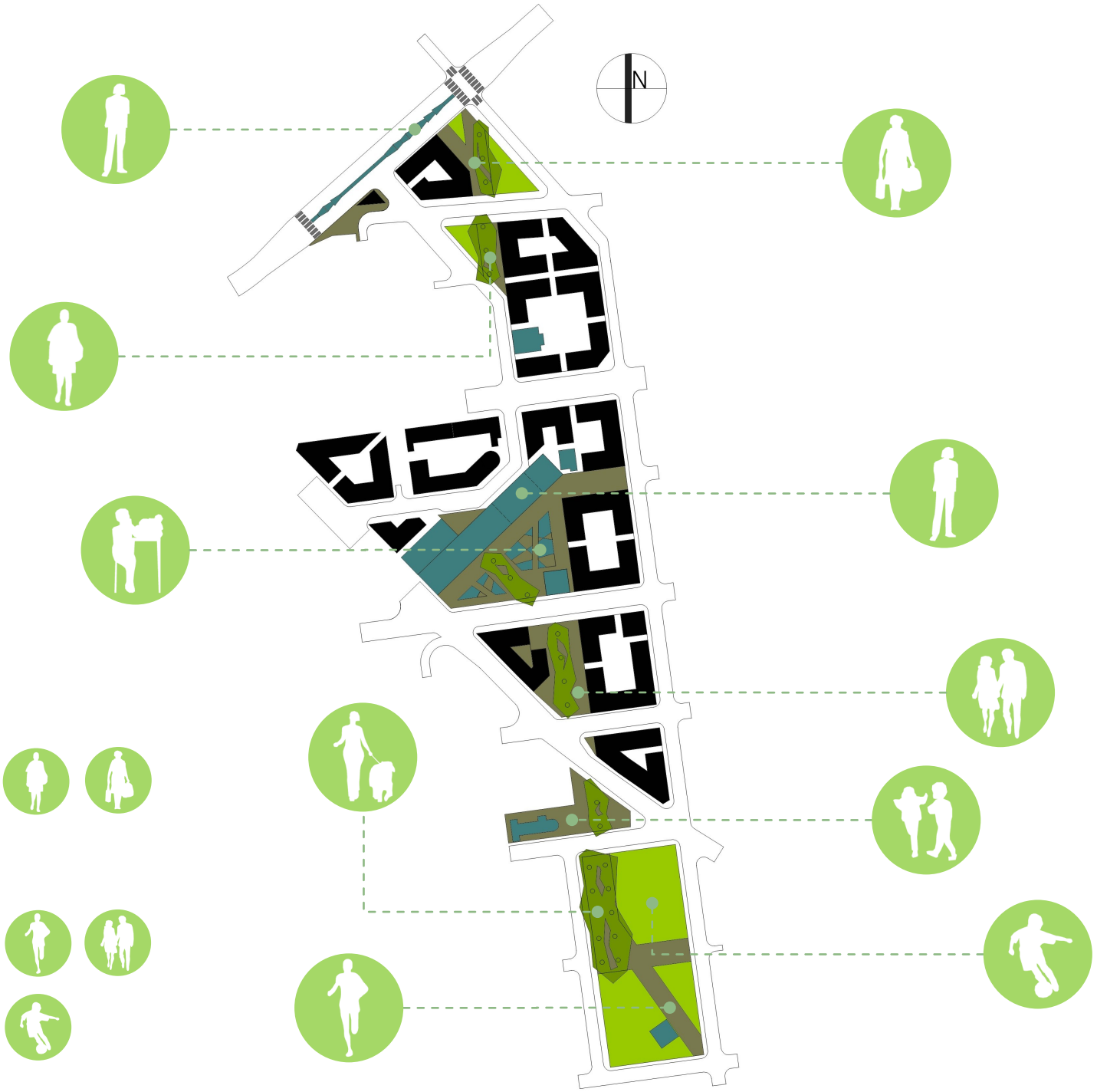


43%

increase in enclosed public space

PUBLIC SPACE ENCLOSURE

The proposed north-south pedestrian spine contains both built-up areas and public spaces. The latter is intended to provide access and connectively and to provide opportunities for income generation and recreation. To this end, both hard and soft spaces are provided, depending upon the location of the public space and its intended function. For example, the public space next to Jeppe station is a hardwearing space, suitable for high commuter volumes and informal trading. Jeppe Park, located on the southern end of the pedestrian spine, is a soft space, allowing for recreation activities.



Using transport

Making a living

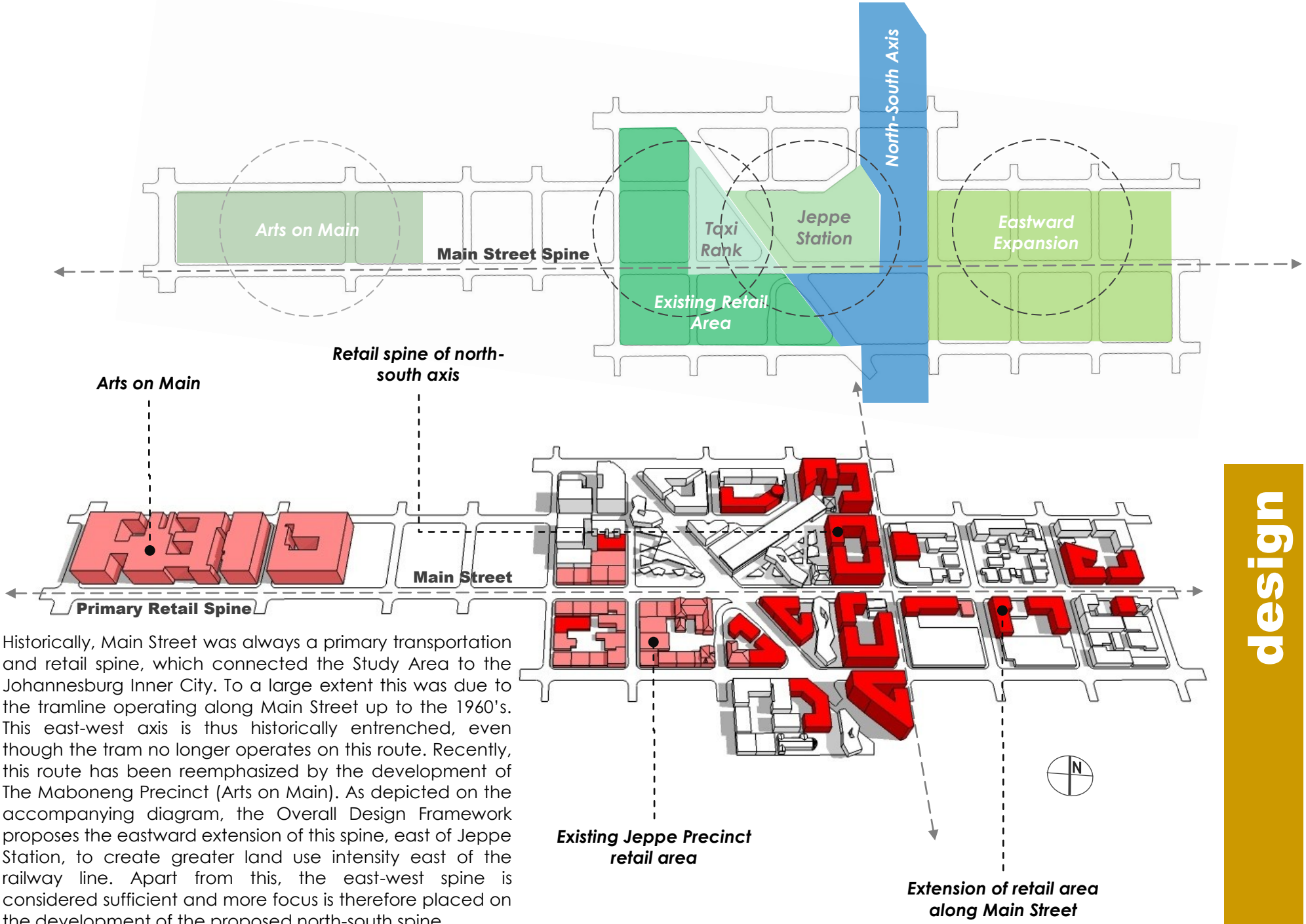
Taking a break

Having fun

PUBLIC SPACE USES+ACTIVITIES



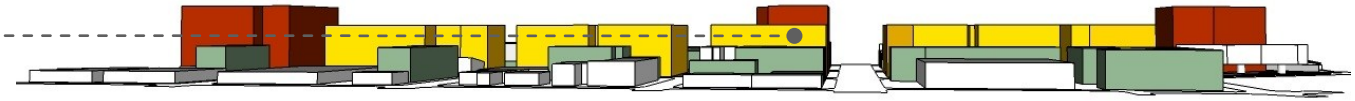
STATION PLAZA+MARKET



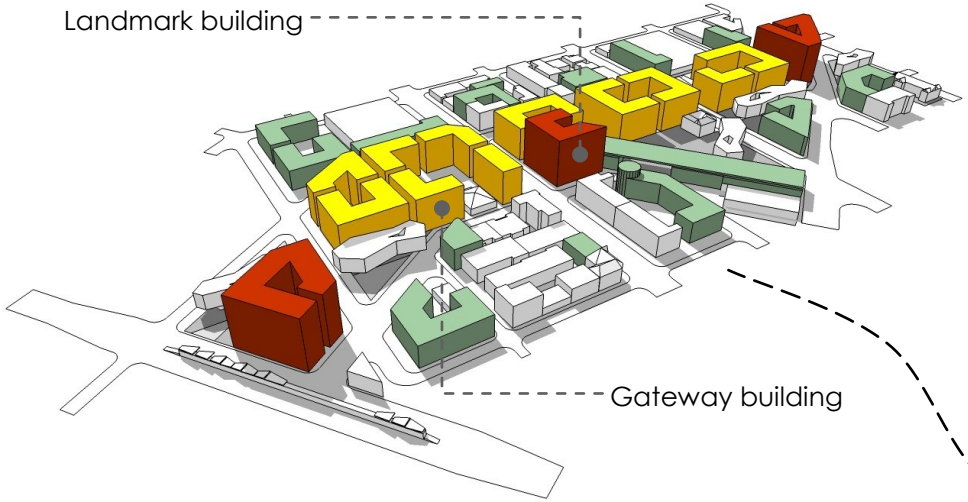
Historically, Main Street was always a primary transportation and retail spine, which connected the Study Area to the Johannesburg Inner City. To a large extent this was due to the tramline operating along Main Street up to the 1960's. This east-west axis is thus historically entrenched, even though the tram no longer operates on this route. Recently, this route has been reemphasized by the development of The Maboneng Precinct (Arts on Main). As depicted on the accompanying diagram, the Overall Design Framework proposes the eastward extension of this spine, east of Jeppe Station, to create greater land use intensity east of the railway line. Apart from this, the east-west spine is considered sufficient and more focus is therefore placed on the development of the proposed north-south spine.

EAST-WEST AXIS

Building height provides gateway to Johannesburg Inner City along Commissioner Street

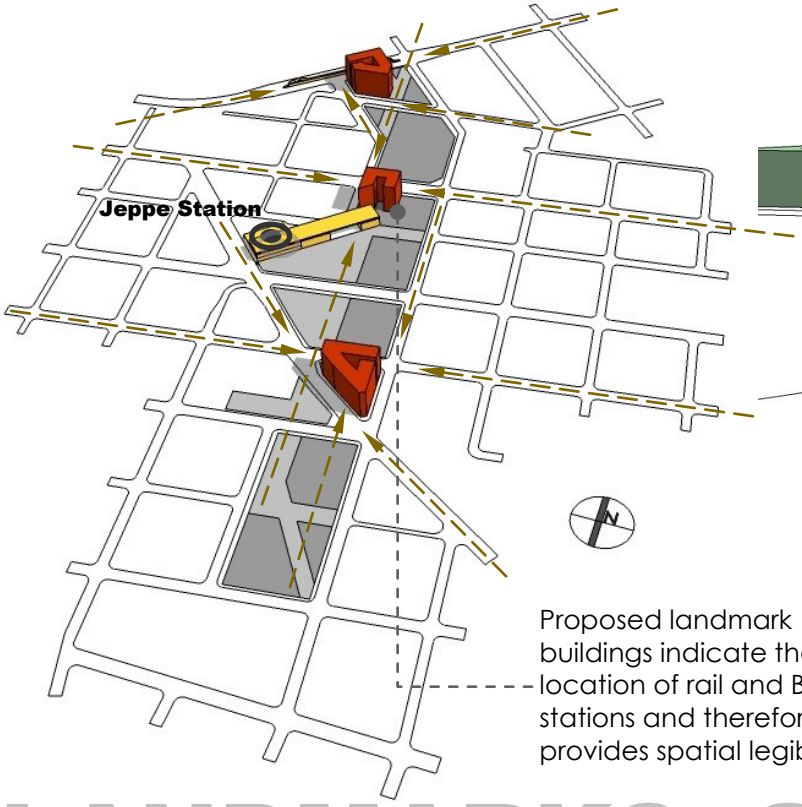


Landmark building

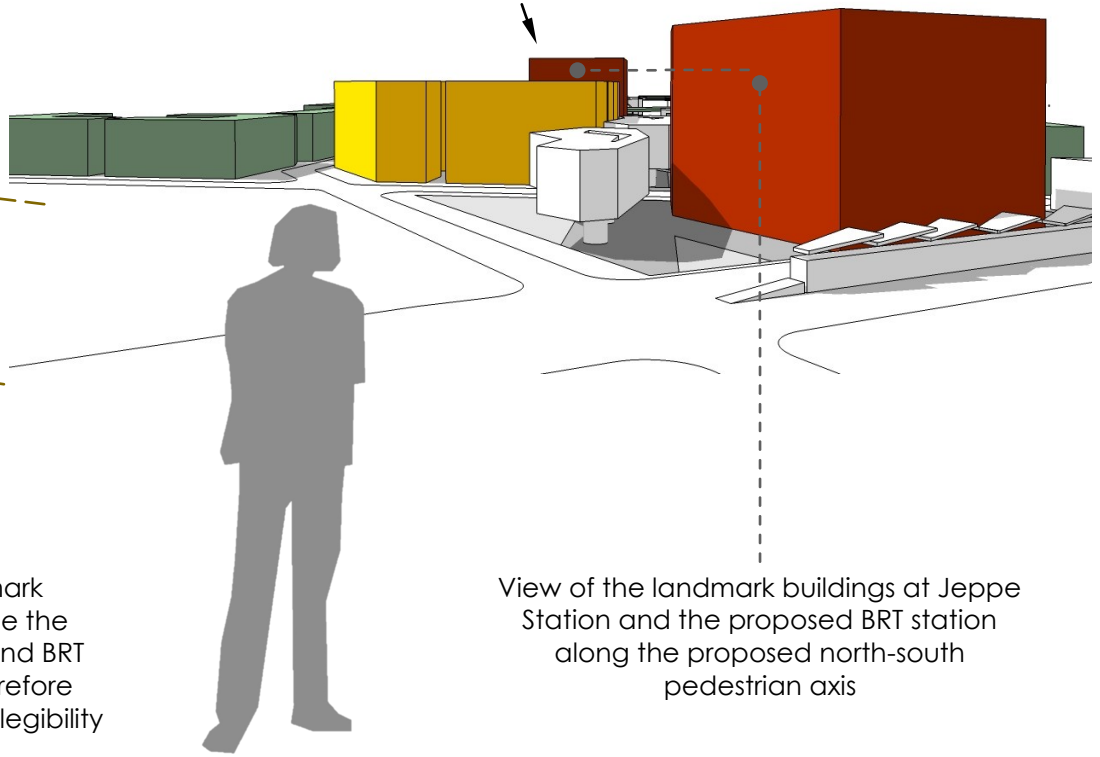


Gateway building

Building height can effectively be used to provide landmarks and gateways within the Jeppe Precinct. In turn, these can be used to improve spatial legibility within the precinct. For example, developing a tall building near Jeppe Station can provide pedestrian orientation regarding the location of the station. Also, taller buildings on Commissioner Street can cause Jeppe Precinct function as a gateway to the Johannesburg Inner City. As determined in the Analysis, the Jeppe Precinct is located on an east-west axis, which links the Johannesburg Inner City with the eastern parts of Johannesburg and Ekurhuleni. Having the Jeppe Precinct function as a gateway will place attention on the precinct, which in turn should facilitate activity within the precinct and around the Jeppe Station.



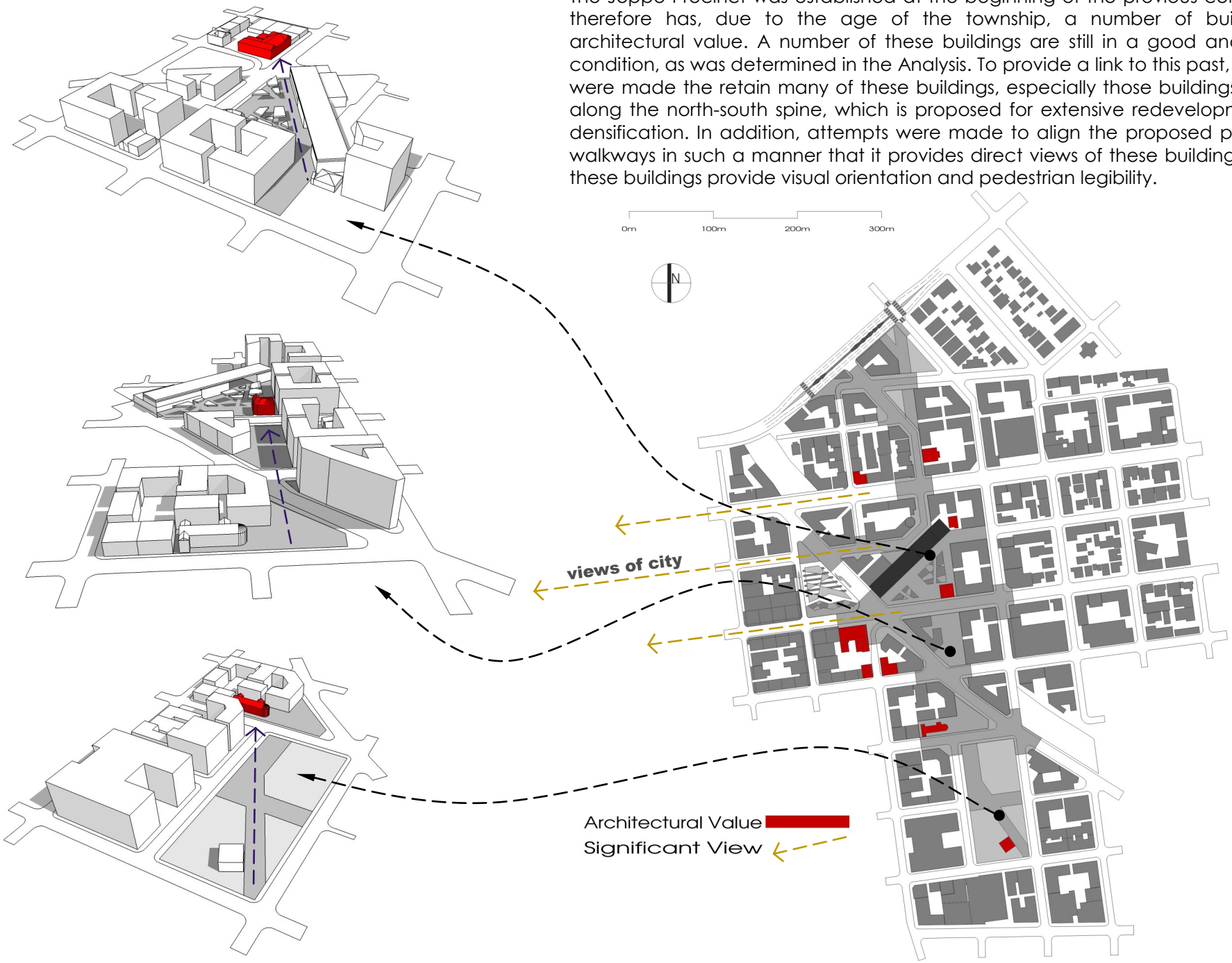
Proposed landmark buildings indicate the location of rail and BRT stations and therefore provides spatial legibility



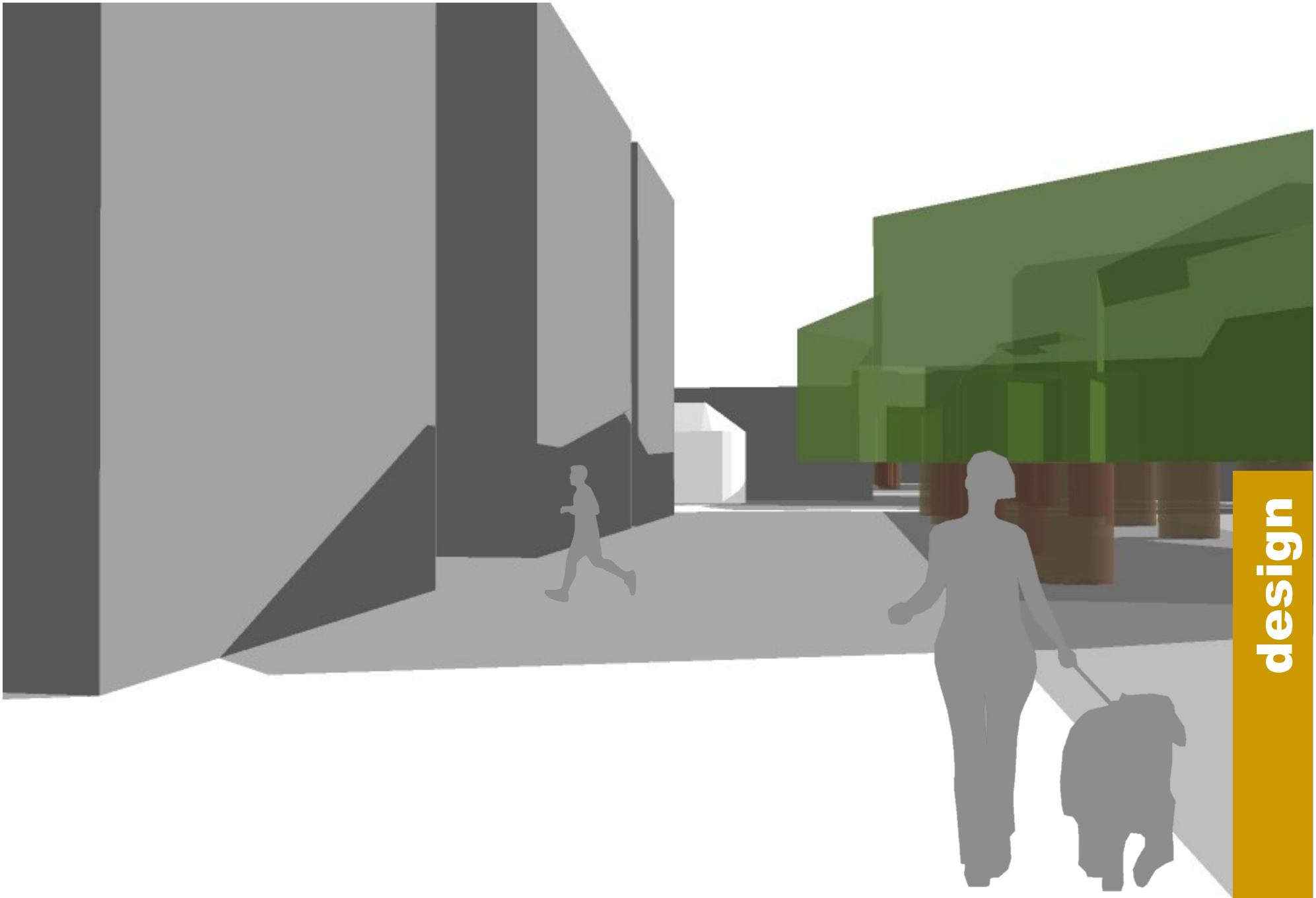
View of the landmark buildings at Jeppe Station and the proposed BRT station along the proposed north-south pedestrian axis

LANDMARKS+GATEWAYS

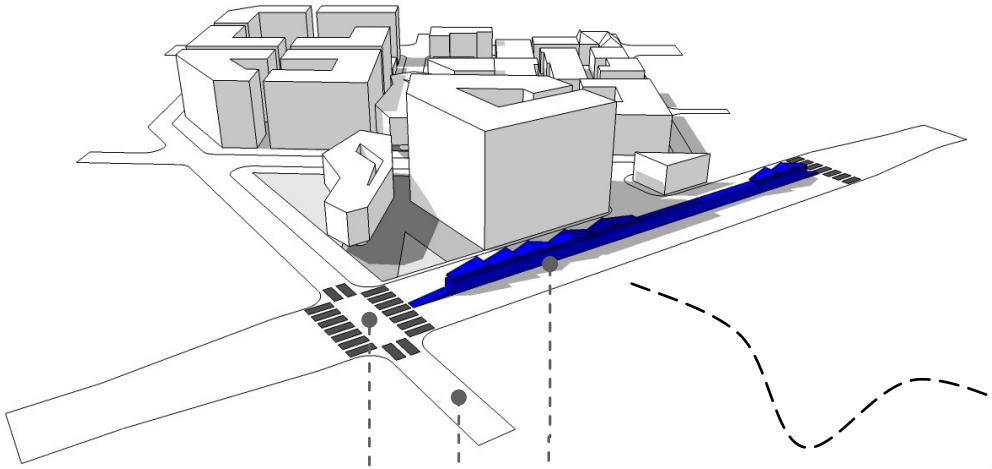
The Jeppe Precinct was established at the beginning of the previous century and therefore has, due to the age of the township, a number of buildings of architectural value. A number of these buildings are still in a good and original condition, as was determined in the Analysis. To provide a link to this past, attempts were made the retain many of these buildings, especially those buildings situated along the north-south spine, which is proposed for extensive redevelopment and densification. In addition, attempts were made to align the proposed pedestrian walkways in such a manner that it provides direct views of these buildings. In turn, these buildings provide visual orientation and pedestrian legibility.



VIEWS+VISUAL ACCESS



PUBLIC SPACE+VISUAL ACCESS



Main pedestrian crossing and access

Main BRT concourse

The BRT station position and orientation retains vehicular flow along Janie Street across Market Street. Janie Street was identified as a primary north-south connector (see map on right)

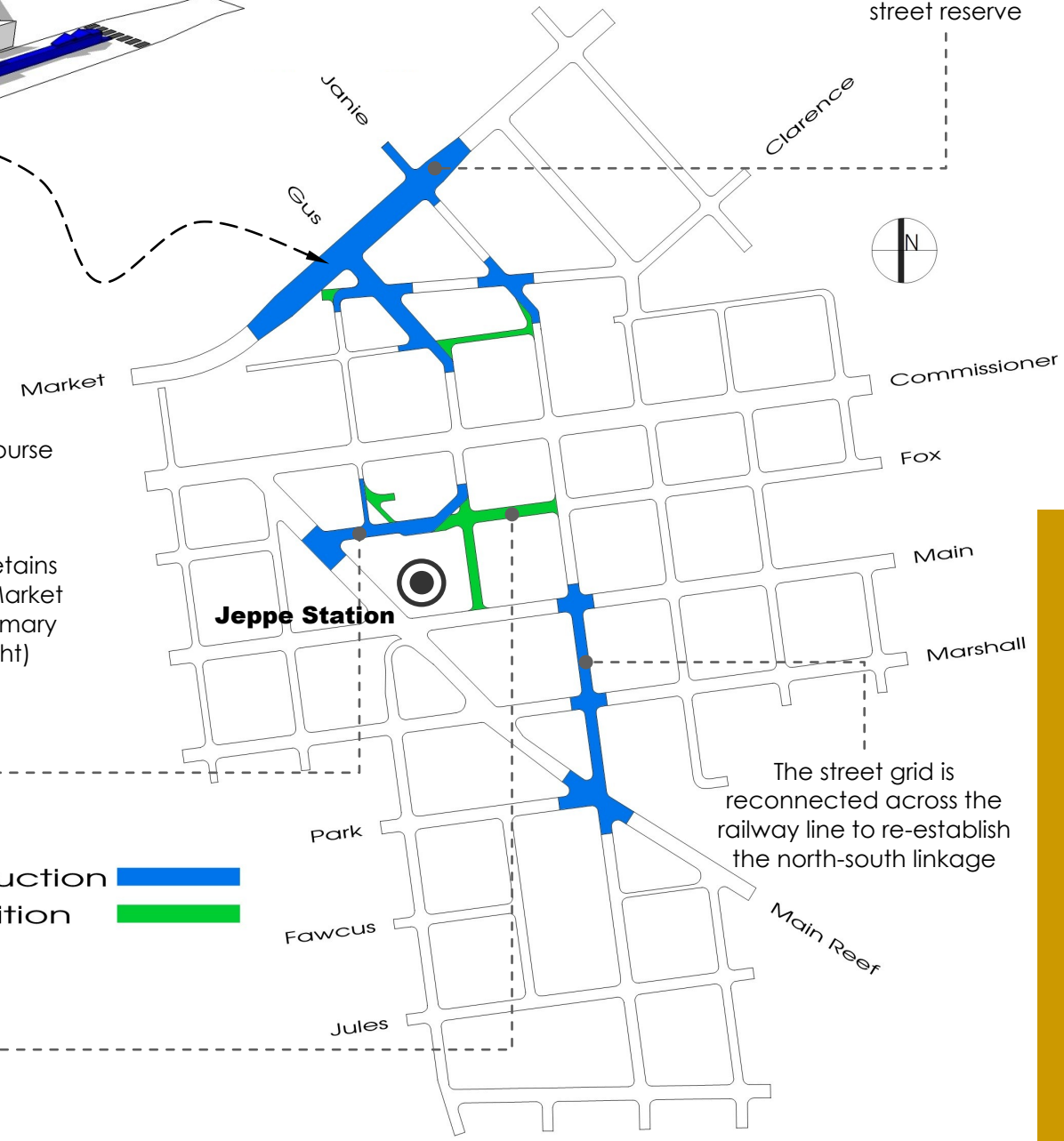
Fox Street is reconnected across the railway line to increase access to Jeppe Station from the existing taxi rank

Road Construction

Road Demolition

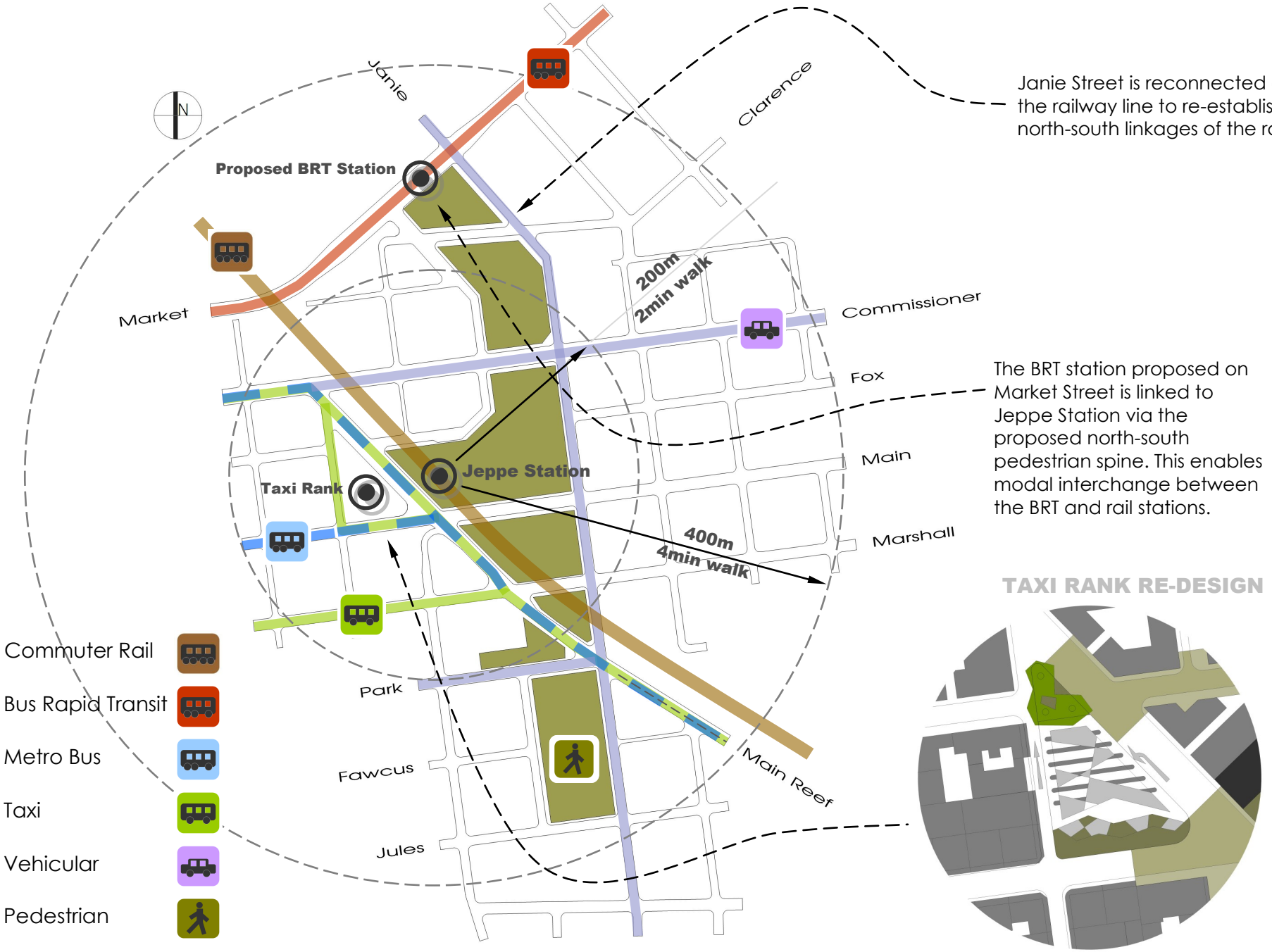
Roads next to Jeppe Station are demolished to increase pedestrian access to the station and to provide a larger public space in front of the station

Market Street is widened to fit in the BRT station. This is done without widening the street reserve



The street grid is reconnected across the railway line to re-establish the north-south linkage

ROAD GRID+BRT STATION

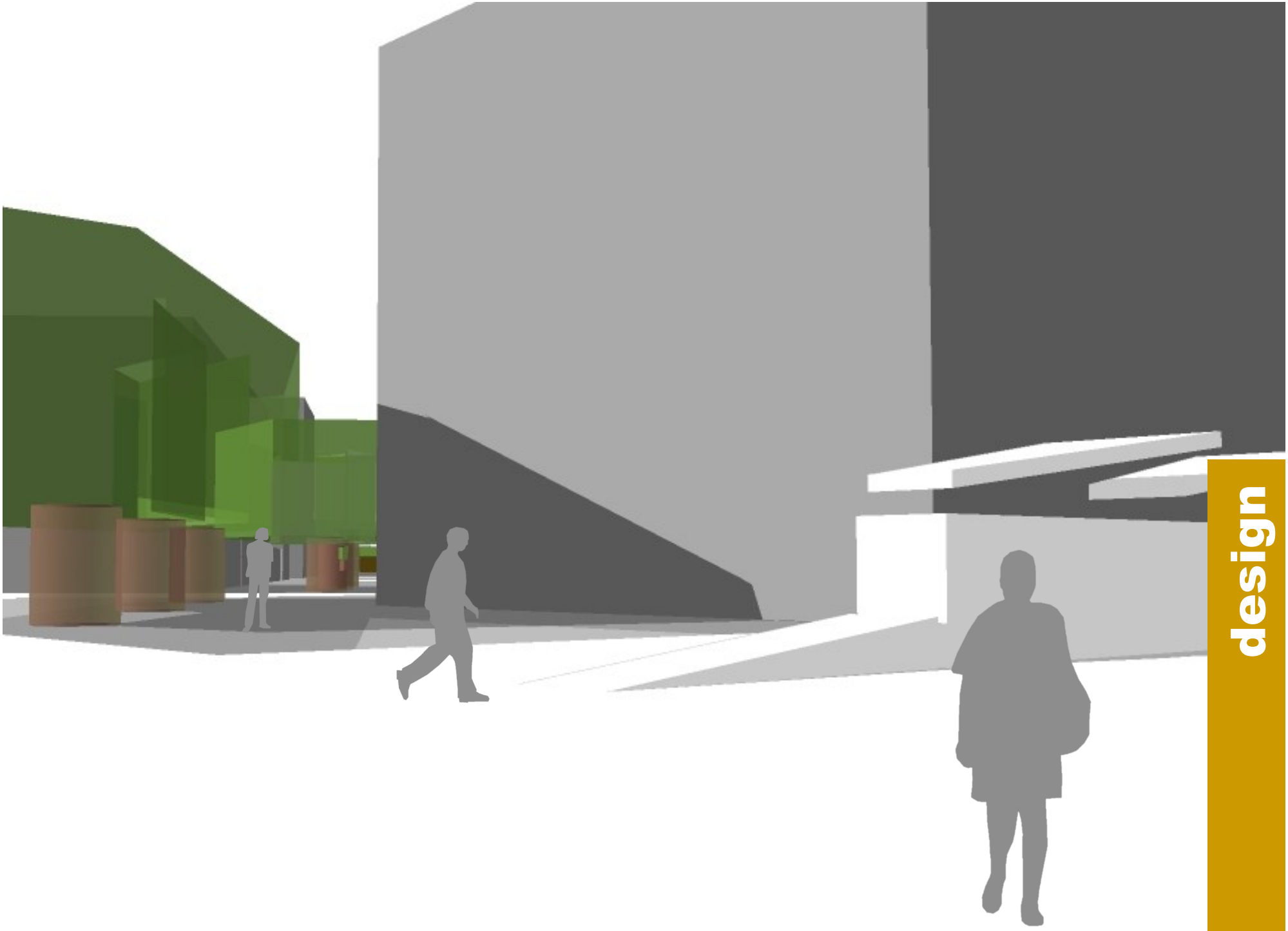


Janie Street is reconnected across the railway line to re-establish the north-south linkages of the road grid

The BRT station proposed on Market Street is linked to Jeppe Station via the proposed north-south pedestrian spine. This enables modal interchange between the BRT and rail stations.

TAXI RANK RE-DESIGN

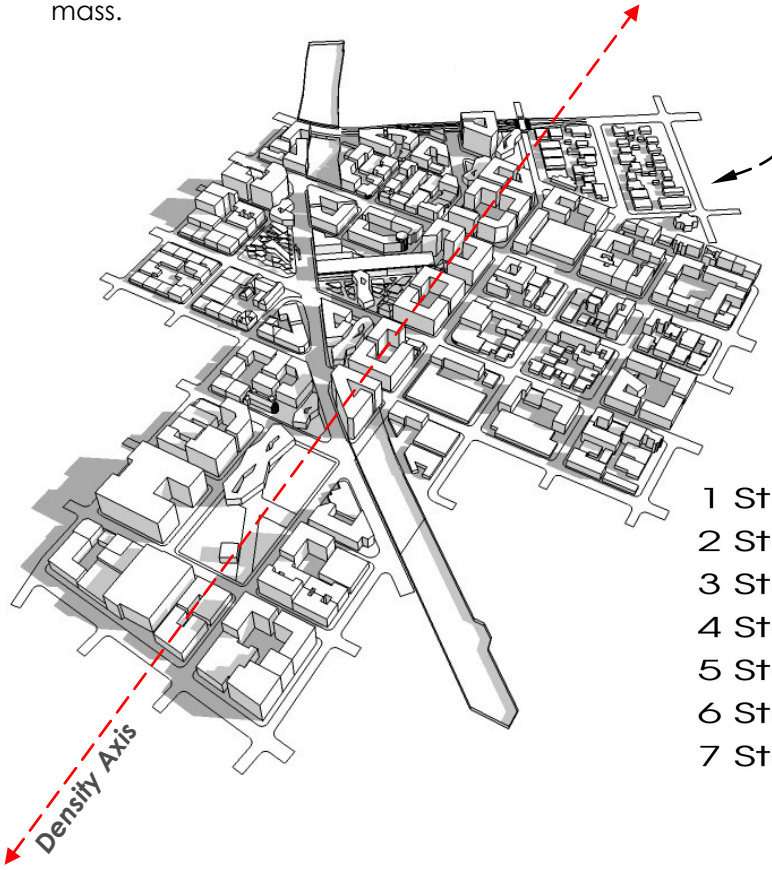
MOVEMENT INTEGRATION



BRT STATION+PEDESTRIAN SPINE

The Overall Design Framework proposed a number of infill buildings to replace the deteriorated building stock within the Study Area and to densify existing vacant properties within the Study Area. Maximum building heights are proposed for each of these infill buildings on the accompanying map. The building heights were allocated individually, based on the following guiding principles:

- To create edges along pedestrian streets and public spaces
- To create selected landmark buildings that help improve spatial legibility within the precinct
- To create appropriate building height and density interface between existing and proposed buildings
- The ensure older buildings of architectural value are not 'dominated' by surrounding building heights and mass.





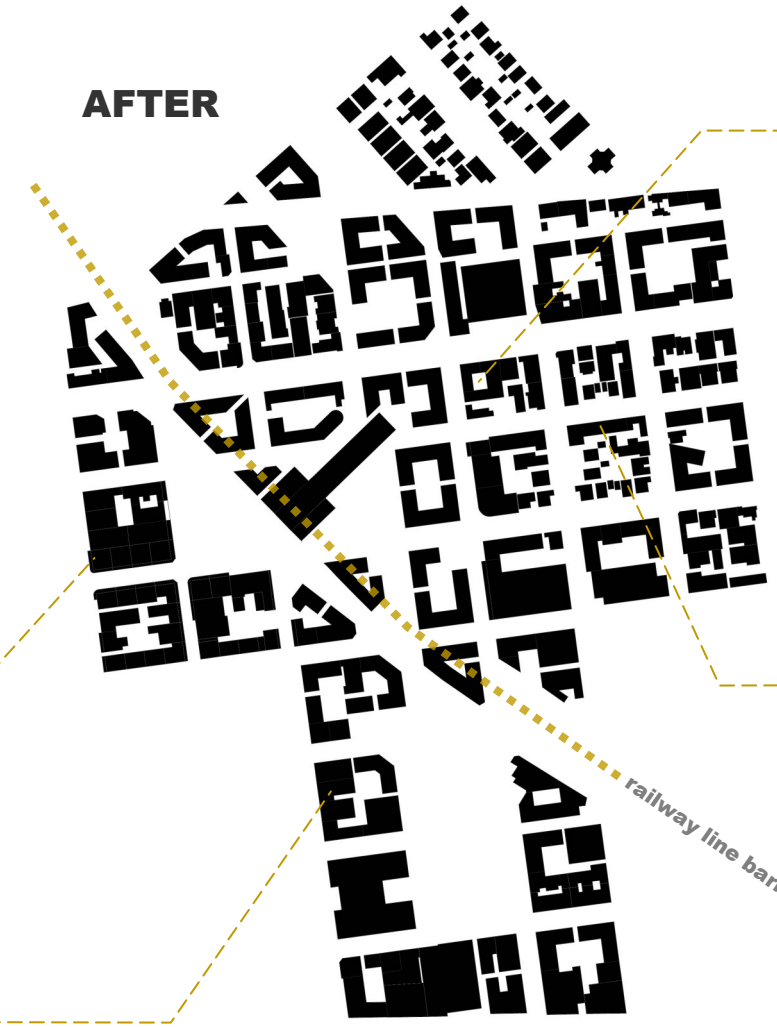
BUILDING HEIGHT+MASSING

The accompanying diagrams show the change is building density between the Study Area is it is today and the Study Area after the design proposals have been implemented. Whereas building density increases west of the railway is nominal, there is a dramatic increase in building density east of the railway line. This is due to infill development on vacant properties and the redevelopment of low-density properties east of the railway line. As a result, the area east of the railway line is densified to a density that is similar to the area west of the railway line. The existing lower densities east of the railway line was identified as one of the drawbacks of the Study Area in the Analysis. Densifying the area east of the railway line potentially increases the number of commuter living and working within walking distance of Jeppe Station, as is suggested in literature on the subject.

BEFORE



AFTER



13,416m²
building floor area per hectare east of railway line; increased from 4,963m² building floor area per hectare

53%
coverage of area east of railway line; increased from 37% coverage

14,954m²
building floor area per hectare west of railway line; increased from 11,342m² building floor area per hectare

45%
coverage of area west of railway line; increased from 41% coverage

BUILDING DENSITY CHANGE

68%

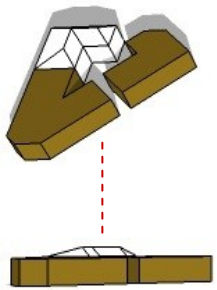
increase in residential space totaling 140,939m^2. This adds an additional

1608 dwelling units to the Study Area

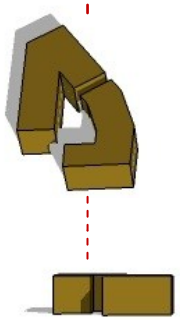


Residential Infill

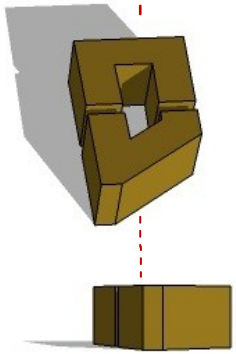
Existing Residential



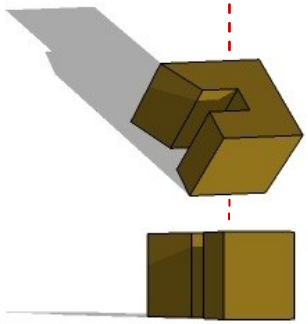
Type: Interface housing
Height: 2 storeys
Function: To enable interface between higher and lower density areas



Type: Infill housing
Height: 3 storeys
Function: To develop vacant sites or redevelop derelict sites to improve building quality

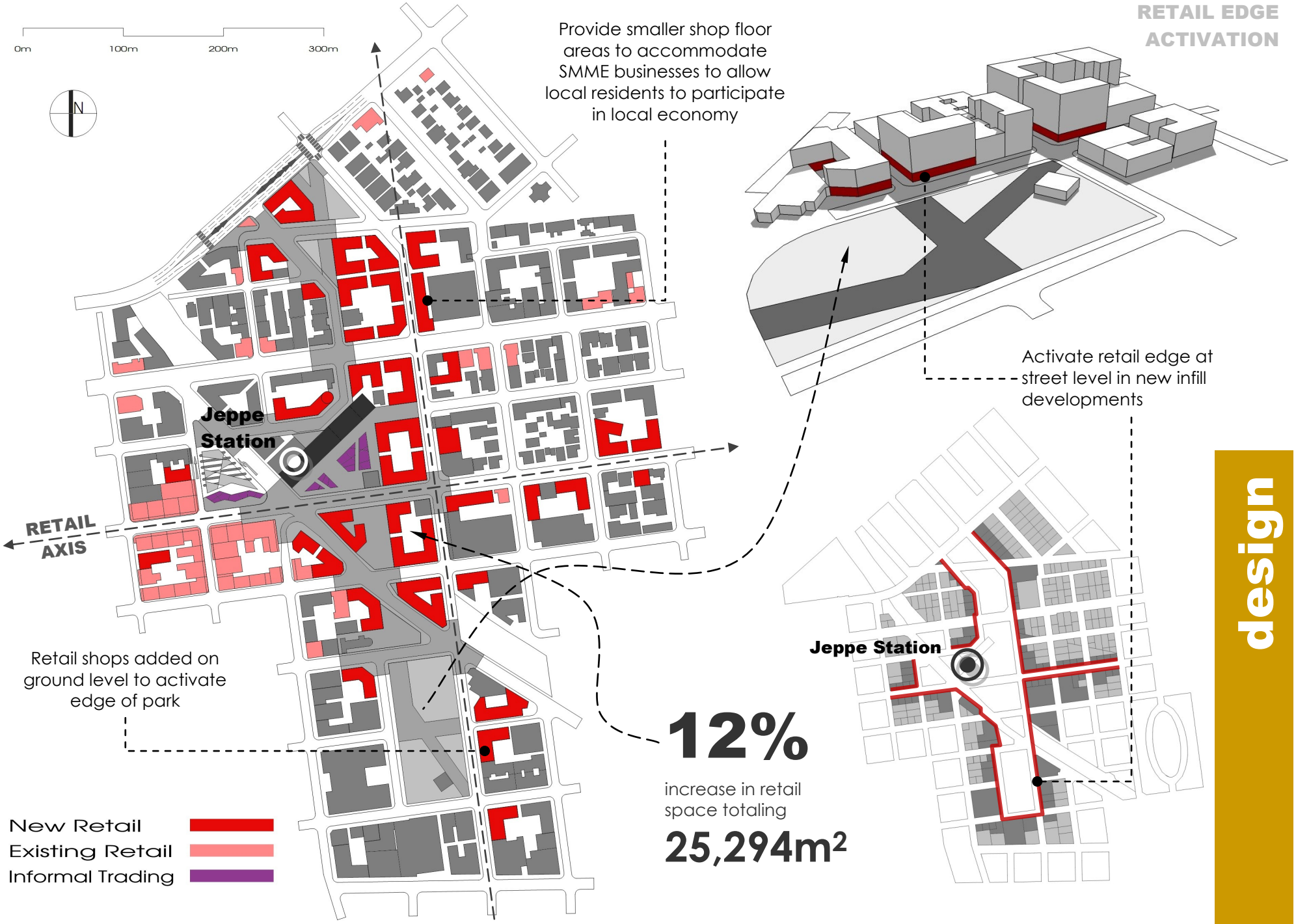


Type: Densification housing
Height: 5 storeys
Function: To densify accessible location near public transport facilities

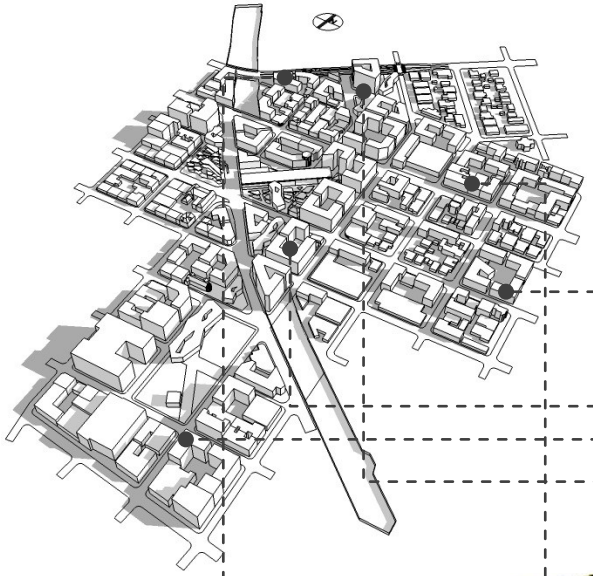


Type: Landmark housing
Height: 7 storeys
Function: To provide spatial legibility which facilitates pedestrian movement

HOUSING INFILL+TYPOLOGY



INTENSITY+RETAIL ACTIVATION



The literature study showed that an essential element of Transit Oriented Development is promoting intensity near transit stations. Intensity is increased by promoting a diverse land use structure, which is turn promotes neighbourhood vibrancy. To optimally use available space within the Study Area to create land use intensity, it is necessary to mix land uses vertically. The street-level storeys of buildings can typically be used for retail and community facilities, such as crèches, whereas the upper storeys of buildings can typically be used for office and residential purposes. The building mix will also need to correspond with the location of the building. For example, a building located along the identified east-west retail axis will need to incorporate retail as part of its building mix.

Mix: Residential only
Location: Peripheral
Function: To increase residential units in non-strategic localities

Mix: Residential + community facilities
Location: Central
Function: To provide community facilities to support residential

Mix: Residential + retail + community facilities
Location: Retail axis
Function: To activate the axis by adding retail at street level

Mix: Residential + retail + office
Location: North-south axis
Function: To increase economic activity along north-south axis

Mix: Residential + retail
Location: Public space
Function: To activate public space edges by provide retail

Mix: Residential + retail + office
Location: Transit stations
Function: To provide land use intensity at transit stations

VERTICAL LAND USE MIX

conclusion

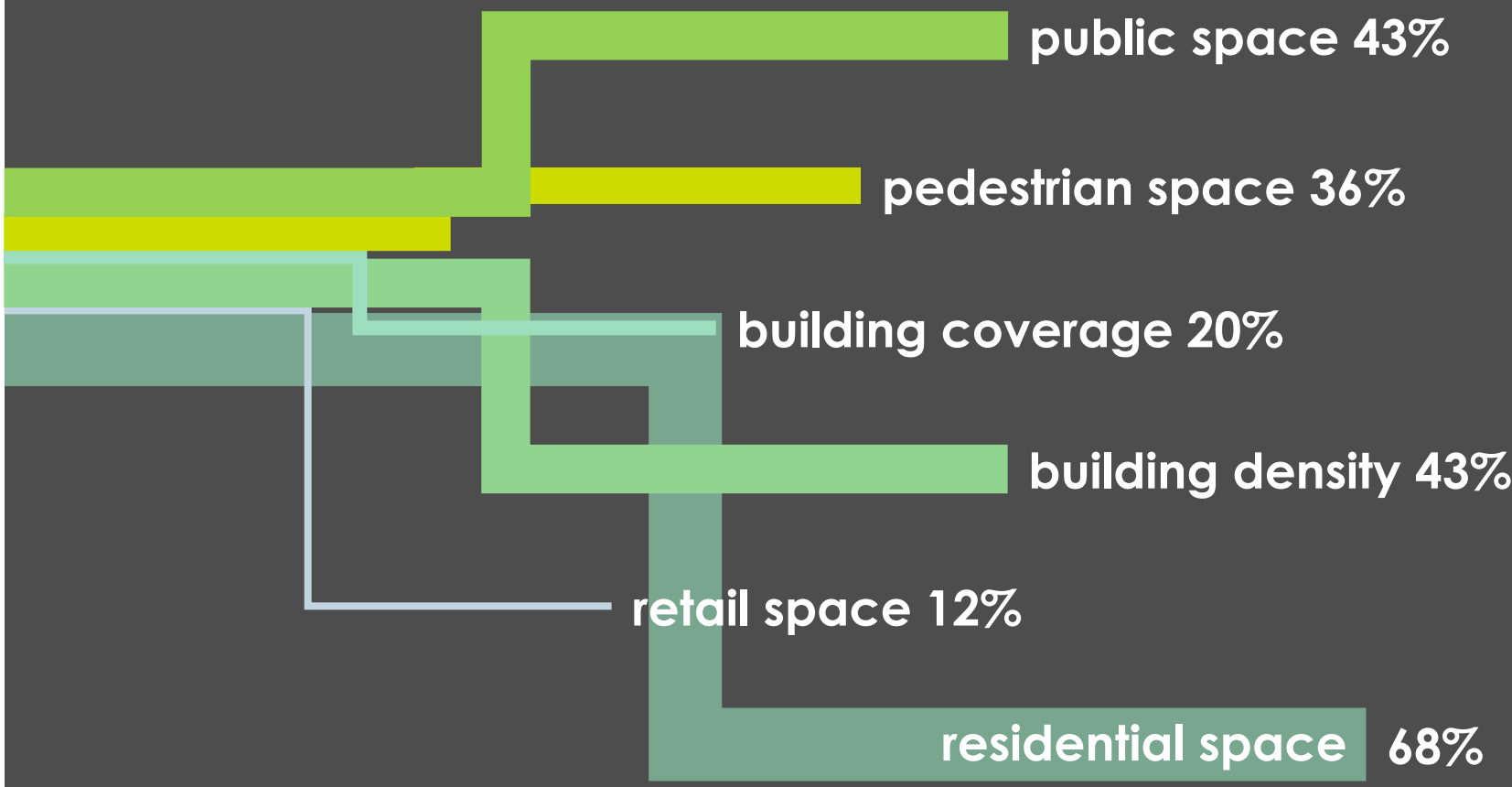
An advantage of the subject on transportation and the impact of the built environment on public transport patronage is the fact that it is in a well-researched subject. A large body of literature thus exists to guide and support the design of transit station precincts or catchment areas. From the literature, it transpired that three factors of the built environment impact of transit patronage: station access, land use density, and land use intensity. This is commonly referred to in literature as the three Ds: design, density, and diversity, a concept coined by Cervero, which is one of the most prolific researchers of the subject.

The Analysis of the Jeppe Precinct largely focused on the presence of access, density, and intensity within the precinct. Deficiencies regarding these factors were identified and it became clear that the part of the precinct located east of the commuter railway line was generally less supportive of the Jeppe station in terms of these factors. The part of the precinct located east of the commuter railway line has a lower density and a lesser intensity. Access was found to be limited in a north-south direction across the railway line, thus affecting access to the station from both sides of the railway line. At the same time, the built environment to the east of the railway line was more deteriorated, with many vacant properties and poor quality buildings located in this part of the precinct. The proposed design interventions thus focused on the area situated east of the railway line and improving this area as a catchment area for Jeppe Station.

The Design Concept and Overall Design Framework largely focused on implementing the Three Ds of Transit-Oriented Development or 'access, density and intensity'. In particular, these factors were implemented east of the railway line, where the Analysis showed an improvement of these factors were needed the most. Improving north-south connectivity by creating a north-south pedestrian spine that crossed the railway line was a key element to improve access to Jeppe Station, but also to reinstate part of the historic grid layout that was designed for Jeppestown. All this was done is a manner that tried to respect the historical context of the precinct, while at the same time attempting to make the precinct area a more relevant, modern-day station catchment area.

As mentioned above, the literature study provided many design principles and measures that can be implemented to improve access to a public transit station. These included applying higher densities to increase potential commuter numbers located within walking distance of a transit station, increase the land use mix of a transit station catchment area to create a 'one-stop-shop' scenario, and reducing walking distances and improving walking access to a public transit station. But these are all 'hard' measures to improve the built environment surrounding a transit station. There certainly is a 'softer', more human side to improving the built environment surrounding a station area. This 'softer' side is about creating a human-scale environment, which responds to the needs of a wide variety of city dwellers. It is about giving people choice, both economic and social choice, and it is about providing various transit options to access these choices. It is about having respect for the history of the built environment and at the same time adapting the built environment to suite the transit needs of today and the demographic profile that resides in the precinct today. Therefore, although this research report tries to improve on the 'hard' issues facing the precinct (as is presented on the following statistical page), the hope is that it will also, whether inadvertently or through conscious design decisions, improve the precinct environment on a social and human level.

The Jeppe Precinct was improved through an increase in:



access=public space+pedestrian space
density=building coverage+building density
intensity=retail space+residential space

QUANTIFICATION

Brown, A. (2006). *Contested Space: Street Trading, Public Space, and Livelihoods in Developing Cities*. University of Cardiff, Cardiff.

Calthorpe, P.G. (1993). *The Next American Metropolis: Ecology, Community and the American Dream*. Princeton University Press, Princeton.

Cervero, R., Murphy, S., Ferrell, C., Goguts, N. and Tsai, Y. (2004). Transit-*Oriented Development in the United States: Experiences, Challenges and Prospects*. Transportation Research Board, Washington.

Dewar, D and Uytenbogaardt, R.S. (1991). *South African Cities: A Manifesto for Change*. Urban Problems Research Unit, University of Cape Town.

Dewar, D. and Watson, V. (1990). *Urban Markets: Developing Informal Retailing*. Routledge, London.

Katz, P. (1994). *The New Urbanism: Towards an Architecture of Community*. McGraw-Hill, New York.

Madanipour, A., Cars, G. and Allen, J. (1998). *Social Exclusion in European Cities: Processes, Experiences, and Responses*. Jessica Kingsley, London.

Puch, C., McGranahan, G and Satterthwaite, D. (2000). *Sustainable Cities in Developing Countries*. Earthscan Publications, Sterling, USA.

Untermann, R.K. (1984). *Accommodating the Pedestrian: Adapting Towns and Neighbourhoods for Walking and Bicycling*. Van Nostrand Reinhold, New York.

Zetter, R. and White, R. (2002). *Planning in Cities: Sustainability and Growth in the Developing World*. ITDG Publishing, London, UK.

Cervero, R. (1996). *Mixed land-uses and commuting: Evidence from the American Housing Survey*. Transportation Research, Part A, Volume 5, p.361-377.

Cervero, R. (2002). *Built environments and mode choice: Towards a normative framework*. Transportation Research, Part D, Volume 7, p.265 -284.

Cervero, R. and Kockelman, K. (1997). *Travel demand and the 3Ds: Density, diversity, and design*. Transportation Research, Volume 2, p.199 -219.

Cervero, R. and Radisch, C. (1996). *Travel choices in pedestrian versus automobile oriented neighbourhoods*. Transport Policy, Volume 3, Number 3, p.127-141.

Chakraborty, A. and Mishra, S. (2013). *Land use and transit ridership connections: Implications for state-level planning agencies*. Land Use Policy, Volume 30, p.458-469.

Delmelle, E.C. and Casas, I. (2012). *Evaluating the spatial equity of bus rapid transit-based accessibility patterns in a developing country: The case of Cali, Colombia*. Transport Policy, Volume 20, p. 36-46.

Guo, Z. (2009). *Does the pedestrian environment affect the utility of walking? A case of path choice in Boston*. Transportation Research, Part D, Volume 14, p.343-352.

Jiang, Y., Zergas, P.C. and Mehndiratta, S. (2012). *Walk the line: Station context, corridor type and bus rapid transit walk access in Jinan, China*. Journal of Transport Geography, Volume 20, p.1-14.

Kim, S., Ulfarsson, G.F. and Hennessy, J. T. (2007). Analysis *of light rail rider travel behavior: Impacts of individual, built environment, and crime characteristics on transit access*. Transportation Research, Part A, Volume 41, p.511-522.

Lee, C. and Moudon, A.V. (2006). *The 3Ds + R: Quantifying land use and urban form correlates of walking*. Transportation Research, Part D, Volume 11, p.204-215.

Loo, B.P.Y., Chen, C. and Chan, E.T.H. (2010). *Rail-based transit-oriented development: Lessons from New York and Hong Kong*. Landscape and Urban Planning, Volume 97, p.202-212.

Murray, A.T., Davis, R., Stimson, R.J. and Ferreira, L. (1998). *Public transportation access*. Transportation Research, Volume 3, p.319-328.

Nkurunziza, A., Zuidgeest, M., Brussel, M. and Van den Bosch, F. (2012). Spatial *variation of transit service quality preferences in Dar-es-Salaam*. Journal of Transport Geography, Volume 24, p.12-21.

Sung, H and Oh, J. (2011). *Transit-oriented development in a high-density city: Identifying its association with transit ridership in Seoul, Korea*. Cities, Volume 28, p.70-82.

Wey, W.W. and Chiu, Y. (2012). *Assessing the walkability of pedestrian environment under the transit-oriented development*. Habitat International, Volume 30, p.1-13.

Zhang, M. and Wang, L. (2012). *The impacts of mass transit on land development in China: The case of Beijing*. Research in Transportation Economics, Volume 30, p.1-10.

City of Johannesburg. (2003). *Johannesburg Integrated Transportation Plan 2003/ 2008*.

City of Johannesburg. Museum Africa Archive. Retrieved September 11, 2012.

Gauteng Provincial Government. (2006). *Gauteng Strategy for Sustainable Development: State of Play Report*.

Jeppestown: Remembering a Forgotten Suburb. (2012). Retrieved September 10, 2012 from http://www.jda.co.za/developments/jeppestown/overview/240-overview.

Joburg's Great Places of Worship. (2007). Retrieved September 10, 2012 from http://www.joburg.org.za/index.php?option=com_content&task=view&id=261&Itemid=51.

LizardTech, MrSID. (2009). Retrieved May 4, 2012.

Modern Architecture: Japanese School Made of Glass. (2007). Retrieved August 8, 2012 from http://www.mymodernmet.com/profiles/blogs/modern-architecture-japanese-1.

My Fundi. (2012). Retrieved September 10, 2012 from http://myfundi.co.za/e/The_history_of_Johannesburg:_Origins.

Oxford Dictionaries Online. (2012). Retrieved September 7, 2012 from http://oxforddictionaries.com/definition/english/.

San Diego TOD Guidelines. (1992). Retrieved May 14, 2012 from http://calthorpe.com/sd-tod.

South African Department of Statistical Services. *SA Census 2001*. Retrieved August 5, 2012.

TENYRS ONAIR. (2012). Retrieved September 6, 2012 from http://www.onair.co.za/10yrs/.

The GS Tram Site. (1998). Retrieved September 7, 2012 from http://www.tundria.com/trams/ZAF/Johannesburg-1935.shtml.