BELLVILLE REBORN

Exploring Infrastructural [TRANS]formation as a Mechanism for Designing Sustainable Environments - the Case for Bellville.

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Master of Urban Design
Urban Design Research Project
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Presented to:

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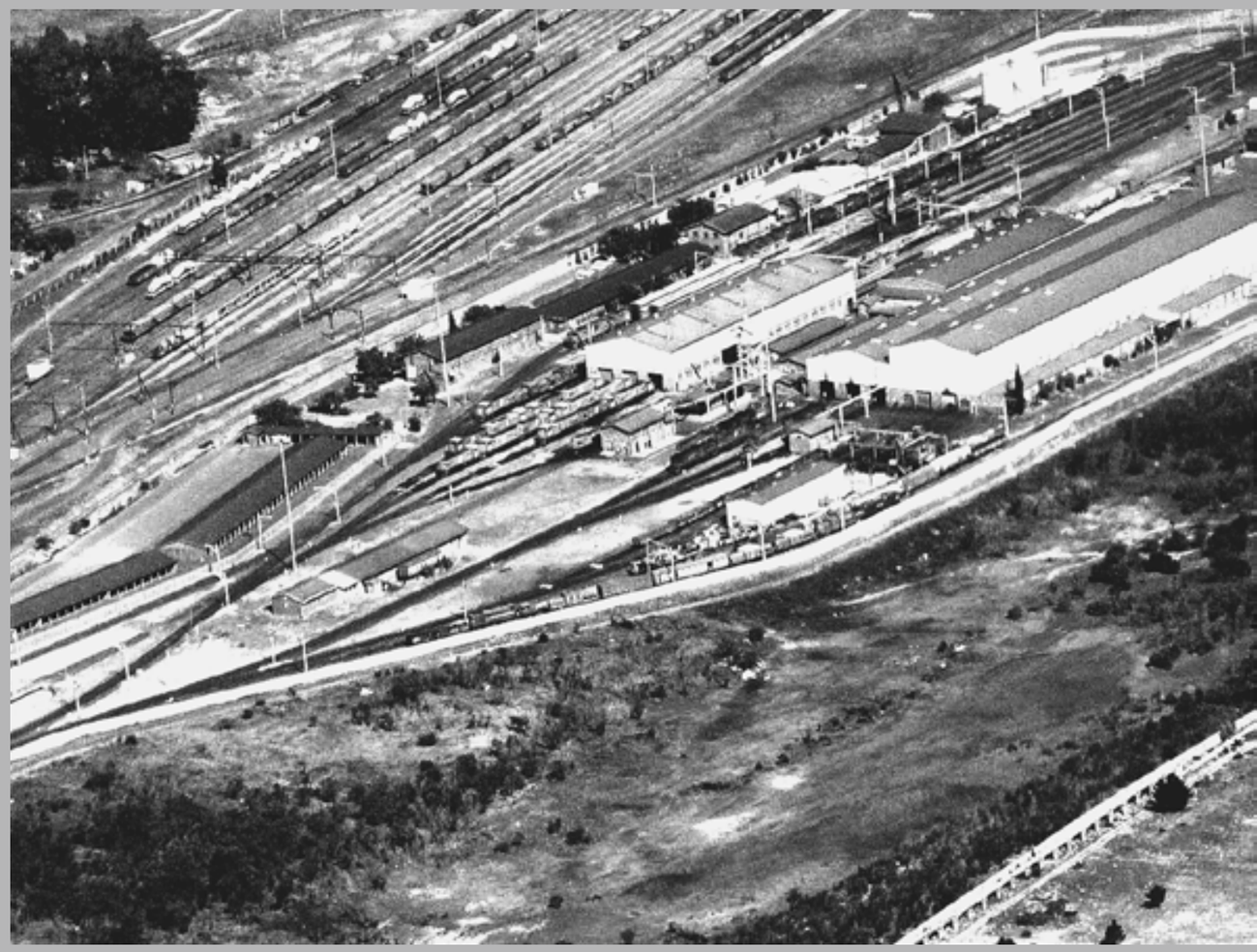

Figure 1: *Aerial Photo of Bellville Marshalling Yard, Belcon Site, Bellville.*
Source: *https://commons.wikimedia.org/wiki/File:Aerial_view,_Bellville_yards_and_loco_depot,_Cape_Town._(11208229683).jpg*

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Figure 2: *Informal Trading below elevated Tienie-Meyer freeway.*
Source: *Meyer & Associates, 2013. PMT Presentation - Bellville Transport Interchange*

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Abstract

It has been noted and widely documented over many years already that the rapid urbanization of cities, in particular cities located in the global south, poses a huge problem for such cities - specifically due to the lack of sufficient developable[1] land that could accommodate the urbanization phenomenon. To this end, spatial planning (in it's various forms - i.e. town and regional planning, urban design and architecture) is seen as central to fixing the challenges which come about due to this rapid urbanization. Unfortunately in African cities, planning is often seen as a failure. One mechanism which forms an important component of a set of tools, generally used for planning cities, regions, towns and even neighbourhoods, is urban infrastructure.

Infrastructure, is considered one of the most important ways in which organs of state and or government structures, work to materially shape urban environments. This research project seeks to investigate the possibility of using existing infrastructure in conjunction with developable land, as a means to respond positively to or maybe even reverse the disparity that infrastructure was required to create initially during the apartheid era.

1 (of land or property) able to be adapted or improved so as to become profitable.

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KEY TERMS and CONCEPTS

Accessibility - In the South African Context needs to be defined in terms of people moving on foot and people using public transport

Accessibility Surface - If a cross-section describing relative accessibility were to be drawn across the plane of any urban settlement, it would emerge as a complex hierarchical system of peaks and troughs. This pattern is one of the main factors informing the distribution of land values in space, and land value, in turn, is a significant factor in influencing the distribution of land use and human activities in space (Dewar et al. 2004)

Activity - Broadly relates to the actions of people carried out in urban space in the daily practices of urban living either through land use ordinances or informality.

Catalytic Development - Holistic development to revitalize the urban fabric through a series of projects that drive and guide urban development.

Efficient - An efficient planning system is one which makes the best use of available resources by ensuring co-ordination, resolving conflicts and promoting convenience.

Employment Density - Number of jobs in an area.

Enclosure - Degree to which buildings, walls, trees and other vertical elements define streets and other public spaces.

Equity - A situation where more advantaged groups do not benefit at the expense of less advantaged ones. In equitable settlements, all inhabitants have reasonable access to the opportunities and facilities which support living there. Equity does not imply or mean that everything is the same. It means everyone will have access to a broadly similar range of opportunities, facilities, special places and event.

Fine-grained - Scaled to pedestrians.

Geometry - Refers to the underlying distribution of structural elements in urban space. In terms of developing hierarchies of accessibility, the most significant are the interrelated geometric forms of point, line, cross-over and grid. These have been widely used to construct the underlying ordering system of settlements where:

- *Point* refers to the greater hierarchical significance of certain places in in space than others;
- *Line* refers to the primary passages of movement in urban space;
- *Cross-over* is formed by the intersection of two lines. The point of cross-over by definition creates an important point - a place of higher accessibility.
- *Grid* refers to the intersection of four lines. It creates four points of equal significance and allows movement in all directions (Dewar et al. 2004).

Grain - This refers to the texture of buildings in urban areas. The essential distinction is between coarse-grained urban fabrics (where the voids between buildings and, in a larger urban sense, between groups of buildings are large), and fine-grained fabrics (where the voids are small.

Human Scale - Relates to the conditions at which humans comfortably experience things or the environment.

Infill - Rededication of land in an urban environment, usually open space, to new construction or construction on any undeveloped land.

Intensification area - Built-up area with good existing or potential public transit links that can support redevelopment at higher than existing densities.

Legibility - Ease with which people can create a mental map so that the spatial structure of a place can be understood and navigated as whole.

Permeability - Extent to which urban forms permit the movement of people or vehicles in different directions.

Population Density - Number of people living in an urban area divided by the land area.

Spatial Quality - Recognizes that public space has sensory and aesthetic dimensions which either attract or repel people. Positive qualities include human scale, sense of enclosure, spatial definition, protection, comfort, safety and surveillance.

Transit-orientated Development - Design strategy that ensures compact, mixed-use, pedestrian - and bicycle friendly, and suitably dense urban development structured around transit stations or stops.

Urban Morphology - The study of the form of settlements and the process of their formation and transformation over time.

LIST OF ACRONYMS and ABBREVIATIONS

BEPP	Built Environment Performance Plan
BRT	Bus rapid transit
CBAs	Critical biodiversity areas
CBD	Central business district
CoCT	City of Cape Town
CDS	City Development Strategy
CEF	Capital expenditure framework
CIF	Capital investment framework
CITP	Comprehensive Integrated Transport Plan
CRR	Capital Replacement Reserve
CSIR	Council for Scientific and Industrial Research
IDZ	Industrial Development Zone
IRT	Integrated rapid transit
IUDF	Integrated Urban Development Framework
IPTN	Integrated Public Transport Network
MSDF	Municipal Spatial Development Framework
NMT	Non-Motorised Transport
PTI	Public transport interchange
TAPS	Transport / transit accessible precincts
TOD	Transit-Oriented Development
UWC	University of Western Cape
VRC	Voortrekker Road Corridor

Figure 3: *Incomplete Foreshore Freeways.*
Source: *City of Cape Town, Transit Oriented Development Strategic Framework.*

1. Introduction

"At first it may appear that pedestrian space is a frivolous issue in a developing country; but the privations of low income people (or communities) are not really felt during working hours – it is during leisure hours that the differences are felt. While higher income people have cars, clubs, country houses, theatres, restaurants and vacations, for the poor, public space is the only alternative to television. Parks, plazas, pedestrian streets and sidewalks are essential for social justice. High quality sidewalks the most basic element of respect for human dignity, and of consideration for society's vulnerable members such as the poor, elderly and children." – Enrique Peñalosa, former Mayor of Bogota.[2]

Historically, urban settlements developed around places that allowed people to meet, exchange ideas and live in safe and secure environments. Networks of private and public streets set the stage for movement and were generally developed in accordance with the needs of pedestrians. This situation changed significantly during the nineteenth century, when street cars became widespread throughout the industrial world (Knoflacher, Rode & Tiwari; 2007). Out of this dichotomy is born the interest to explore transportation – movement, and its relationship to urban environments and urban design. If we want to understand transport in cities, we have to understand human behaviour in the urban environment. No society can exist without the movement of people, goods and information. This movement is considered an important structuring and spatial element in urban settlements (Dewar; Todeschini, 2004).

2 Bus Rapid Transit Planning Guide - June 2007 Vol. 2 of 2

This research project, in conjunction with prior written papers[3] (under separate courses) seeks to highlight the demise of the urban street, once a positive social space due to the introduction of the motorcar during the Nineteenth century, generally and the influence of Modernism that led to this phenomenon. With South Africa, specifically Cape Town as a case study the aim is to demonstrate how the assumptions of the modernist approach to urban movement is unfortunately still deeply entrenched in most areas. This approach together with Apartheid (as in the case of South Africa) has resulted in stark, inappropriate and almost intractable problems in urban areas. This in turn, produces unsustainable city form or structure.

1.1 BACKGROUND and CONTEXT

Throughout the twentieth and into the twenty-first century there were a number of automobile utopias which presaged a conflict on infrastructures that had – and perhaps still has – profound implications for (traditional) urban form and city structure.

One of the most influential figures in architecture, Le Corbusier fused the ideas of Modern architecture and city form with modern technology. Through a number of proposals for different cities, each one attempting to refine thoughts and ideas from a previous one, Le Corbusier aimed to explore four major objectives.

3 Two papers submitted by the author for the course Urban Design Theory 2 (Course Code: APG5085S).

These objectives were to de-congest the centre city; increase density; improve circulation and to provide more natural verdure[4], light and air (Spreiregen, 1965). These objectives do not seem any different to that of the of the aspirations within the urban design profession currently. Inasmuch as these seem logical, ideal and even right, the way these objectives played themselves out materially had varied consequences. Unfortunately Le Corbusier felt that the old role of the street as an artery for pedestrians and vehicles was no longer possible. The two modes of movement / transport had to be separated.

In response to this, a new infrastructure, the limited access highway, was being developed. The so-called utopias referred to earlier, were attempts at addressing this conflict between vehicle and pedestrian movement – a challenge that seems to be prevalent still today, but with more complexity as cities have obviously grown in population & physical size – thereby demanding for the (transport) infrastructure to be increased or extended. The initial objective or goal that Le Corbusier was trying to achieve with the concept, and now reality of the elevated freeway, was for the ground plane to become omnidirectional pedestrian movement with areas free for recreational use as well. With Le Cobusier being very influential in the field of architecture, his influence and ideas spread over to developing countries as well.

4 Lush greenness of flourishing vegetation

South Africa is one of those developing countries that have adopted the Modernist planning ideology. This in turn provided the perfect platform for the Apartheid social policies of the time to be enforced resulting in the inefficient urban form and structure which in turn reflects fragmentation, separation and a high degree of urban sprawl.

> *"Dominant urban planning and management practices in South Africa are based largely either on simple ideological considerations of race separation or on conventional planning wisdoms which have been developed primarily in relation to the contextual circumstance of Western Europe and the U.S.A. Although some of the concerns upon which these were based are valid, there is increasing evidence to suggest that their formal manifestations are inappropriate even to those contexts: they are certainly inappropriate to the very different circumstances of developing countries"*[5]

It is from the background and context outlined above, that this Research Project aims to investigate the role of urban infrastructural transformation as a concept to address the disparity still very much prevalent in the mono-functional and often environmentally sterile settlements. By coupling this concept with the aim to address urbanization / sprawl the focus is on available land within the greater Metropolitan area of Cape Town that may be considered suitable for urban growth or intensification.

5 (Dewar; Uytenbogaardt, 1991)

1.2. PREMISE

Very simply, the premise of this research is to investigate, how through existing urban infrastructure one could address and possibly transform existing infrastructure in a way that will still allow for the development of a settlement to be equitable, sustainable and coherent in its form and structure.

1.2.1. PROBLEM STATEMENT

From the introductory text thus far and various literature, it is widely recognised that Cape Town has been facing and still do faces serious problems on many fronts. According to the City of Cape Town Draft Muni-SDF, the structure and form of the city generate enormous amounts of movement, at great cost in terms of infrastructure, energy consumption, pollution and public finance. Traffic congestion has since then become an increasingly common feature of daily life. As a result of the afore-mentioned effects of Modernist-Apartheid planning, for the majority of people who cannot afford a car, life is appallingly inconvenient and expensive. Many are trapped where they live which gets further exacerbated by inefficient and expensive public transportation. It is difficult to switch from one mode of transport to another which makes it increasingly difficult to get to different parts of the city.

Railway lines and limited access vehicular routes, in some cases highways (either elevated or at grade) create many virtually impenetrable barriers between parts of the city and even neighbourhoods - See Figure 4.

As a result, many parts of the city are functionally discreet and inwardly focused. However, some parts and sites that bear the same characteristics unfortunately remain underdeveloped and in extreme cases, undeveloped. Consequently this invariably leads to unsafe and unsustainable environments.

Figure 4: *Cape Town - Manenberg / Phola Park - Areas separated by major vehicle routes and railway line.*
Source: *https://www.unequalscenes.com/more-unequal-scenes*

1.2.2. PURPOSE OF RESEARCH

The purpose of this research is to emphasise the importance of urban infrastructure within the development of city structure, provided that it addresses and responds equally to the needs of all its inhabitants. This concept is explored through existing infrastructure as a basis from which to generate solutions. According to the UN-HABITAT Expert Opinion Survey (Arimah, 2016), infrastructure can contribute to the prosperity of African cities if it is developed and effectively managed. One way this could be achieved is by facilitating urban mobility in an attempt to reduce intra-urban disparities.

1.2.3. FOCUS AREA

In addition to the previously noted introduction of high-speed mobility routes and public transport infrastructure, vast areas of land were also used to enforce the Apartheid spatial planning regimes. As such, a number of large state-owned land that are currently vacant or underutilised, remain as stark reminders of the old legacy. Despite being very well-located, these sites or pieces of land have not resulted in any meaningful development that is able to address the phenomenon of urban sprawl. These sites include Wingfield Aerodrom, Youngsfield Military Airbase, Culemberg Industrial Area, parts of District Six, the Athlone Power Station and Swartklip in Khayelitsha.

In addition to the above there are also a number of privately-owned pieces of land that have the same characteristics. One such site is the Belcon site which houses the Bellrail or Transnet Marshalling yards in Bellville, which is the chosen site to investigate the concept of infrastructure transformation.

1.2.4. ABOUT THE SITE

The site was planned in the 1970s when the Apartheid state pursued absolute racial segregation on a spatial level. The immense terrain, measuring approximately 350ha, was used to separate the so-called “white” suburbs in the north from the coloured neighbourhoods and university in the south. Currently the completely enclosed site still functions as a serious barrier in Bellville and restrains the integration of the university campuses with the urban core and Bellville CBD in the north.

The site is within walking distance from Voortrekker Road which is one of the oldest movement routes in Cape Town and is currently the backbone of the Voortrekker Road Corridor. The VRC has become one of the City’s strategic projects for catalytic investment and strategic development. Bellville CBD has for this reason been earmarked for economic intensification in an attempt to revitalize the area.

1.2.5. SCOPE AND LIMITATIONS

Inasmuch as the site is considered a large underutilized piece of land it currently still functions as a marshalling yard for the Transnet Railway Company. This reality places an interesting dynamic on the process of urban design in terms of implementation. As a privately owned property and functioning site, access to the site is very restricted. Due to this limited access to the site, the analysis was conducted largely in the form of a desktop study using GIS mapping, government publications, presentations and articles associated with the property. Further investigations involved a visual perimeter survey, recorded through a series of panoramic photographs (Figures 49 & 50, pg.35) and a video recording while traveling in the train from Tygerberg train station to Bellville train station and PTI. In order to further contextualize the challenges set out earlier (i.e. areas that are not conducive for pedestrian movement and large vehicular routes dominating the transport mode) , CCTV footage was sought of a very busy intersection at the North-Eastern “corner” of the site. Figures 5 and 6 show snapshots at approximately 15-minute intervals highlighting the resultant congestion.

Figure 5: *CCTV Footage of intersection at Robert Subukwe Road and Reed Street, Bellville.*
Source: *City of Cape Town*

Figure 6: *CCTV Footage of intersection at Robert Subukwe Road and Tienie Meyer Street, Bellville.*
Source: *City of Cape Town*

1.3. METHODOLOGY AND APPROACH

The research question, confines itself to transport infrastructure specifically, as a type of critical infrastructure in the urban design field. In the case of transport infrastructure, it is fundamentally concerned with connectivity – also referred to as accessibility. In most poor or developing countries this type of infrastructure is grossly inadequate and as a result economic activities or opportunities are disconnected from each other and from global markets. In Cape Town this socio-economic inequality and exclusion is represented in Figures 7, 8 and 9.

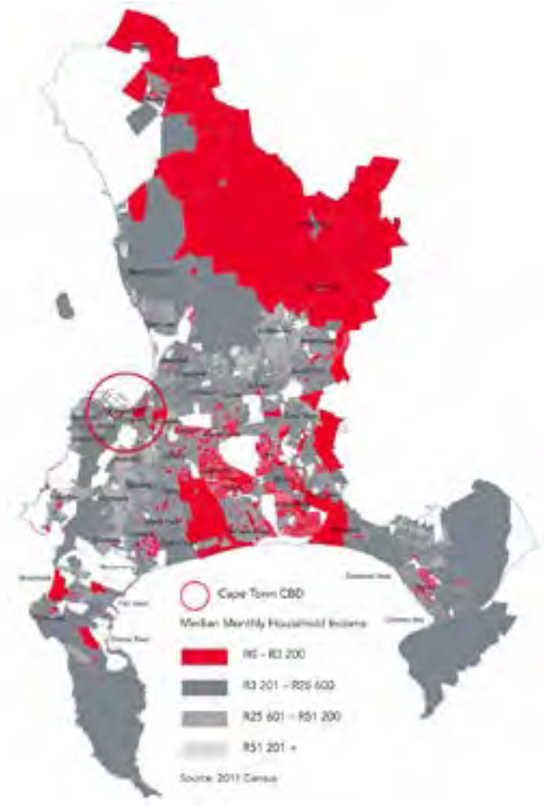


Figure 7: *Population distribution with Median Monthly Household Income.*
Source: *City of Cape Town*

The process that was followed for producing this research document adheres to standard architectural experience through typical site investigation strategies as per Figure 10.

Figure 8: *Residential Density - Majority of the city's residents live approximately 45km from the CBD.*
Source: *Author's Own adapted from CoCT MSDF 2017.*

Figure 9: *Employment Density - In comparison to the residential density, the most economic opportunities are situated far from where people live .*
Source: *Author's Own adapted from CoCT MSDF 2017.*

Below are three principles that aim to ground the research project in urban design and specifically transport infrastructure literature in order to identify and highlight the theoretical underpinnings of the research question and its importance as an investigation.

1.3.1. LITERATURE REVIEW

The introduction of (major elevated) roads brought about a character that is somewhat averse to "publicness" in its starkness toward people - the pedestrian. Perhaps it could be argued that this contributed to the decline in the quality of transport infrastructure whether it is road networks and their quality or public transport modes such as rail and its physical infrastructure.

This is most notable in the case of sub-Saharan Africa as it is the region with the largest infrastructure deficit. For example roads constitute only around 10 percent of the land area of several large African cities, whereas in a well-connected large city the figure would be around 30 percent (Collier and Venables, 2016).

According to Dewar et. al, investment in public transportation continues to be outweighed significantly by road-based investments directed mainly at improving private vehicular mobility (Dewar; Todeschini; 2004). This is an important observation as it appears to still be the case today. Dewar et al. proved that there is a heavy weighting towards 'technical' issues like the engineering components of transportation and that only 2,4% dealt with the integration of for example land use and transportation, and none of these examine the central issue of the role of transportation in (or as) settlement making.

> *"Across the globe, public authorities view infrastructure - particularly transport infrastructure - as their primary field of investment.* [6] *In a world where urbanization is increasingly produced by private capital, infrastructure appears as the backbone onto which these building initiatives can be grafted. As such, infrastructural design emerges as one of the last resorts to allow public authorities to give structure to haphazard settlement and reclaim the discipline of urbanism. Furthermore, the importance of mobility and transport is universally recognized. Accessibility lies at the root of development and the infrastructure needed to secure it determines the quality of the environment, both at the global level (by giving access to places and making them part of the world economy), and at the local level (by enhancing the dwelling quality of the public realm)." (Shannon, Smets; 2010)*

Given the above reference, it is clear that the investigation into transport infrastructure transformation is not only relevant, but entirely necessary.

1.3.2. THEORETICAL APPROACH

In their publication, South African Cities: A Manifesto for Change, Dewar and Uytenbogaardt note that "a cohesive approach to urban development derives from the methodological sequence which underpins any physical design decision: being need; programme; idea and context". Need gives rise to programme: the identification of the elements out of which projects must take form.

6 This however does not seem to be the case with Cape Town as much of the City's public transport suffers heavily from infrastructure failure.

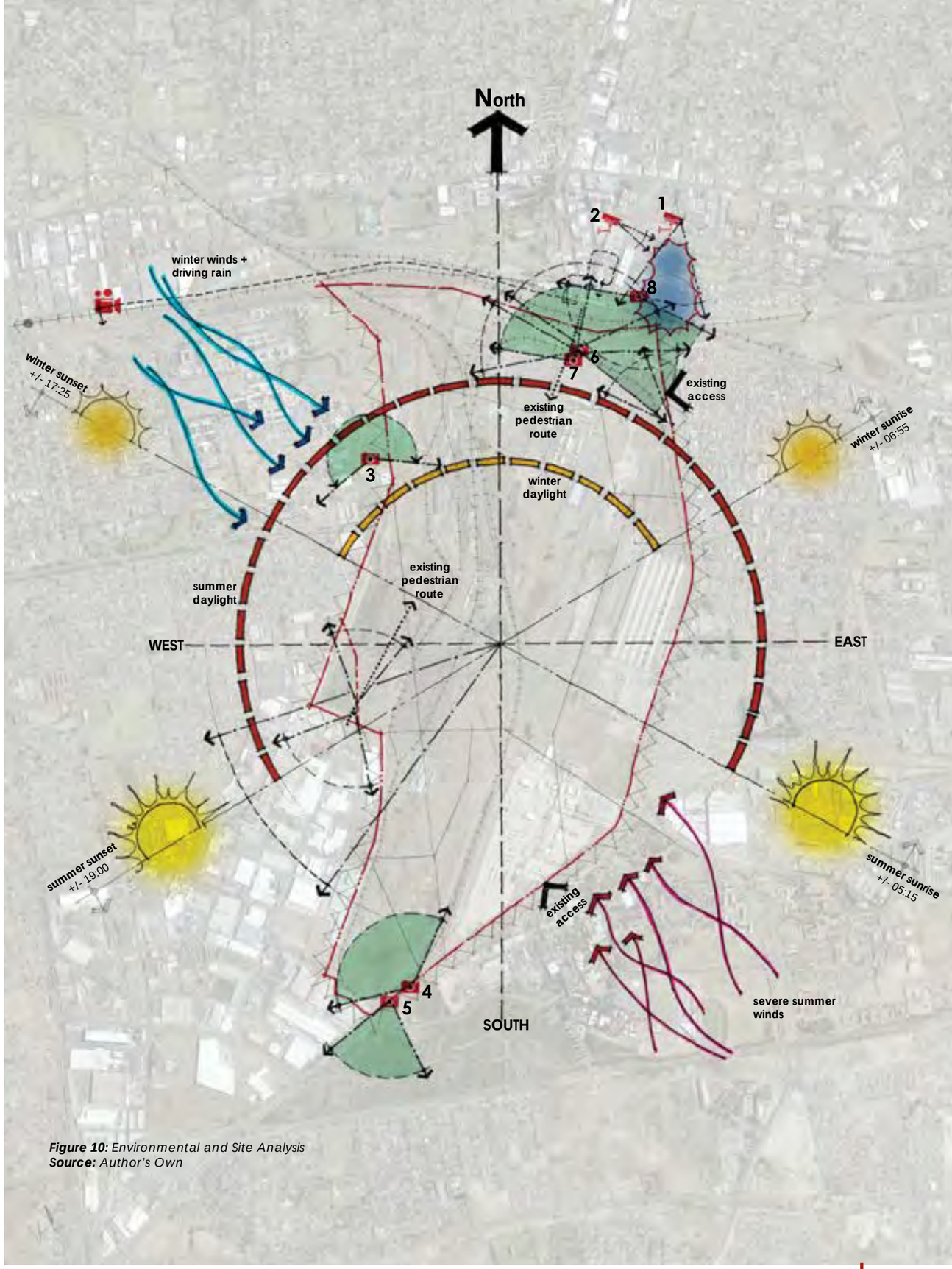


Figure 10: *Environmental and Site Analysis*
Source: *Author's Own*

"Idea" identifies spatial relationships which contribute to the meeting of "need": it has form but is not yet design. Context is the application of idea to place: it gives reality to the idea and is the design response to the particularities of place. Although all physical design engages with these stages, it does not necessarily do so sequentially. Thus context frequently prioritizes need or sparks idea, and so on. All stages, too, are creative. Further, the design process is not a linear but a cyclical one: understandings gained in one stage feed back into, and lead to adjustments in the others (Dewar and Uytenbogaardt; 1991).

The above approach is explained in a lot more detail in the referenced publication, however the diagram shown in Figure 11 aims to summarize part of this approach through a diagrammatic representation of "NEED" that outlines some key words, thoughts and ideas associated with the approach.

1.3.3. RESEARCH METHODOLOGY

Based on the above theoretical approach, the research & subsequent design methodology was fundamentally influenced by my inherent values and ethics. These values were made explicit at the start of the planning or research process that placed the needs of pedestrians above those of the privately owned vehicle. Thus the research and design methods are concerned with how things need to be and specific ways in which these ideas manifest themselves in the project and later in the profession of urban design.

1.4. PRINCIPLES AND OBJECTIVES

The quality of human life has to be a fundamental concern of planning and urban design. As such, urban design as a profession is meant to serve people - a diverse community with countless voices, like the heterogeneous multi-cultural society of Cape Town. The disposition that underpins the thrust of this research document therefore, suggests that the qualities of urbanity (vibrancy, livability, sense of place etc.) are important. Which is to say that it needs to value the pursuit of the greater public good; and the need to create favourable conditions that would provide sustainable opportunities, not only for development, but for the inhabitants of the city (or any settlement) to lead a dignified life, should be recognised. Thus the principle of this research project is to place the human dimension at the forefront of the creation of urban environments.[7]

As outlined previously, planning has historically been governed by a modernist disposition that has exerted a supreme, guiding influence over the urban development processes. This resulted in a preoccupation with pursuing the qualities and values of surburbia; the separation of activities and functions and unfortunately with it a concern with promoting unrestricted mobility for motor vehicles to the detriment of pedestrians and public transport commuters. In South Africa this approach also created ideal conditions for the ideology of Apartheid to be promoted. The objective of this research project is then quite simply to explore how the same "structure" may be transformed to reverse this effect.

7 This approach is in contrast to the apparent results of the Modernist & Apartheid planning regimes of the past.

1.5. DOCUMENT STRUCTURE

The remainder of this document is structured in six chapters (although they're not specifically titled as chapters). Chapter 2 aims to introduce the importance of urban infrastructure in general before establishing its place within settlement making / a mechanism for urban design within a city context.

In Chapter 3 the focus is drawn toward Transportation as a type of critical urban infrastructure as a possible starting point to address the disparity it was once used for creating.

Chapter 4 looks at precedent within the realm of revitalization of urban environment through transformation of urban infrastructure.

Chapter 5 is very important as it outlines the main argument of the research question. It contextualizes the project within the greater Cape Metropole and its importance within the Voortrekker Road Corridor - which has been identified as an area for economic intensification. The proposed intervention or main ideas also form part this chapter as a response to the central concerns outlined in the preceding chapters.

Chapter 6 very briefly looks at the Implementation and Management synonymous with dealing with sites of this nature by proposing possible scenarios for development.

Chapter 7 concludes with the emphasis on the need for a change in the status quo by proposing a way forward.

Figure 12: *New highway system in central Shanghai, China.*
Source: *Splintering Urbanism - Stephen Graham.*

An extreme case of a car-dominant urban environment is shown in Figure 12 above.

URBAN DESIGN AS A PROCESS

APPROACH

NEED

PROGRAMME

IDEA

CONTEXT

Urban Generation → economic, social, cultural and recreational opportunities | Urbanization demands | Specialization and Diversity | High levels of Poverty and Unemployment | self-generated economic activity | "informal sector" | sufficient freedom to manoeuvre.

Access → ease of access | equity | urban form | effect of imposition | mainstream of urban life | urban policy | viable and co-ordinated public transport system | spatially marginalized | technology of movement | range of choices.

Collective Activities → social contact and interaction | urban development | innovation and diversification | communication | urban management strategies | collective activities | social security | quality of life | urban dwellers | intensive cities.

Individual Needs → physical needs | nutrition, health, safety, shelter, potable water, adequate sewerage | social needs | community ties | psycological needs | identity | sense of belonging | sensory needs | considerable freedom.

Figure 11: *Diagrammatic representation of the Cohesive Approach to Urban Development.*
Source: *Author's Own - derived from: South African Cities - A minfesto for change.*

2. Urban Infrastructure

Physical infrastructure covering transportation, power and communication through its backward and forward linkages facilitates growth; while social infrastructure including water supply, sanitation, sewage disposal, education and health, which are in the nature of primary services, has a direct impact on the quality of life (Pottas, A)[8].

2.1 INFRASTRUCTURE GENERALLY.

Cities and urban regions have in a sense become a staging post in the perpetual flux of infrastructurally mediated flow, movement and exchange. A critical focus on networked infrastructure - transport, telecommunications, energy, water and streets – offers up a powerful and dynamic way of seeing contemporary cities and urban regions (Dupay, G. 1991). The key premise of this research is based on the assertion that infrastructure networks are the key physical and technological assets of modern cities. This gives reason to regard infrastructure's influence on the urban environment as critically important and to disregard this during the process of urban design, places the sustainability of cities in much danger. According to Graham et. al a 'bundle' of materially networked, mediating infrastructures, transport, street, communications, energy and water systems constitute the largest and most sophisticated technological artefacts ever devised by humans (Graham and Marvin, 2001).

They further argue that much of the history of modern urbanism can be understood, at least in part, as a series of attempts to 'roll out' extending and multiplying road, rail, airline, water, energy and telecommunications grids, both within and between cities and metropolitan regions. Within the context of the current global concern of urbanization, it makes sense that these vast lattices of technological and material connections have been necessary to sustain the ever-expanding demands of contemporary societies for increasing levels of exchange, movement and transaction across distance (Graham and Marvin, 2001).

2.2 THE CASE FOR CAPE TOWN.

It is worth noting that the full extent of Cape Town's infrastructural challenges is too vast to cover in this research project. However this introduction aims to highlight the overall importance of infrastructure on the development of urban environments (Figure 13) and the far reaching consequences of its deficits and how these failures are often, unfortunately highly politicised.

In 2006 David Beretti, then a civil servant in Cape Town with nearly thirty years of experience, referred to the city's infrastructure as a "burning platform" (Woldemariam, 2011). This reference related to a massive backlog of maintenance and repairs had built up as the previous city government had concentrated on building new projects while ignoring existing ones. Woldemariam further notes that while water and sanitation infrastructure collapsed, Cape Town's roads and bridges also atrophied, and the electricity grid fell into disrepair. in addition, government's commitment to expanding infrastructure had stretched the city's revenue base past the breaking point. Addressing these challenges while having to reverse the spatial inequality that resulted in a fragmented city structure remains one of the biggest challenges for the City of Cape Town.

As the profession of urban design is concerned with all matters related to the design, structuring and often transformation of settlements, it is worth understanding the different infrastructures that play a role in the functioning and sustainability of a city. The aim of this research project is not to provide an exhaustive investigation and approach to mitigate the effects of the high infrastructure risks synonymous with rapid urbanization, however the rest of this chapter serves as means to highlight and introduce the reader to the various types of infrastructure that requires consideration when embarking a particular urban design project.

This is done with specific reference to the study area within the Voortrekker Road Corridor.

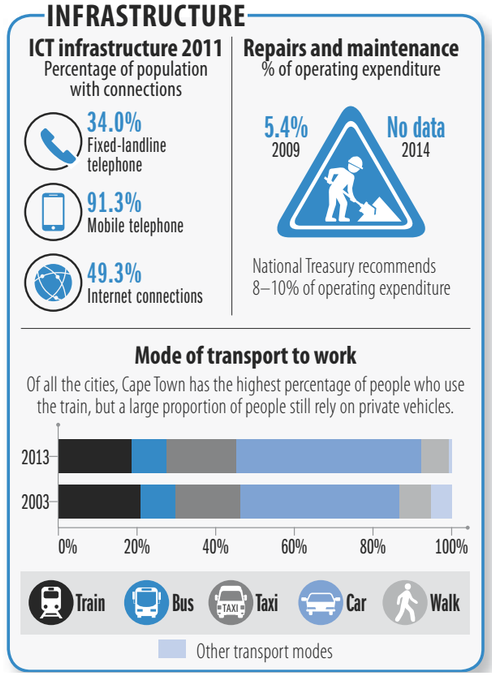


Figure 13: *Infographic - Cape Town Infrastructure Index*
Source: *State of South African Cities Report 2016 (pg 321)*

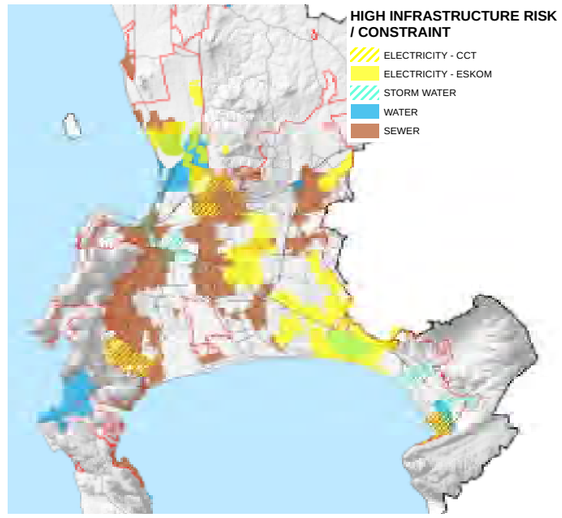


Figure 14: *Indication of Infrastructural constraints.*
Source: *Integration Syndicate*

8 Addressing Africa's Infrastructure Challenge - date of publication by Deloitte unknown.

2.3 SOCIAL INFRASTRUCTURE

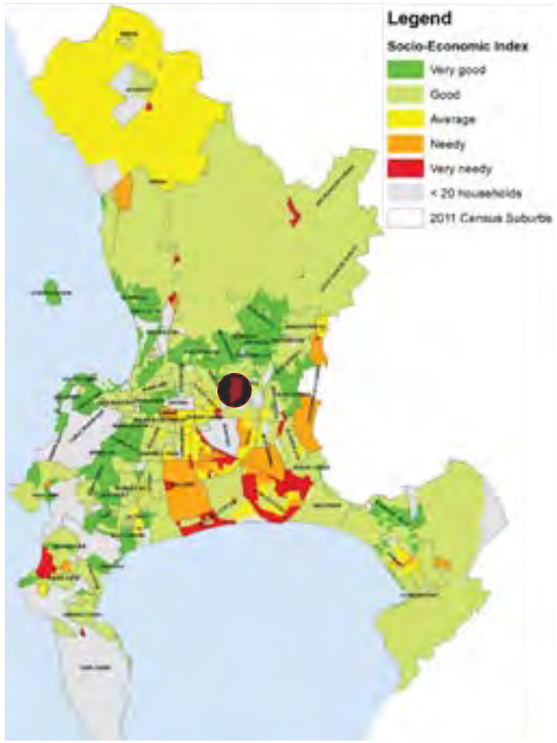


Figure 15: *Socio-economic Index.*
Source: *Comprehensive Integrated Transport Plan (2013-2018)*

Social infrastructure can be broadly defined as the construction and maintenance of facilities that support social services. With reference to this definition (pertaining to facilities, the types of social infrastructure include healthcare (hospitals), education (schools and universities), public facilities (community housing, Libraries, Civic halls and prisons) and transportation (railways and roads). Notwithstanding this reference to facilities which is generally considered to be built structures, there's also public parks and playgrounds which sits under the banner of social infrastructure. All of these structures serve as the backbone for communities and societies .

2.4 ELECTRICITY INFRASTRUCTURE

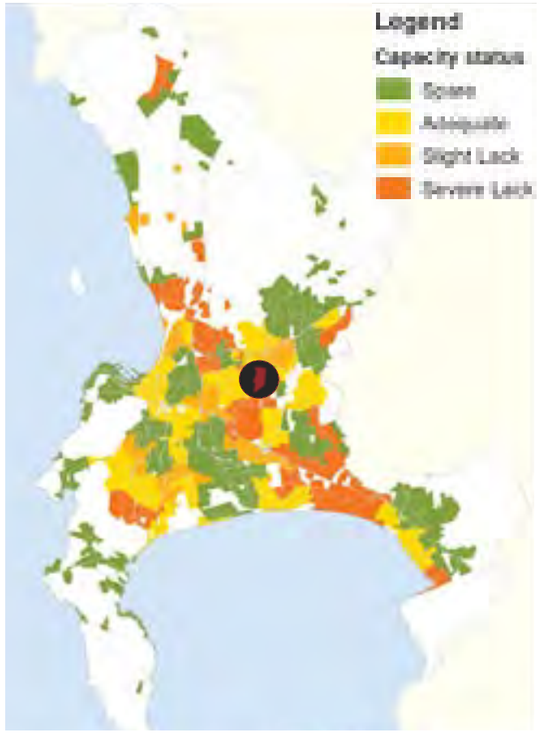


Figure 16: *Electricity Network - Existing Capacity Constraints.*
Source: *Medium-Term Infrastructure Investment Framework (2017)*

Where infrastructure refers to the basic, underlying framework or features of a system or organization, Electrical Infrastructure can be defined as the network / framework that comprises / ensure electrical distribution throughout a region, city or neighbourhood. In light of literature and initiatives pertaining to sustainability and efforts to combat greenhouse gas emissions, the term Energy has come to more widely associated with electrical infrastructure, with evidence mounting that renewable energy will become the cheapest form of additional electricity generation capacity (displacing fossil fuels).

2.5 WATER INFRASTRUCTURE

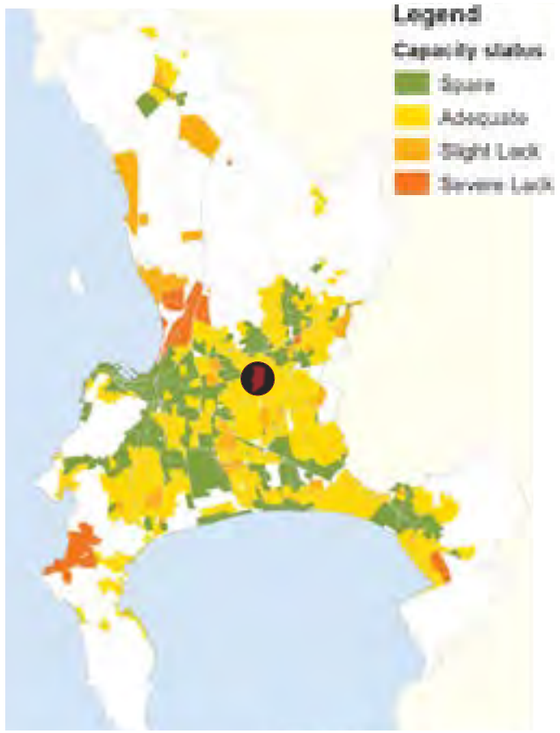


Figure 17: *Water Network - Existing Capacity Constraints.*
Source: *Medium-Term Infrastructure Investment Framework (2017)*

Water infrastructure is a broad term for systems of water supply, treatment, storage, water resource management, flood prevention and hydro-power. The term also includes water based transportation systems such as canals . Common types of water infrastructure include, but are not limited to Aqueducts, Rain Gardens and Cisterns (eg. Constructed dams / reservoirs). The condition of the water infrastructure along Voortrekker Road is fair from the Salt River on the western end to the eastern end and in places there are up to three water mains as between the Black River and Second Avenue.

2.6 SANITATION INFRASTRUCTURE

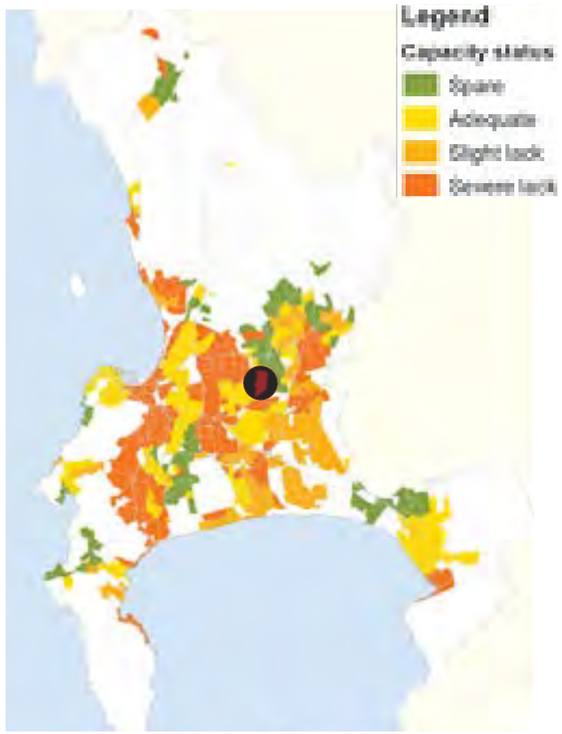


Figure 18: *Sanitation Network - Existing Capacity Constraints.*
Source: *Medium-Term Infrastructure Investment Framework (2017)*

The sewer network along Voortrekker Road drains to two Waste Water Treatment Works (WWTW): Athlone and Bellville WWTW. Voortrekker Road west of the Mike Pienaar Road intersection drains to Athlone Waste Water Treatment Works via the Northern Areas Sewer Line (currently being upgraded), while the network east of Mike Pienaar Road drains to Bellville Waste Water Treatment Works. Bulk sewer capacity in both of these catchment areas is under varying degrees of risk. Part of the existing treatment load would therefore need to be diverted to Cape Flats WWTW in order to provide additional capacity to the Voortrekker Road Corridor.

2.7 GREEN INFRASTRUCTURE

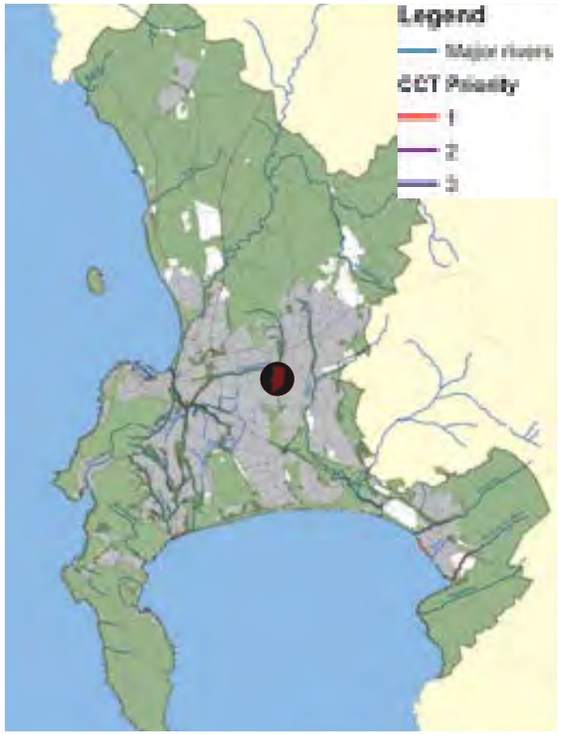


Figure 19: *Major rivers overlaid onto Biophysical Assets.*
Source: *Medium-Term Infrastructure Investment Framework (2017)*

Green Infrastructure is a network providing the "ingredients" for solving urban and climatic challenges by building with nature. The main components of this approach include stormwater management, climate adaptation, less heat stress, more biodiversity, better air quality, sustainable energy production, clean water and healthy soils, as well as increased quality of life through recreation and providing shade and shelter in and around towns and cities. Green infrastructure also serves to provide an ecological framework for social, economic and environmental health. Green Infrastructure is considered a subset of Sustainable and Resilient Infrastructure.

2.8 TRANSPORT INFRASTRUCTURE

Figure 20: *Transportation - Metropolitan Road + Rail Network.*
Source: *Medium-Term Infrastructure Investment Framework (2017)*

Transportation infrastructure are foundational structures and systems for transporting people and goods. It consists of fixed installations, including roads, walkways, railways, airways, waterways, cycling routes, canals air terminals, railway stations, bus stations, refuelling depots and seaports. Terminals may be used both for interchange of passengers and cargo and for maintenance. Transportation infrastructure has bearing on social infrastructure in that it affords the opportunity for people to interact (e.g. at public transport interchanges, inside trains and buses etc.). In addition, transport infrastructure plays an important role in economic growth for a settlement.

2.9 GREEN OBJECTIVE

Figure 21: *Biophysical assets and destination places.*
Source: *Municipal Spatial Development Framework (25 April 2018)*

Natural features (figure 20) including the biodiversity, agricultural, coastal and topographic assets of the city have historically defined its growth parameters. These assets continue to play a structuring role that shapes the urban and rural / natural form and quality of life enjoyed by citizens. They also help to mitigate climate change, provide food security for the city and region and support the growing tourism economy. The importance therefore of green infrastructure relies on the functional integrity and connectivity of the various ecosystems to facilitate easy movement of fauna and growth of flora.

2.10 TRANSPORT OBJECTIVE

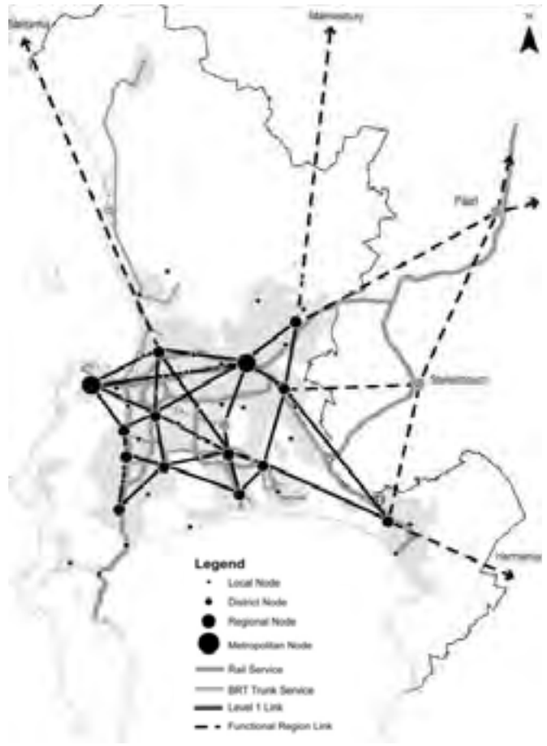


Figure 22: *Desire lines between nodes of Metro Significance.*
Source: *Comprehensive Integrated Transport Plan (2013-2018)*

Figure 21 illustrates conceptually how the desire lines are connecting the 2 Metropolitan and 13 Regional nodes identified by the CTSDF. The desire lines are rationalised to pass through nodes, with the aim to link all nodes to the two major nodes of Cape Town CBD and Bellville. This section deliberately ends with Green and Transport Infrastructure as these two infrastructure types form the main considerations of this research document with Transport Infrastructure being the primary focus. As such the following section is solely dedicated to transport matters.

3. Transport Matters

In the past couple of decades at least, it has not been so clear what the 'ideal' form or structure of transport layouts might be, whether applied to existing urban areas or as a basis for forming new urban structures. That is to say, it is no longer considered ideal for urban areas to be structured on a road system optimised for traffic circulation. Rather, there has been a return to favour of traditional mixed-use streets, which has precipitated the need to consider what kinds of streets best meet today's needs, and how these streets might form different kinds of urban pattern (Marshall, 2005).

During the course of working on this research project, it became clear that the most pressing unresolved issues for transport and urban design were not so much to do with the destructive impact of modern transport infrastructure on the urban fabric, but with the formative role of streets and street layout in structuring the setting for urban design. According to Marshall (2005), urban structure in its physical sense is significantly influenced by the structure of movement and access. Therefore it can be argued that transport infrastructure has had a particularly strong influence on the fabric of cities. The amount of urban land occupied by transport-related land uses, including streets, lanes, car parks, highway intersections, railway yards, and so on, can easily account for a third of the total land areas of cities.

3.1 ROADS vs STREETS.

The central challenge that this research project aims to address within the context of transport infrastructure is to rethink how transport may better serve urban design and how the urban layout in turn, may be improved towards better 'place-making' without compromising the basic functionality of circulation and access. According to Marshall this implies adapting structures to be more sympathetic to urban design ends, rather than simply throwing away the engineering altogether. This is the approach adopted and applied to the subject site of this research project.

The traditional pattern of urban structure or infrastructure constituted by urban streets (Figure 20), was swept away by a system of vehicular highways separate from buildings and public spaces. It lies within this context that an argument could be made suggesting that the "traditional" urban street has lost its "identity" of a linear urban space for the pedestrian, to the introduction of a new kind of infrastructure - the high speed, and sometimes elevated freeway / mobility Road.

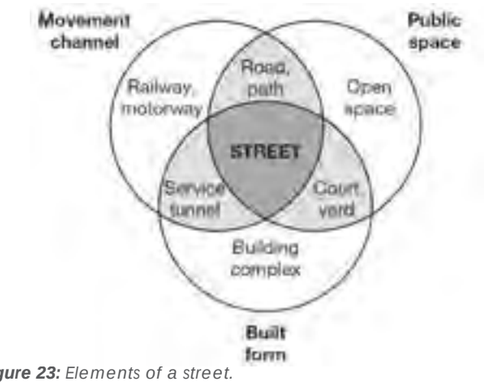


Figure 23: *Elements of a street.*
Source: *Streets and Patterns - Stephen Marshall (2005).*

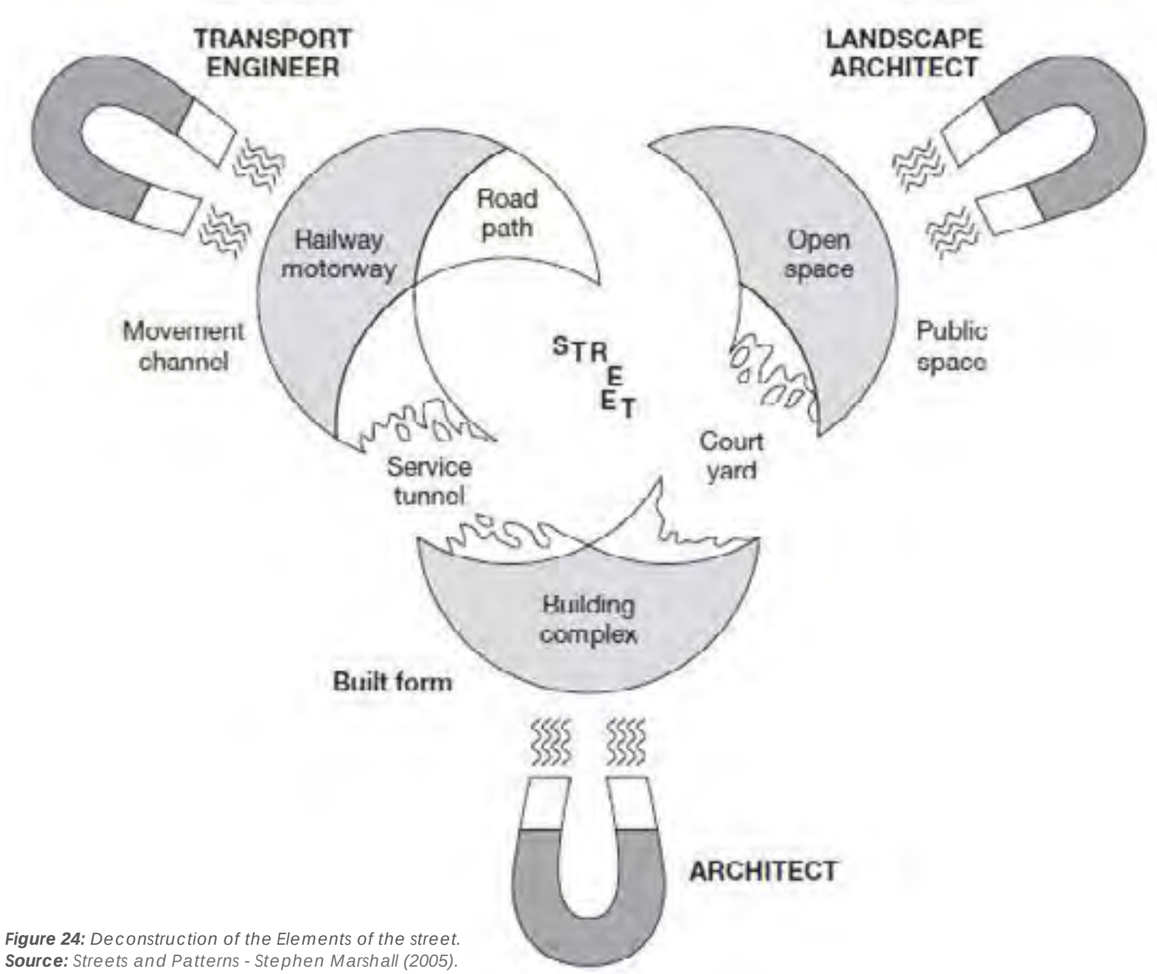


Figure 24: *Deconstruction of the Elements of the street.*
Source: *Streets and Patterns - Stephen Marshall (2005).*

The revolutionary rhetoric of Modernism thus killed the notion of the urban street which effectively amounted to a schism in urban design between the treatment of roads as movement channels, and the treatment of buildings and public space. This led to the deconstruction and separation of the elements of the street (Figure 21).

Jane Jacobs considered streets as the lifeblood of cities rather than mere traffic channels. In light of this provocation it is evident that the cataclysm of Modernist road planning altered the fundamental relationship between routes and buildings. According to Marshall (2005) this effectively turned cities inside out and back to front.

3.2 TRANSPORT AND URBAN DESIGN.

During the era of Modernism, transportation efficiency was considered the 'prime shaper of urban space' (Marshall, 2005). This consideration was primarily born of the recognition of the significance of transport for structuring cities. According to Paul Spreiregen, the architect should consider the circulation system as a 'total urban concept'. Edmund Bacon describes various ways in which 'shafts of space', 'simultaneous movement systems' and grand axes – or their modern equivalents – may be used to structure cities. Both theorists and practitioners have actively considered the transport system, and particularly the street system, in its role as the primary structural element of the city[9]. Given this provocation it is clear that the 'movement space' constituted by streets forms the essential connective tissue of urban public space.

By emphasizing transport as key to urban structuring it is not implied that transport as an urban function is of higher importance than housing or public open space[10]. Nor does it mean that transport is the primary influence on the patterns of streets and resultant land parcels. Street patterns or urban environments are generally also influenced by land ownership, land value, topography, geology and other social, economic and physical factors. However, emphasis on transport does mean that the attention to the structural logic of the access network - otherwise also known as the accessibility surface, is important for understanding how settlements are structured and how new urban environments may be designed.

> *This is why the street may be regarded as a fundamental building-block of urban structure. The public street system forms the principal part of the urban transport system, and is therefore pivotal to our story. This explains why a change in transport mode (from horse power to the internal combustion engine) was more than just a technological regime change, but more like an urban revolution – and why it might seem to need a 'counter-revolution' to put it right (Marshall, 2005).*

As a means to start exploring this counter-revolution, the focus is shifted toward Public Transport and Urban Mobility.

3.3 PUBLIC TRANSPORT AND URBAN MOBILITY.

Unfortunately South Africa's urban public transportation systems are generally dysfunctional. This is the case for a number of reasons, which include lengthy traveling distances between residential areas and economic centres, high cost of transport, Traffic congestion, over-crowded vehicles which are also uncomfortable and poorly maintained. None of which can be solved by only one type of critical infrastructure. The attempt to address this challenge has been the laying of new roads and highways, despite the fact that the introduction of this large scale infrastructure, increases the dependence on cars and reduces the amount of productive urban space. According to the African Centre for Cities, the short-term savings on road-based transport make it an attractive option, however the long-term recurrent costs, such as maintenance, traffic accidents and social exclusion are heavy. According to the MSDF the overall modal split between public and private transport in Cape Town is around 50:50, which is fairly high for a large city. However there is a strong correlation between household income and public transport use which result in a high use of public transport in lower income households and a very low use by higher income households(MSDF). Therefore the any vision or objective for an integrated, inter-modal and inter-operable public transport system requires that the appropriate mode is strengthened to meet existing and future needs. African cities have made little progress in improving urban mobility, raising the question what can be done at city level to improve the functionality, inclusivity and sustainability of urban transport systems. This research project proposes a diverse transport system which entails a mix of trains, trams, buses and paths for pedestrians and cyclists as a possible intervention that could act as a catalyst for transforming and designing settlements.

Figure 25: *Percentage of employed inhabitants using Public Transport.*
Source: *Comprehensive Integrated Transport Plan (2013-2018)*

Figure 26: *Percentage of employed inhabitants using Private Cars.*
Source: *Comprehensive Integrated Transport Plan (2013-2018)*

9 Hilberseimer (1944: 104); Smithson and Smithson (1967;1968: 42); Trancik (1986: 106); Brett (1994: 71); Friedman (1998); Roberts et al. (1999: 55); Roberts and Lloyd-Jones (2001); Erickson (2001); Lillebye (2001: 5).

10 Housing and Public Open Space are both in their own right, critical urban design components within the South African context.

4. Precedent Studies

The purpose of this section is to contextualise and give substantive grounding to the research question by introducing precedent that addresses similar design elements or challenges to that of the research project. This takes the form of a photographic "essay" rather than a case study method of analysis. Each type of precedent represents the various approaches manifested in the final design resolution. The first set of examples relate to the conceptual approach where transport infrastructure played an integral role in the transformation of an urban environment. This is followed by examples where transformation of existing infrastructure resulted in the revitalisation or restructuring of the area in which it locates itself. The third precedent study focuses on green infrastructure as a type of vision and motivation for the final design resolution. The fourth set of examples relate to city structure as a possible vision for the settlement pattern of the design project and guide to inform the precinct development of the final design resolution. This section on precedent studies is intended to spark interest and inspiration in an attempt to strive for a vision for a sense of place which the design might aim to achieve.

Apart from this section which is dedicated to specific precedent studies, it should be noted that reference to other precedent studies will be made in chapter 5 where these relate to specific ideas reflected on the panels.

4.1 CONCEPTUAL APPROACH

4.1.1 MEDELLIN, COLUMBIA.

After being known as the 'murder capital of the world' in the 1990's, Medellin has pioneered innovative forms of city planning and management. One of the key elements that resulted in it being acclaimed the most innovative city in the world has been the creation of innovative transport infrastructure in the form of its metro cable - linking poorer peripheral districts to the city centre.

Figure 27: *North-Eastern Urban Integration Project, Medellin.*
Source: *https://www.archdaily.com*

4.1.2 CURITIBA, BRAZIL.

Curitiba, located in Parana State, Brazil, has implemented several innovative systems to create jobs, improve public transportation accessibility, promote housing development, and improve waste management. The city has integrated a "radial linear-branching pattern" to protect density by diverting traffic from the city center and protect green areas. It's BRT system has contributed much to transformation.

Figure 28: *Evolution of Curitiba's Public Transport Network.*
Source: *https://curitibacityplanning.weebly.com/public-transportation.html*

4.2 PROGRAMMATIC APPROACH

4.2.1 ATLANTA BELTLINE, USA

The Atlanta BeltLine is a dynamic and transformative project. Through the development of a new transit system, multi-use trails, green space, and affordable housing along a 35m loop of old rail lines that encircle the urban core, it connects neighborhoods, improve travel and mobility options, spur economic development, and elevate the overall quality of life in the city.

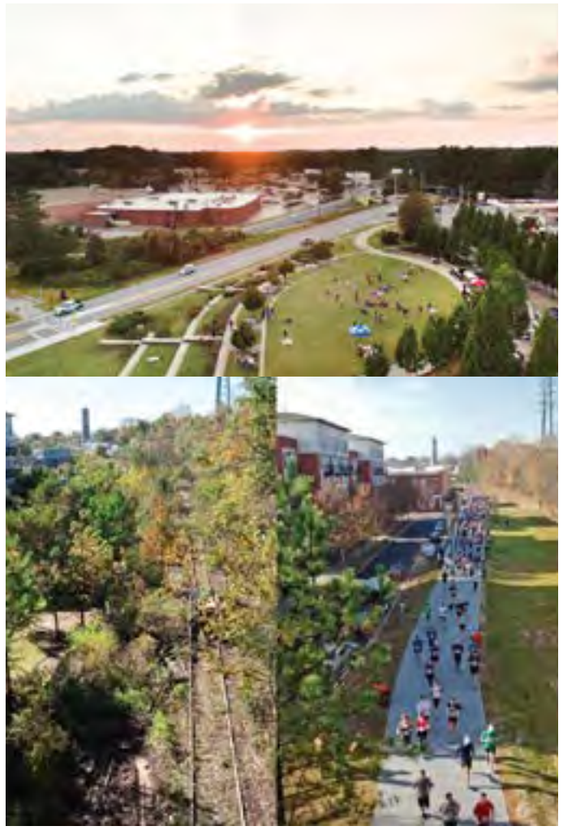


Figure 29: *Atlanta BeltLine Parks and Trails.*
Source: *https://beltline.org/*

4.2.2 THE HIGH LINE, NEW YORK, USA

The High Line is a public park that has been reinvented from abandoned elevated railroad tracks that were once the life-blood of Manhattan's West Side manufacturing and shipping industries. The High Line offers the New York community a wealth of environmental, social and economic value. It brings wildlife and plant life to an otherwise industrial area mostly covered in cement and asphalt.

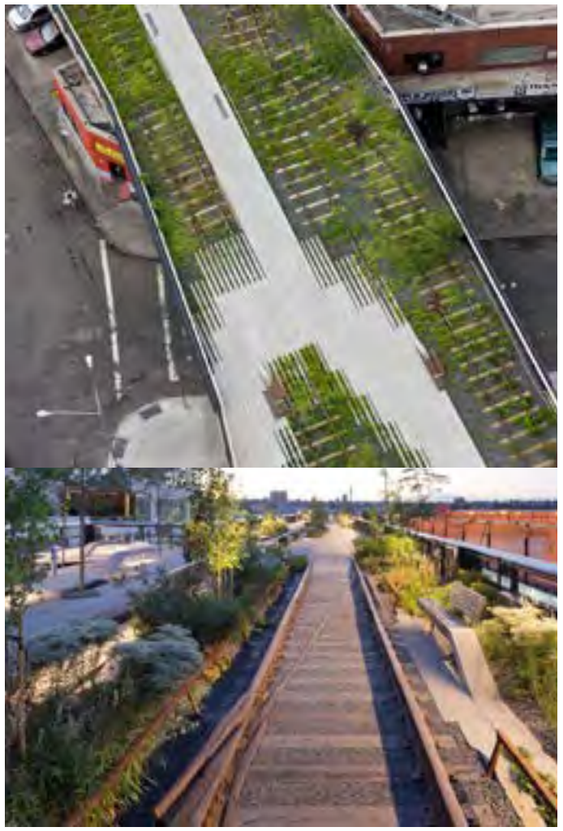


Figure 30: *Repurposing of Rai Infrastructure - The High Line, NY.*
Source: *https://www.thehighline.org/photos-videos/*

4.3 GREEN STRUCTURE APPROACH

4.3.1 SANLIHE CORRIDOR, CHINA

Located in Qian'an City, the Sanlihe River uses landscape to revive and construct both existing and new city infrastructure; it reduces pollution, provides opportunity for urban land development, and serve ecological functions This project which is essentially a linear park, transformed a seriously polluted landscape back to its previous splendor as a scenic urban ecological corridor.

Figure 31: *Sanlihe Corridor - Truenscape Landscape Architecture.*
Source: *http://www.landezine.com/index.php/2012/01/ecological-coridor-landscape-architecture/*

4.4 CITY STRUCTURE APPROACH

4.4.1 COPENHAGEN, DENMARK

Copenhagen's land-use planning has been strongly influenced over many decades by its 'Finger Plan', creating a compact urban form with high levels of accessibility. More than half the metropolitan population lives within 1km of a railway station, and around a quarter within 500 metres – figures commensurate with much larger and denser cities internationally. The city is a world leader in cycling mobility.

Figure 32: *Stroget, Pedestrian Shopping Street + Figure-Ground.*
Source: *Google Images + Great Streets (Alan Jacobs)*

4.4.2 PORTLAND, USA

The unique street grid of Portland was developed by Thomas Brown in 1845. Brown's design provided Portland with two defining characteristics that are integral to the downtown layout. He surveyed and developed a 200x200 foot grid for the first sixteen blocks of the city that extended two blocks west of the river and eight blocks running parallel to the river rather than true north points.

Figure 33: *"Bird's Eye-view"of Portland Downtown.*
Source:*Google Images + Great Streets (Alan Jacobs)*

5. BELLVILLE REBORN

5.1 CAPE TOWN's SPATIAL HISTORY

The city's spatial form was shaped by the development of its transport infrastructure, most notably the rail service and road network which formed part of a southern corridor. By the 1950s, however, Cape Town's urban form was increasingly being shaped by apartheid. This notorious policy resulted in forced removals and the implementation of discriminatory laws. Increasingly black and coloured communities were forced to live in segregated dormitory townships on the fringes of the city. This contributed fundamentally to the sprawling urban form that has stubbornly persisted in the post-apartheid era. Apart from this spatial dynamic, more recent 'localised' challenges have been a routinely failing rail system and increasing levels of congestion of the City's roads, which in turn compound many of the fundamental and structural inefficiencies in the City's current urban form and function. To this extent the new Municipal Spatial Development Framework (MSDF) introduced an investment rationale that considers how and where the City should invest in infrastructure (Figure 33).

The effects of the persistent and unsustainable urban form synonymous with the Cape Metropole's spatial structure have been the disparity between the location of job seekers and the location of the economic opportunities within the historic city centre. Undeveloped and underdeveloped land together with infrastructure failure highlight the need for transformation and integration to be thought of strategically in order to knit the city together in away that is sustainable (Figure 34).

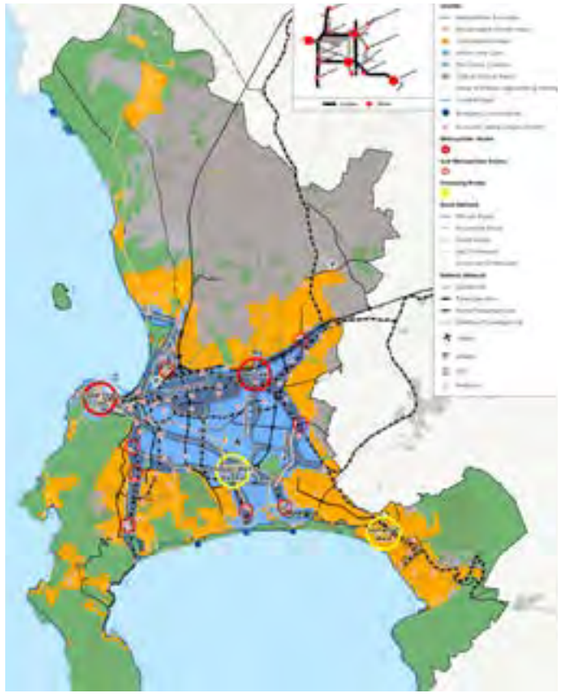


Figure 34: *Spatial Development Framework - Consolidated Spatial Spatial Plan Concept - MSDF.*
Source: *Municipal Spatial Development Framework (Policy Number 56952).*

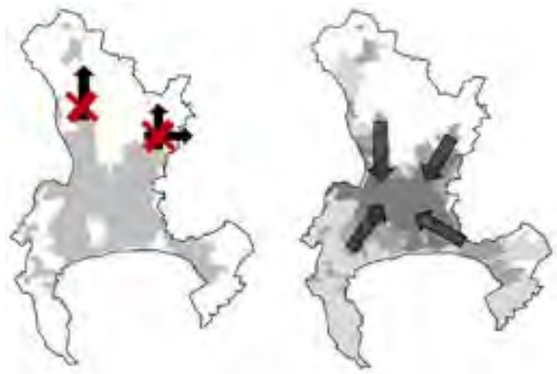


Figure 35: *Revised spatial logic - 2012 VS 2017 long-term vision*
Source: *Municipal Spatial Development Framework (Policy Number 56952).*

Figure 36: *Transport Accessible Precincts (TAPs) in relation to Integrated Public Transport Network (IPTN).*
Source: *Municipal Spatial Development Framework (Policy Number 56952).*

Figure 37: *Integrated Public Transport Network (IPTN).*
Source: *Municipal Spatial Development Framework (Policy Number 56952).*

5.2 CAPE TOWN's TRANSPORT VISION

Development corridors are generally supported by a hierarchy of transport services that function as an integrated system to facilitate ease of movement for private and public transport users. Corridor development is focused predominantly on routes serviced by mass rapid public transport services (i.e. rail or bus rapid transport (BRT) trunks). However, the routes may serve different functions, with some routes combining route functionality in terms of accessibility and mobility. The concentration of intense bands of high-intensity urban development reduces overall trip lengths and improves access to opportunities, offering a means of conveniently integrating communities with service provision, and fulfilling a range of economic and social needs.

The IPTN encompasses the rail and road based modes as well as making proposals for improving non-motorised transport access and park-and-ride facilities at modal interchanges. It determines which modes are best suited to cater for the existing and future public transport demand, route descriptions and modal interchanges, station and stop locations, system operational parameters, infrastructure needs and estimates of total system costs.

The long-term network plan indicates prioritised public transport corridors for implementation according to available funding. The public transport routes, as defined in the approved IPTN 2032, consist of the existing rail network and the planned Blue Downs rail link, the extension of the Strand line as shown in Diagrams 19 and 20 and the existing and planned BRT trunk routes.

5.3 CAPE TOWN's GROWTH HISTORY

The original growth of the city was concentrated along the southern and Tygerberg arm, marked by Main Road and Voortrekker Road respectively. The Southern arm forms a linear spine, which functions well due to the paralleling railway line which supports the functions of the economic nodes along its route. During the apartheid era, when modernist planning principles were at the fore, the growth of the city was drastically altered. Prior to the construction of the N1 national highway, Voortrekker Road was the primary access road into the City Centre. The city sprawled out toward the northern suburbs, and the outer Cape Flats grew under the influence of rapid urbanization[11]. The historically evolved areas of the two belts were substituted by the system of "neighbourhood planning" which resulted in introverted neighbourhoods within the Cape Flats area.

The introduction of the high-speed mobility routes, to cater for the increase of vehicular use which disregarded the pedestrian, added to the fragmentation of the city form. Needless to say that the modernist programmatic planning principles have significantly impacted on the lifestyle of the individual.

The unsustainable environments listed above have also created a number of problems at varying scales of city performance. Due to deficient public transport infrastructure even the poorer sections of society are "forced" to use the private car. This in turn exacerbated the congestion referred to earlier.

11 Voortrekker Road Corridor Regeneration Framework, Technical Report, BETA Edition March 2014; The Greater Tygerberg Partnership.

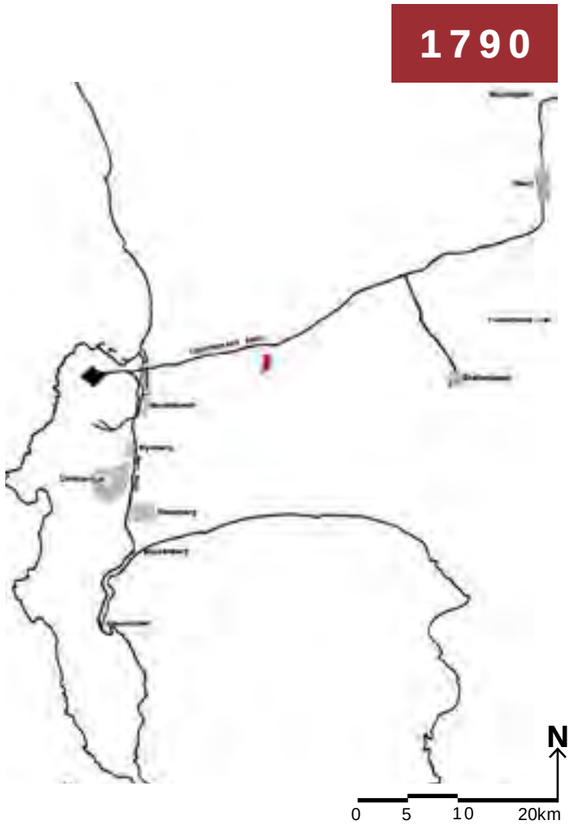


Figure 38: *Map of the first farms / Winelands with Main Road & Voortrekker Connecting them to the CBD.*
Source: *Dewar; 1991.*

Figure 39: *Walking and Horse Cart Era.*
Source: *https://www.satplan.co.za/western-cape-settlements/*

Figure 40: *Extension of CBD and introduction of railway line*
Source: *Dewar; 1991.*

Figure 41: *Suburban Rain Era.*
Source: *Roger Behrens - Urban Infrastructure Lecture-unpublished*

Figure 42: *Further expansion of Cape Metropole*
Source: *Dewar; 1991.*

Figure 43: *Freeway + Private Motor car Era.*
Source: *Roger Behrens - Urban Infrastructure Lecture-unpublished*

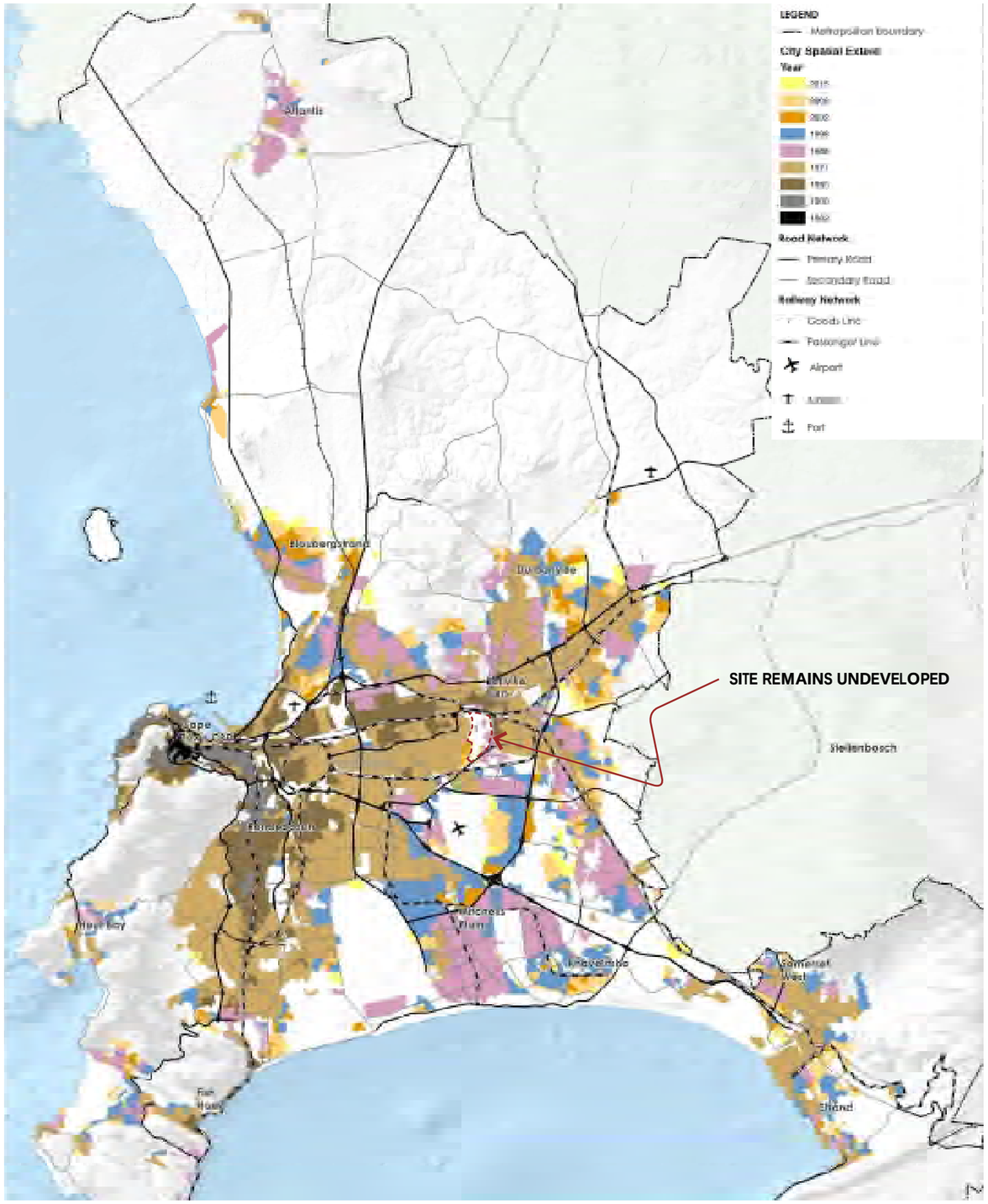
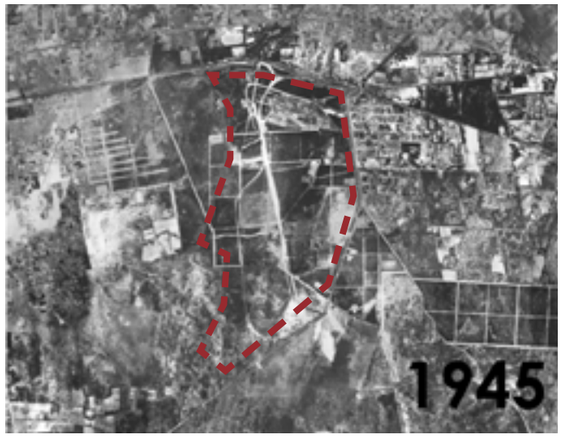
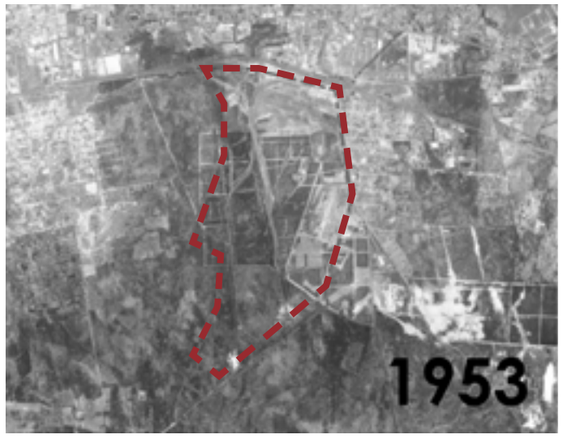
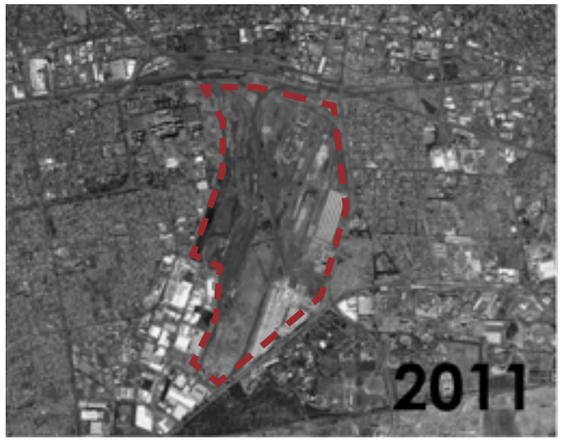


Figure 44: *City Historic Growth - Cape Town's development 1862 - 2015*
Source: *Municipal Spatial Development Framework (Policy Number 56952).*







5.4 SITE MORPHOLOGY

This historical imagery indicates the growth of development surrounding the site. This phenomenon clearly illustrates how through large scale transport infrastructure, vast land parcels act as large barriers which in the past served as the "perfect" structuring devices for planned separation between different races, socio-economic class groups and institutions. Sites like these, with its inherent negative background, now offer opportunities for spatial reconciliation through urban transformation.

Figure 45: *Historical map showing the rail network extended into the site to facilitate the Marshalling Yard*
Source: *https://adrianfrith.com/historical-maps-of-ct/*

Figure 46: *Bellville Marshalling Yard (circa 1955)*
Source: *Scheepers C (1981) Bellville: Growth of a City; Tafelberg Publishers*

Figure 47: *Bellville Train Station (date unknown)*
Source: *Independent Newspaper - online*

Figure 48: *Historical map showing increase in urban footprint + industrial uses surrounding the site*
Source: *https://adrianfrith.com/historical-maps-of-ct/*

Figure 49: *Photo from North-Western site boundary looking toward neighbouring Tygerberg Hospital*
Source: *Author, 2018.*

Figure 50: *Photo from Tienie Meyer Overpass (Northern site boundary) looking South toward the site.*
Source: *Author, 2018.*

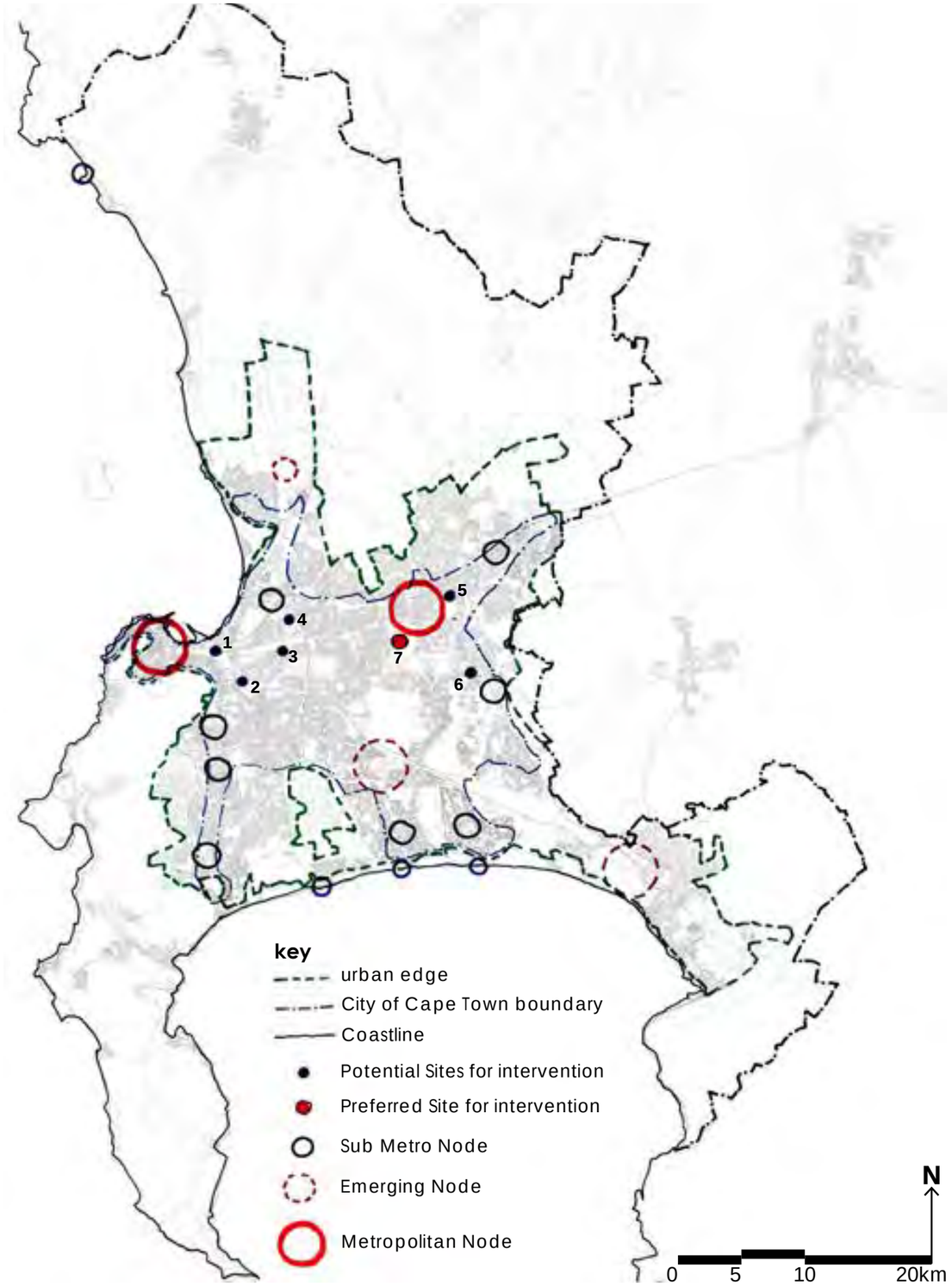


Figure 51: *Locating the site, with other potential sites, within the MSDF indicators for spatial reform.*
Source: *Author's own.*

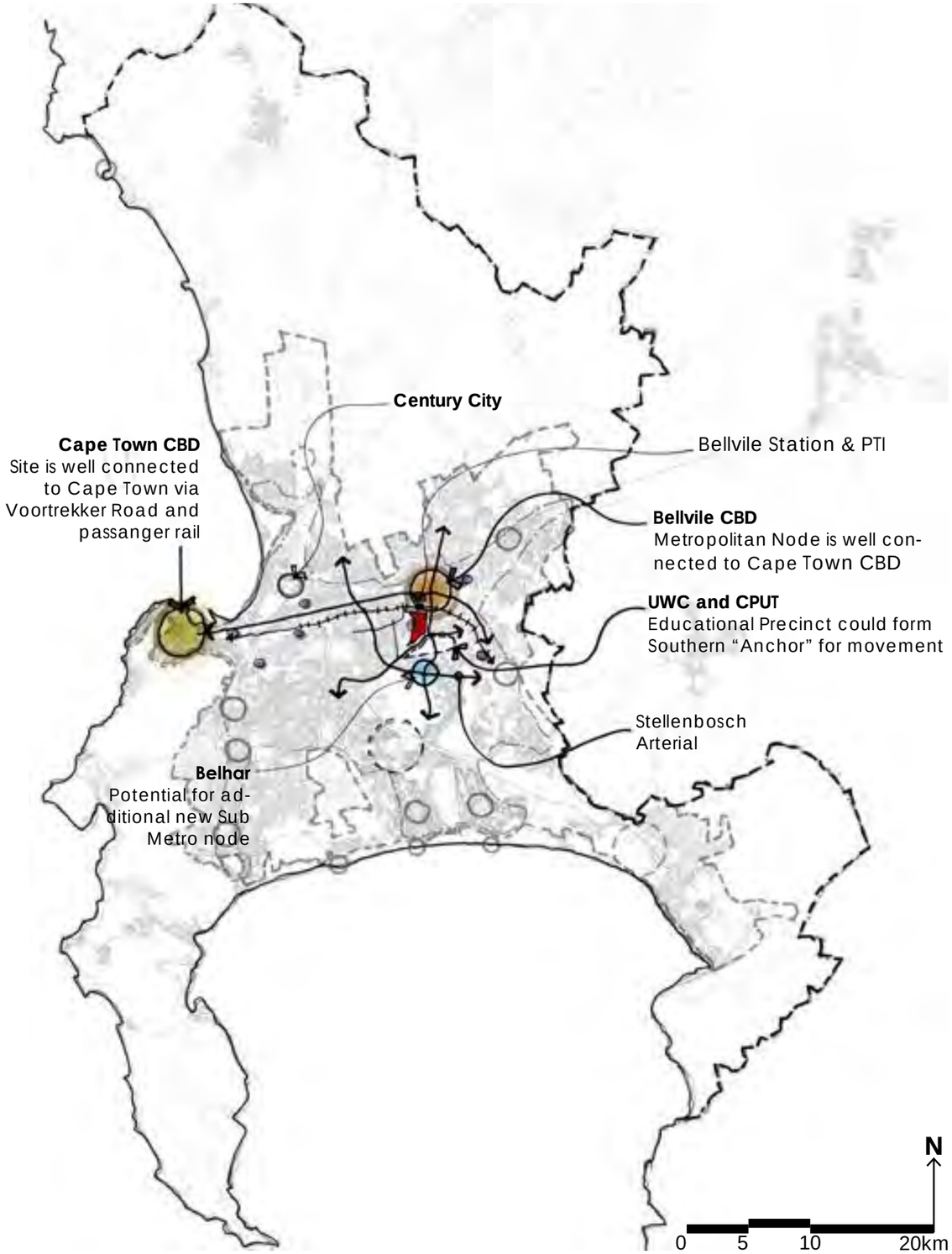


Figure 52: *Locating the site among key nodes, substantiating the site's potential for development.*
Source: *Author's own.*

5.5 SITE SELECTION

Given the spatial challenges, such as the fragmentation and inefficient use of land highlighted earlier, resulting from modernist planning strategies, it is not surprising to find well located parcels of unused or underutilised land that may be developed in order to facilitate the spatial transformation required to restructure the City and mitigate low-density sprawl on the periphery. Through a diagrammatical exercise, a number of sites within or close to the Voortrekker Road Corridor were identified for this purpose with the criteria of it being situated near public transport routes and or stations while being connected to the broader Metro via mobility routes and with a close link to green infrastructure.

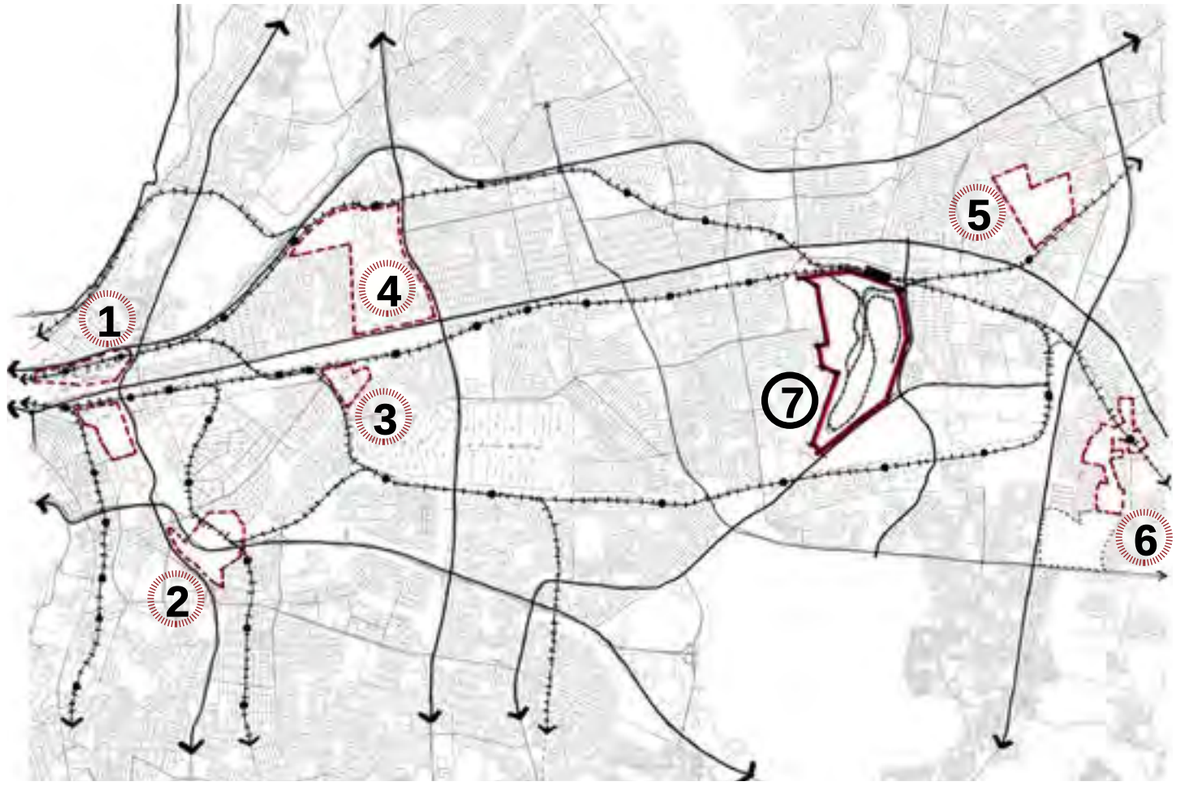


Figure 53: *Strategic sites for urban development based on research question.*
Source: *Author's own.*

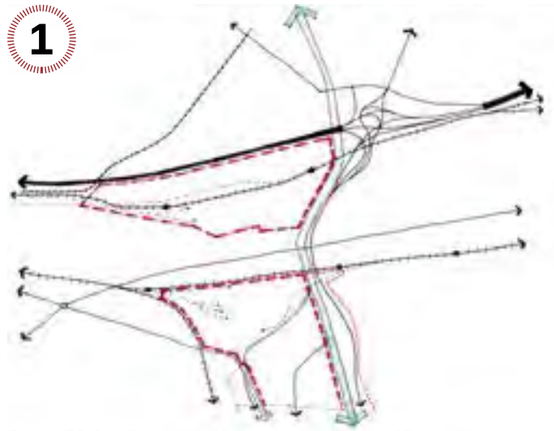


Figure 54: *Salt River and Surrounds = Approx. 125ha*
Source: *Author's own.*

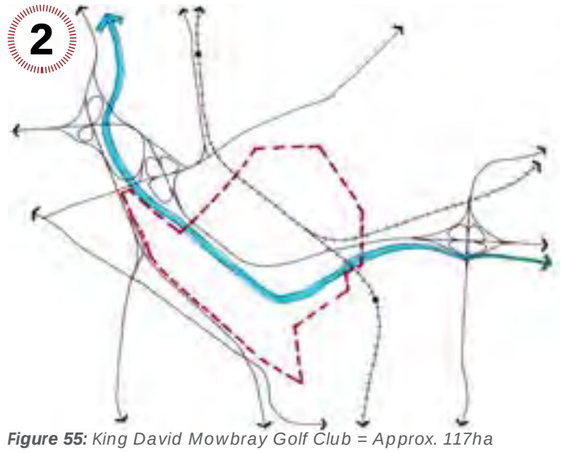


Figure 55: *King David Mowbray Golf Club = Approx. 117ha*
Source: *Author's own.*

Figure 56: *Mutual Station and Surrounds = Approx. 38ha*
Source: *Author's own.*

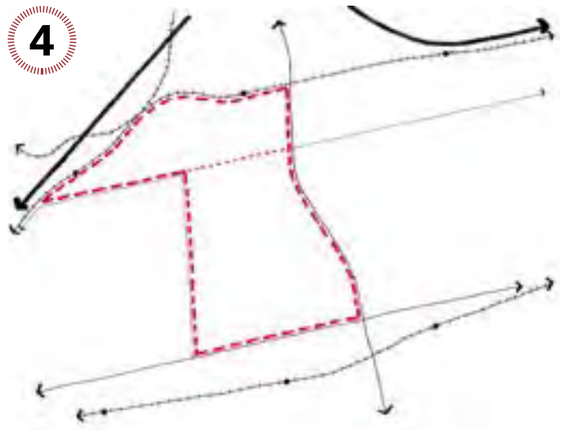


Figure 57: *Wingfield = Approx. 338ha*
Source: *Author's own.*

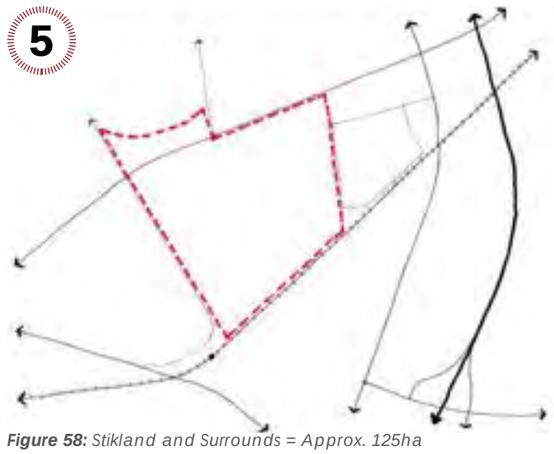


Figure 58: *Stikland and Surrounds = Approx. 125ha*
Source: *Author's own.*

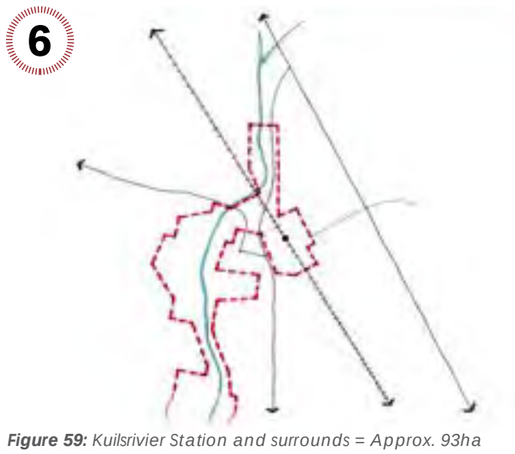


Figure 59: *Kuilsrivier Station and surrounds = Approx. 93ha*
Source: *Author's own.*

5.6 CORRIDOR AS STRUCTURE

It is imperative that development is planned within or very close to activity corridors. An activity Corridor is considered a linear zone of development adjoining a public transport route; where public transport facilities, mixed land uses, and people are all concentrated; where diverse social and economic opportunities are integrated with high density housing, providing access to a wide range of facilities and activities (CMC, 2000).

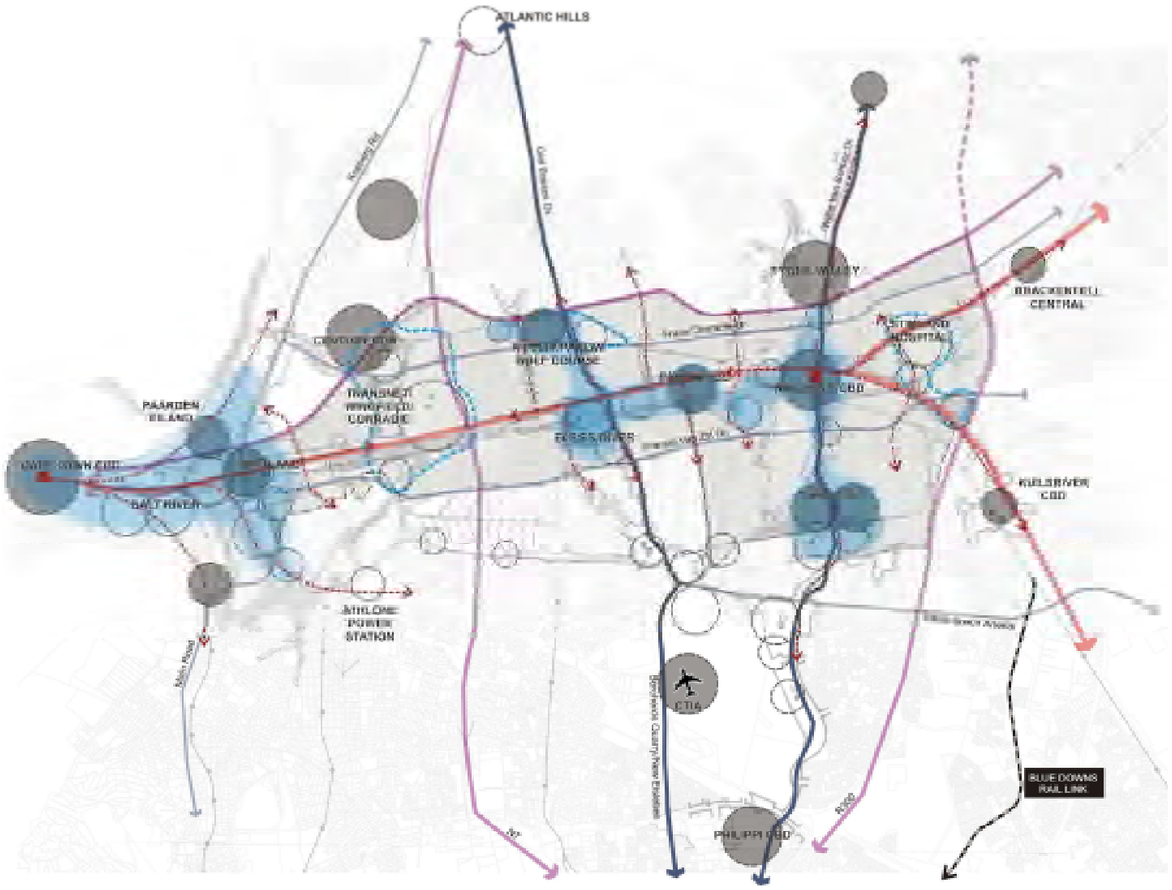


Figure 60: *Voortrekker Road Spatial Structure.*
Source: *MSDF Review 2017 Council Approved*

Figure 61: *Site is well located within the Voortrekker Road Corridor and connected to Bellville CBD*
Source: *CoCT (unpublished).*

5.7 STRATEGIC IMPERATIVE

The chosen site is the Belcon Site which houses the Belrail Marshalling Yards, located south of and connected the Bellville train station. This site was chosen on account of its strategic location withing the Voortrekker Road Corridor (VRC) and proximity to Bellville CBD, which has been identified as one of the key areas for strategic development. The VRC has also been "earmarked" for economic intensification in an attempt to revitalize the Bellville area. In addition, and perhaps more pertinent to the research question, the site offers the unique opportunity to test the transformation of infrastructure through the under utilized rail network currently on site. The site further offers the opportunity to reshape the preconceived notion that infrastructure serves as a separator - which it was certainly used as in the past - but that it can now serve as a connector. The magnitude of the site size also means that it has the ability to accommodate a vast range of uses to such an extent that it can become a self-sustaining city, which has positive implications for addressing sprawl and contribute to the sustainability of Cape Town as whole, on a global level. As much as the site offers many opportunities for urban design interventions, it also provides a platform for an interdisciplinary approach to take root with various key stakeholders such as the Tygerberg Hospital with Stellenbosch Medical Campus, Transnet, University of Western Cape, Cape Peninsula University of Technology, City of Cape Town, Cape Flats Nature Reserve and the Greater Tygerberg Partnership, that can promote and drive development in a positive way.

5. Bellville ReBorn

5.8 META ANALYSIS

CONSTRAINTS + ABSTRACT RESPONSE

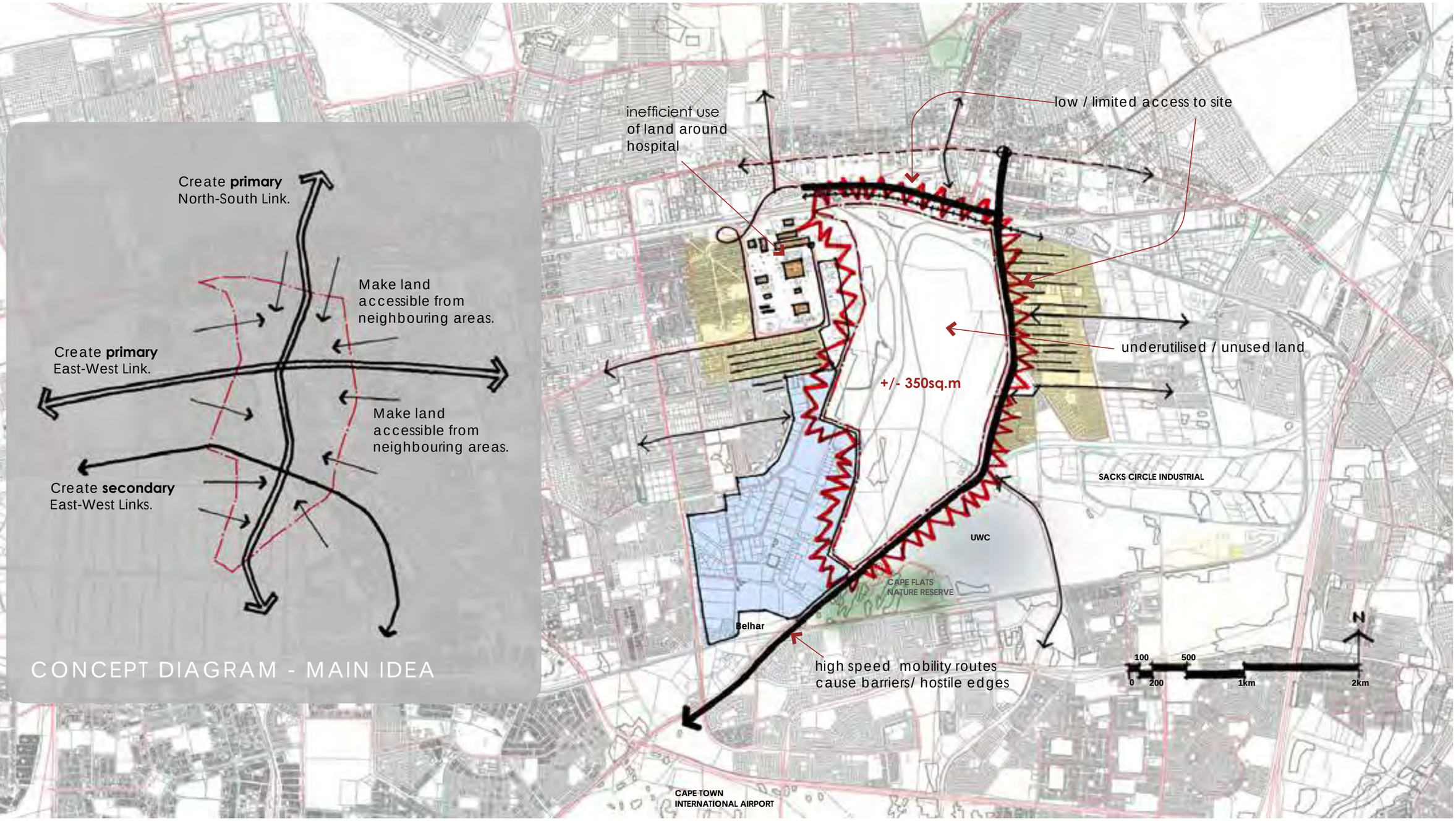


Figure 62: *Site Constraints + Abstract Response Diagram*
Source: *Author's Own - Research Project Presentation*

5. Bellville ReBorn

HIGH-LEVEL OPPORTUNITIES

1. Existing Rail Infrastructure connects site to broader Cape Town.
2. Bellville CBD identified as Metro Node - Densification.
3. Size of site - very high percentage of development.
4. Located within transport integration zone - low parking requirement.
5. Future BRT along Robert Subukwe - integration of ex. residential.
6. Sits within VRC - Follows a spatial logic at metro scale.
7. Elsieskraal River links with TRUP - runs through part of the site.
8. Site size can accommodate connection between social services.
9. TOD can be explored on account of points 1, 4 and 5 above.
10. Age of rail infrastructure may afford site heritage significance.
11. Abundant transport infrastructure allows for multi-modal streets.
12. Hospital rationalisation / consolidation frees up more land.
13. Existng water courses + river can set up N-S Ecological Corridor.
14. New East-West links opens site up for development.
15. Crossing of N-S link (existing rail infrast.) with new E-W link (new road infrastructure) sets up opportunity for nodal development that can become new civic hub.

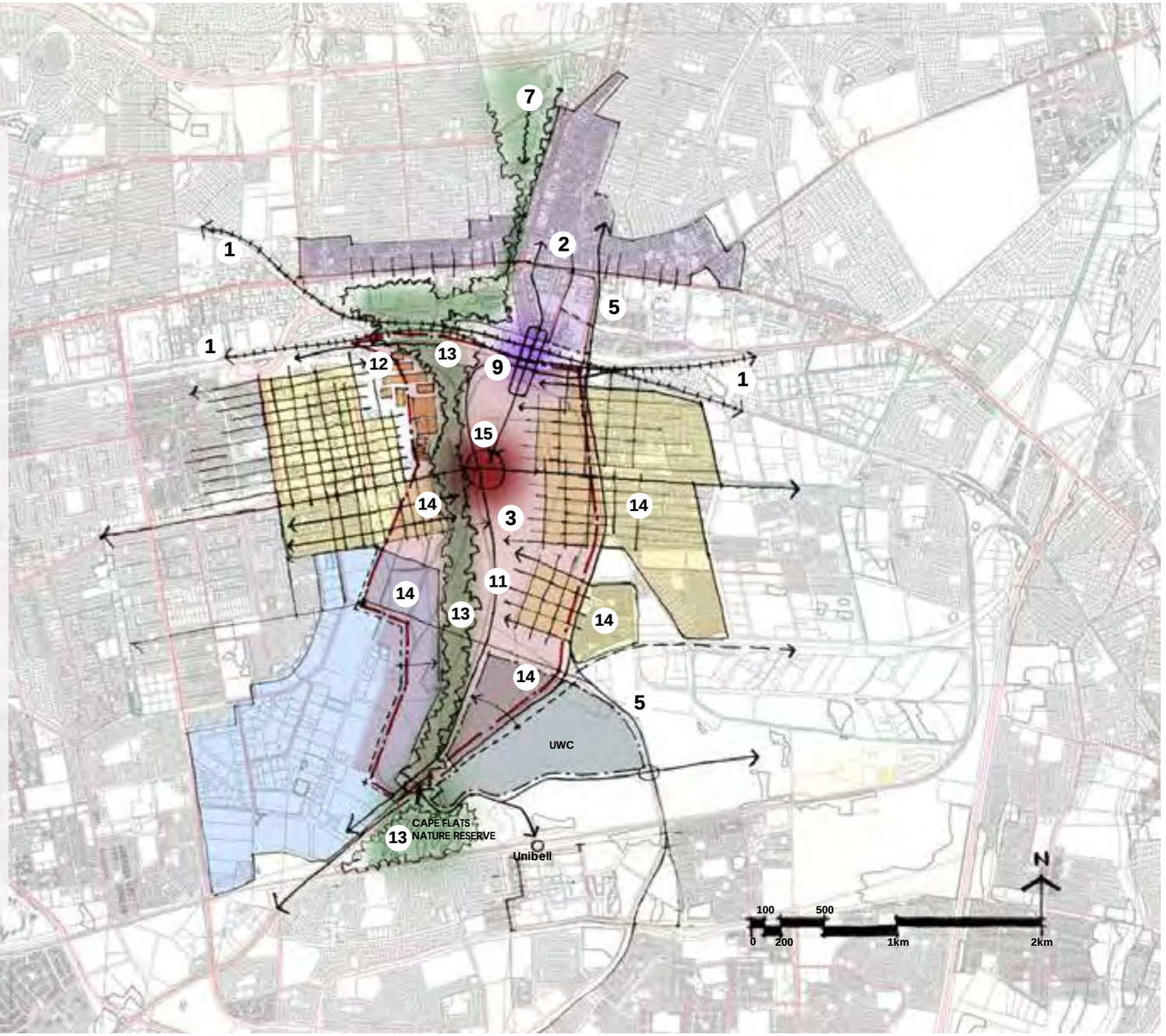


Figure 63: High-Level Opportunities in response to constraints.
Source: *Author's Own - Research Project Presentation*

5. Bellville ReBorn

ENHANCE MOVEMENT + SOCIAL NETWORK

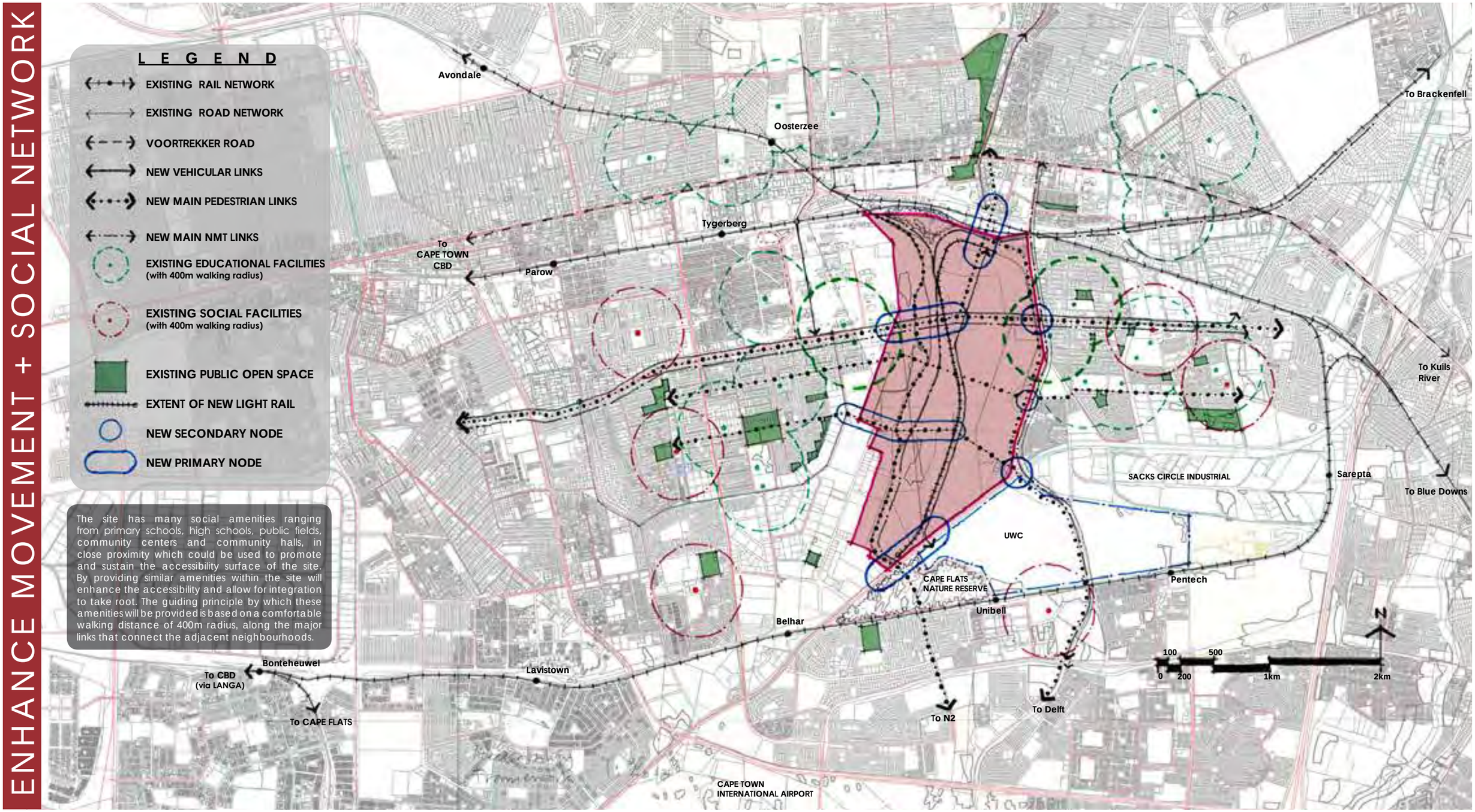


Figure 64: Strategy for enhancing the Movement and Social Networks.
Source: *Author's Own - Research Project Presentation*

5. Bellville ReBorn

5.9 MICRO ANALYSIS

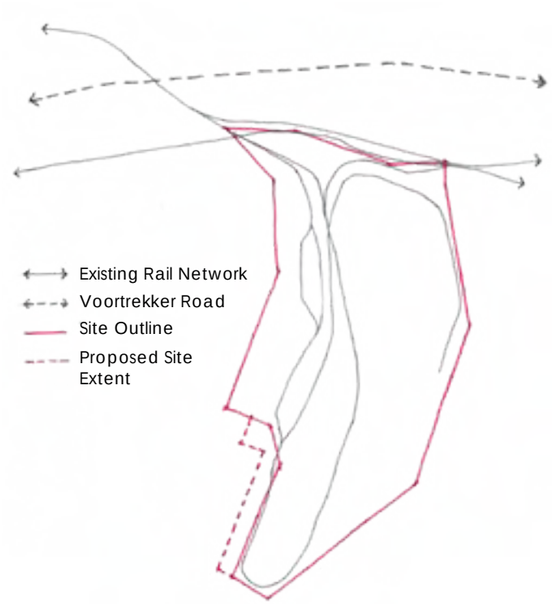


Figure 65: *Existing Rail Infrastructure on site.*
Source: *Author's Own - Research Project Presentation*

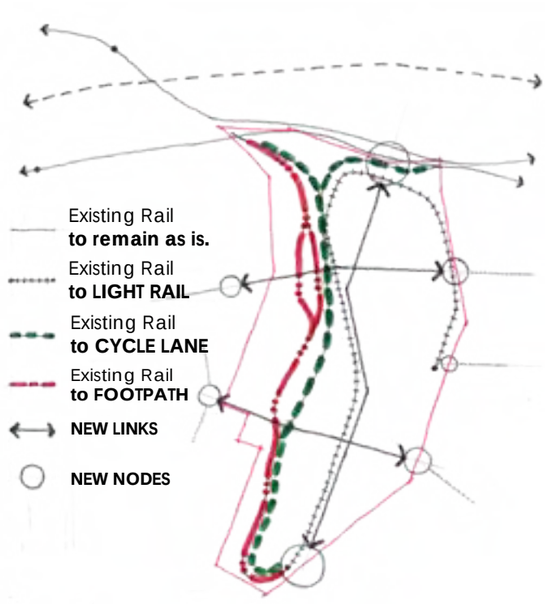


Figure 66: *Repurposed Rail + New Movement Network.*
Source: *Author's Own - Research Project Presentation*

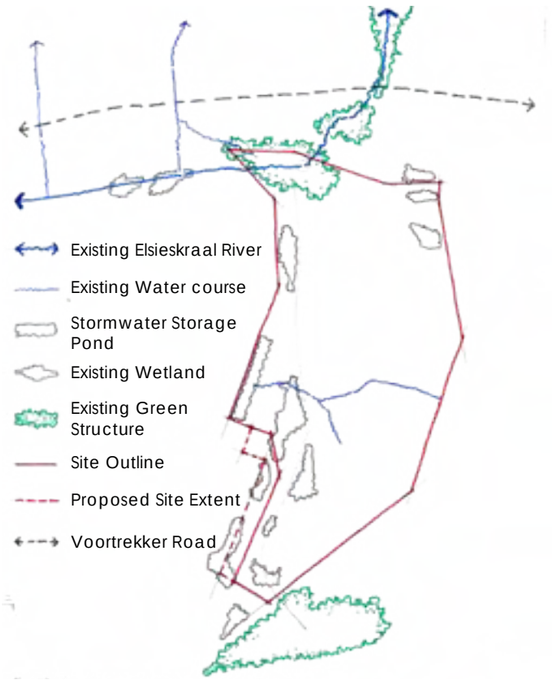


Figure 67: *Existing Natural System - to sustain movement.*
Source: *Author's Own - Research Project Presentation*

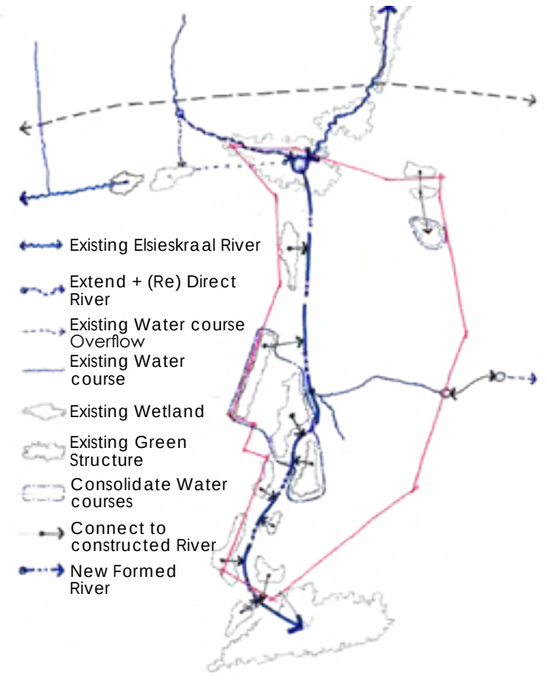


Figure 68: *Formation of Proposed Ecological Corridor*
Source: *Author's Own - Research Project Presentation*

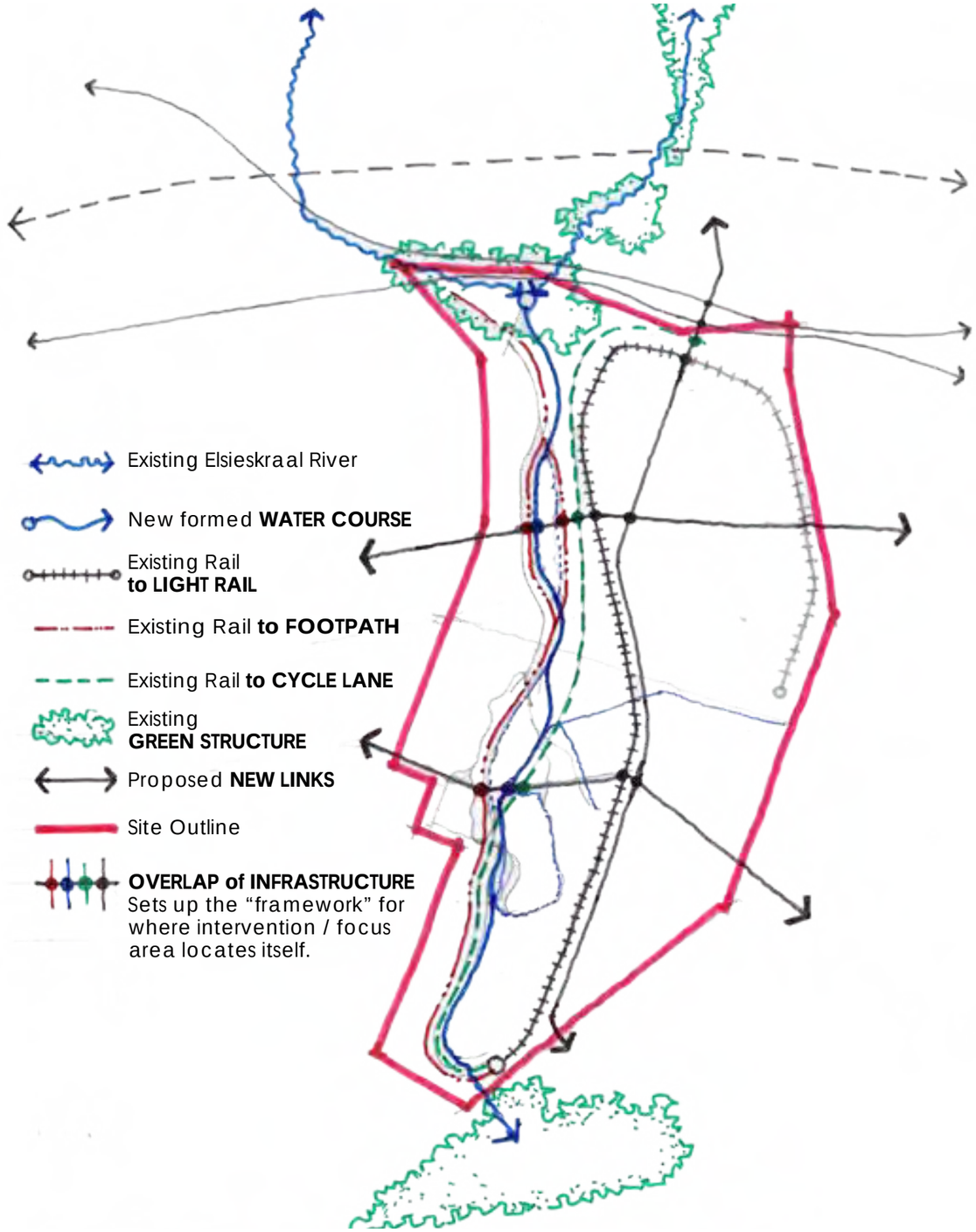
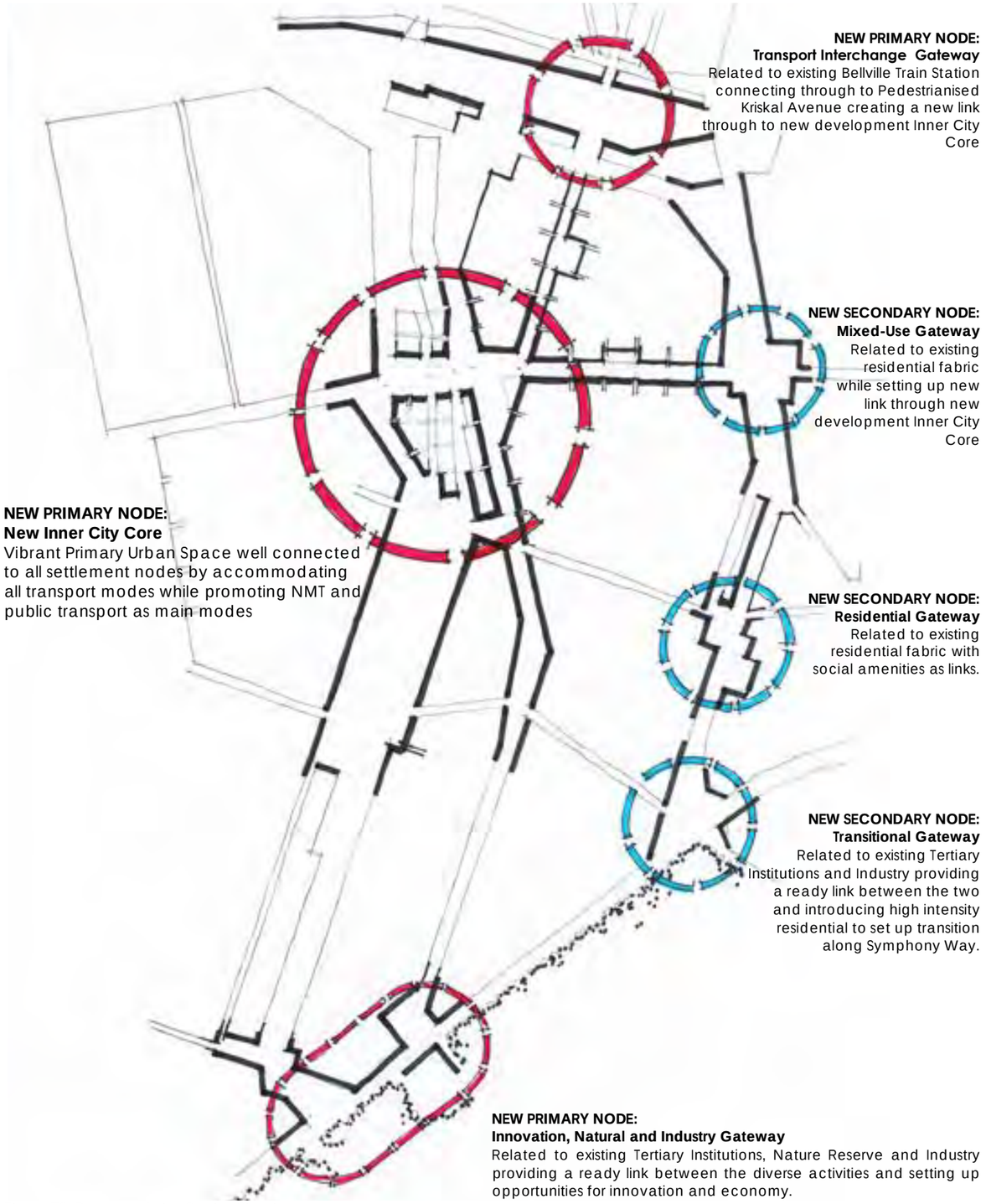


Figure 69: *PROPOSED NEW COMBINED MOVEMENT + ECOLOGY NETWORK*
Combination of these two infrastructures used toward setting up a spatial structure
Source: *Author's Own - Research Project Presentation*

5.10 INITIAL SPATIAL STRUCTURE



NEW PRIMARY NODE:
Transport Interchange Gateway
Related to existing Bellville Train Station connecting through to Pedestrianised Kriskal Avenue creating a new link through to new development Inner City Core

NEW SECONDARY NODE:
Mixed-Use Gateway
Related to existing residential fabric while setting up new link through new development Inner City Core

NEW PRIMARY NODE:
New Inner City Core
Vibrant Primary Urban Space well connected to all settlement nodes by accommodating all transport modes while promoting NMT and public transport as main modes

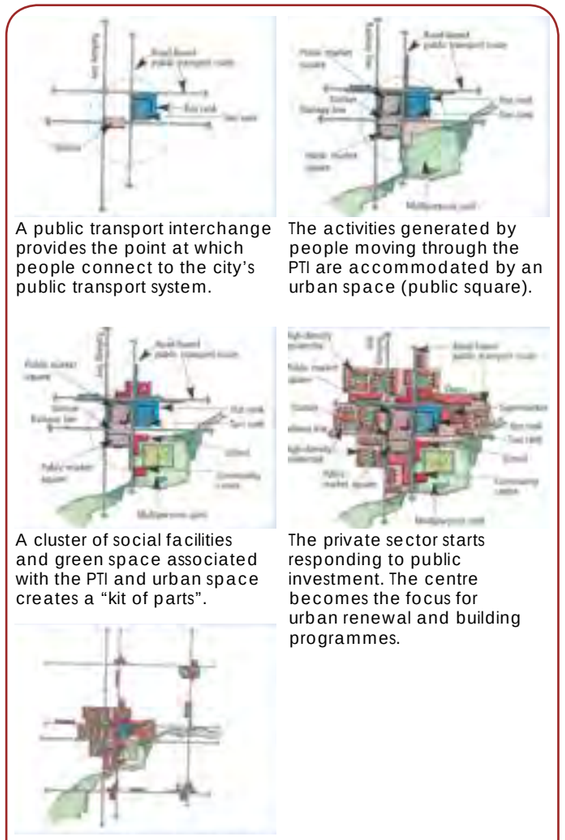
NEW SECONDARY NODE:
Residential Gateway
Related to existing residential fabric with social amenities as links.

NEW SECONDARY NODE:
Transitional Gateway
Related to existing Tertiary Institutions and Industry providing a ready link between the two and introducing high intensity residential to set up transition along Symphony Way.

NEW PRIMARY NODE:
Innovation, Natural and Industry Gateway
Related to existing Tertiary Institutions, Nature Reserve and Industry providing a ready link between the diverse activities and setting up opportunities for innovation and economy.

Figure 70: *Proposed Initial Spatial Structure.*
Source: *Author's Own - Research Project Presentation*

5.11 GENERIC STRUCTURING IDEAS



A public transport interchange provides the point at which people connect to the city's public transport system.

The activities generated by people moving through the PTI are accommodated by an urban space (public square).

A cluster of social facilities and green space associated with the PTI and urban space creates a "kit of parts".

The private sector starts responding to public investment. The centre becomes the focus for urban renewal and building programmes.

A system of larger and smaller centres linked by continuous public transport routes.

Figure 71: *How a Public Transport Interchange (PTI) becomes a centre over time.*
Source: *CoCT.*

A series of "generic" or general concepts are explored here that give guidance to the formalizing of an intervention in the sections that follow. The sequence through which nodal points generate development is expressed in Figure 71. In Urban Design and planning, another key consideration is the concept of **Human Scale**, which describes those levels, limits and conditions at which humans comfortably experiences things. The concern for scale hinges on decisions about relative size, heights, distance and magnitude. The string of beads concept (Figure 72) illustrates the estimate of distances which are comfortable for pedestrians. This in turn relates to **Walkability** which can be seen as the biggest sign to achieving liveability. In respect of transport the goal is to shift from a radial transport network to a mult-diectional grid based system (Figure 73). This approach will assist with the integration of exclude parts of the city and improve access to the new economic backbone with its opportunities, services / facilities, recreation and special places.

Figure 72: *The Human Scale and accessibility of corridors.*
Source: *CoCT - Muni-SDF*

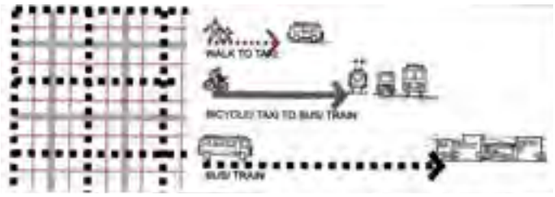


Figure 73: *Shift from radial to multi-directional transport network.*
Source: *CoCT - Muni-SDF*

5.12 DESIGN PRINCIPLE ONE

This principle relates to activations of the North and South boundaries and is premised on the concept of two points of interest connected by a line. These two points are the Bellville train station and Public Transport Interchange (PTI) to the North and the University of Western Cape (UWC) to the South. It is envisaged that intensive development and activity in and around Bellville station will be the catalyst for the Northern activation. The Southern activation hinges primarily on the notion that the academic institutions will in all likelihood expand, with UWC specifically looking to grow their research capability. This calls for a dedicated (research) campus, together with a requirement for additional student accommodation. The very nature of such a programmatic requirement generates vibrant activity of students. The existing rail network automatically becomes the line that connects the two nodes with its stops providing opportunities for future "crossover" points.

PRECEDENT: Valencia, Calle Mondúber.
(before and after the replacement of the rail-way by the light metro)

Figure 74: *Valencia, Calle Monduber, Railway as barrier.*
Source: *http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/conversion_rail_lines_pwc.pdf*

Figure 75: *Valencia, Calle Monduber, Railway repurposed.*
Source: *http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/conversion_rail_lines_pwc.pdf*

REPURPOSE RAIL INFRASTRUCTURE

PRINCIPLE 1: North + South Boundary Activations.

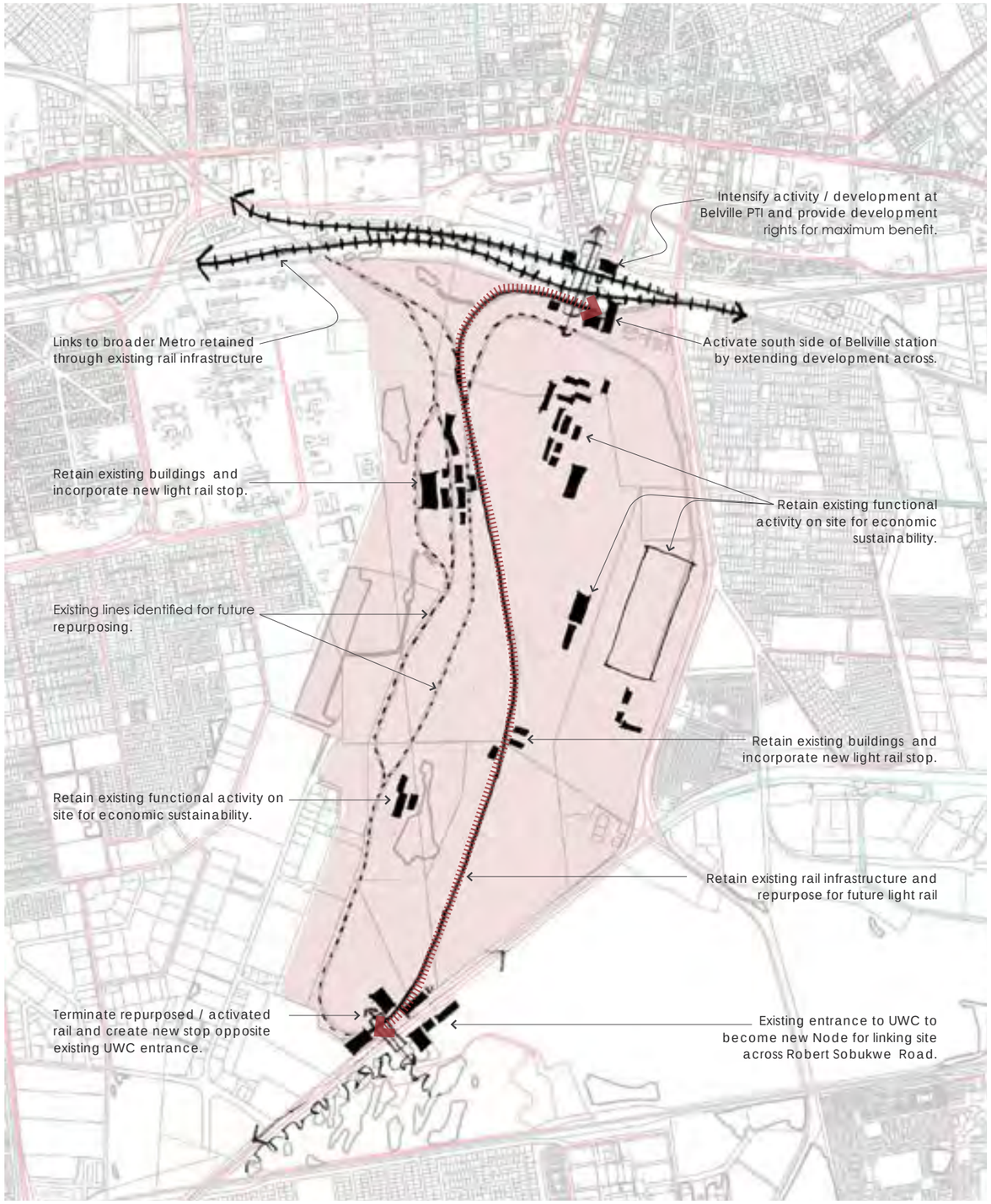


Figure 76: *Principle One - Repurposing of Rail of Rail infrastructure to accommodate future light rail network.*
Source: *Author's Own - Research Project Presentation*

5.13 DESIGN PRINCIPLE TWO

The East boundary activation hinges on the anticipated Bus Rapid Transit (BRT) network which proposes a trunk route along Symphony Way, which is currently the barrier that separates the site from the adjoining residential neighbourhood. Thus, this principle manifests itself through leveraging the City's planned public transport infrastructure as the catalyst for connecting the site to the neighbouring residential area. This is premised on the developmental potential associated with Transit Orientated Development (TOD) which comes about through intense activities at the Trunk Stops along the BRT route. These trunk stops offer the potential for small scale nodal development to happen, which then sets up opportunities for intensification of land-use with the existing fabric and new development on the site which corresponds with the same point of activity.

PRECEDENT: Curitiba, Brazil.
(introduction of BRT as a means to accom-

Figure 77: *Curitiba, Brazil - BRT network*
Source: *https://www.123rf.com/photo_58778084_curitiba-brazil-october-7-2014-people-ride-city-bus-in-curitiba-brazil-curitiba-s-bus-system-is-worl.html*

Figure 78: *Curitiba, Brazil - BRT network*
Source: *https://www.123rf.com/photo_58778084_curitiba-brazil-october-7-2014-people-ride-city-bus-in-curitiba-brazil-curitiba-s-bus-system-is-worl.html*

LEVERAGING PLANNED INFRASTRUCTURE

PRINCIPLE 2: East Boundary Activation through BRT.

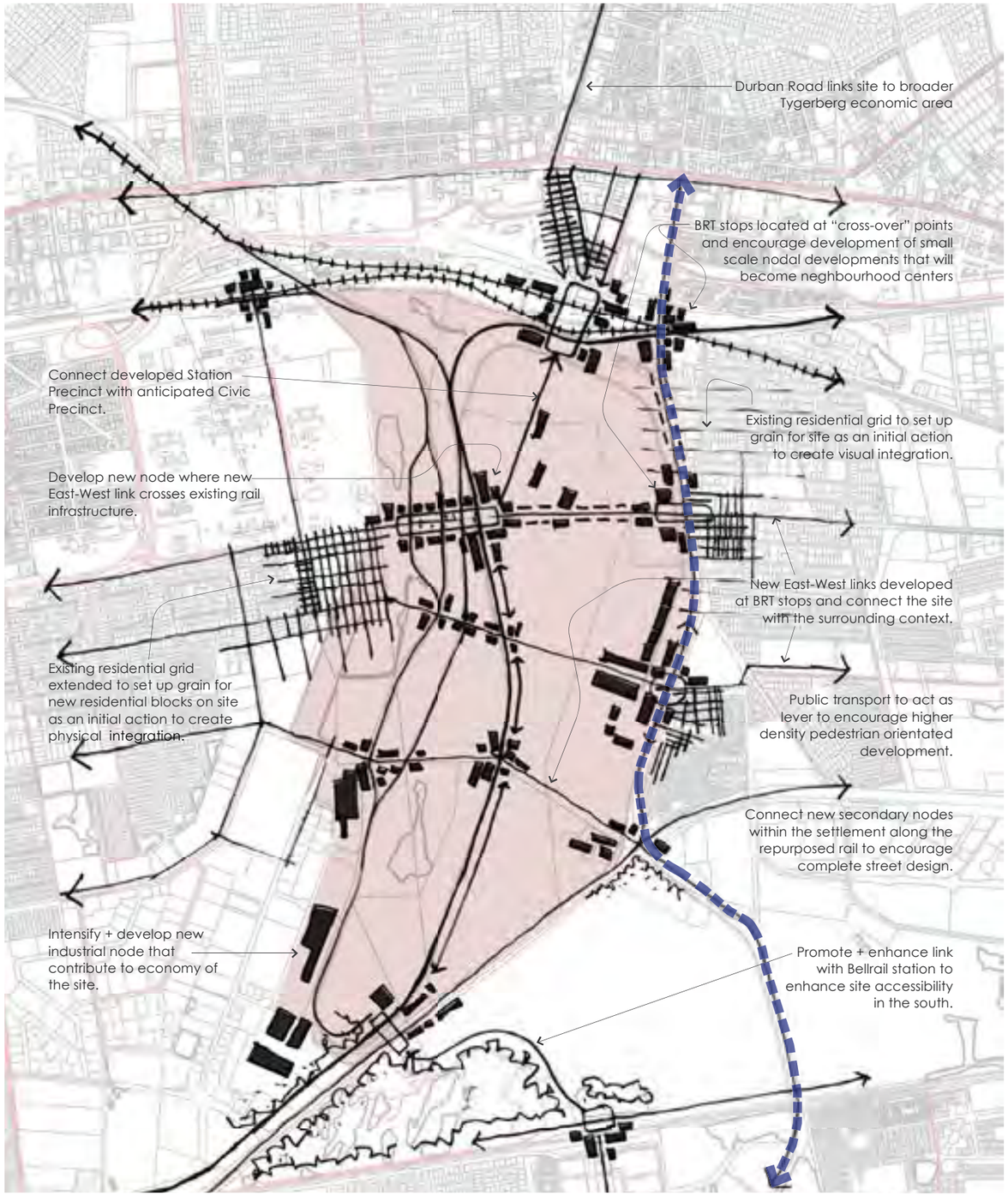


Figure 79: *Principle Two - Boundary activation through leveraging planned infrastructure.*
Source: *Author's Own - Research Project Presentation*

5.14 DESIGN PRINCIPLE THREE

This principle addresses the West Boundary approach to development through green infrastructure which extends beyond the site and connects to the city-wide green structure. A number of recreational fields and parks are situated close to the site. By revitalizing these with a view to link with and through the main spatial structures if the city the site becomes as sustainable source of natural systems.

PRECEDENT: Sanlihe Corridor, China.
(Linear park revitalised as a scenic ecological corridor)

Figure 80: *Sanlihe River Polluted and inhabitable.*
Source: *http://www.landezine.com/index.php/2012/01/ecological-coridor-landscape-architecture/f*

Figure 81: *Sanlihe River transformed into functional Eco Corridor.*
Source: *http://www.landezine.com/index.php/2012/01/ecological-coridor-landscape-architecture/f*

DEVELOPING AN ECOLOGICAL CORRIDOR

PRINCIPLE 3: West Boundary "Activation" through Ecology

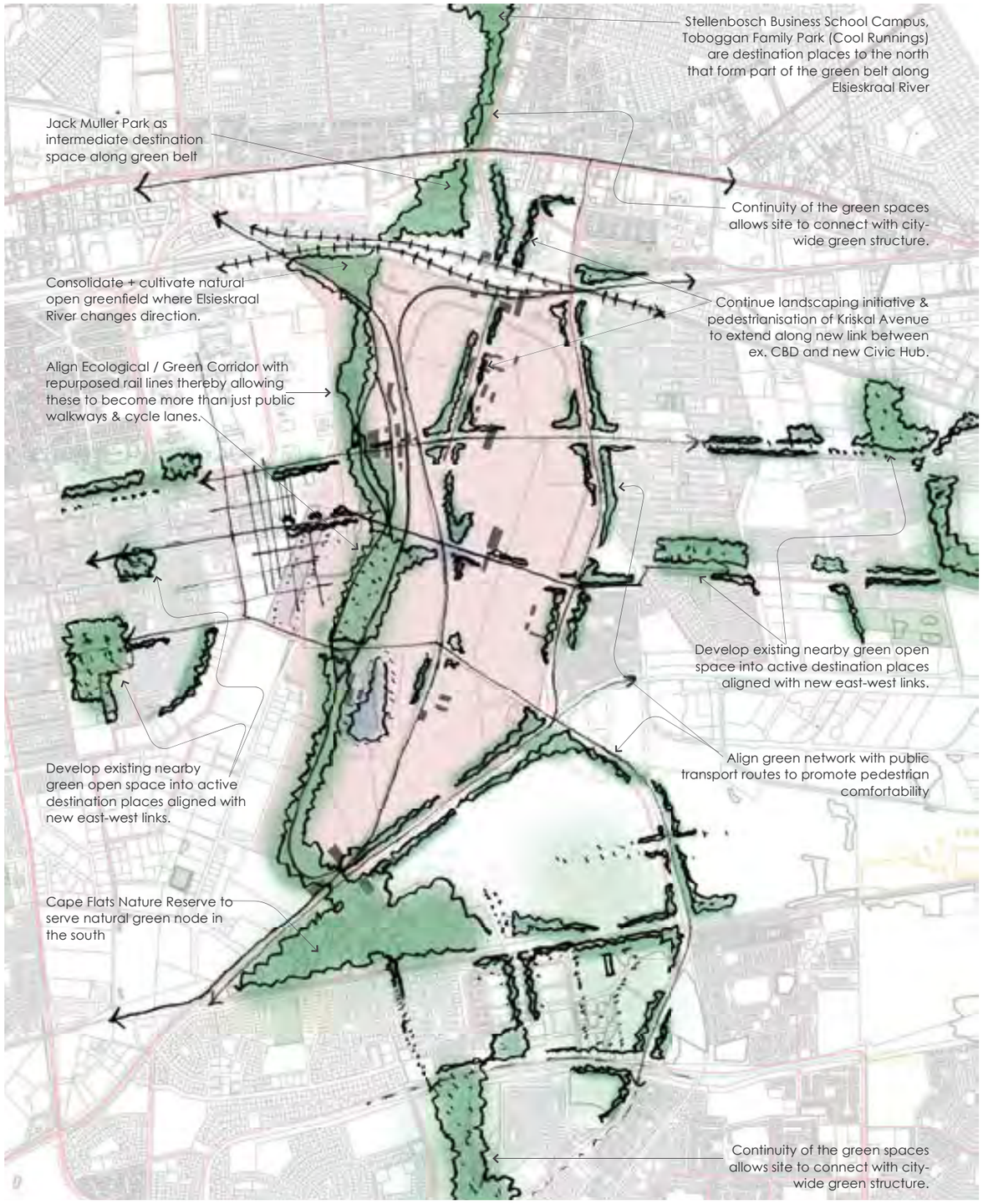
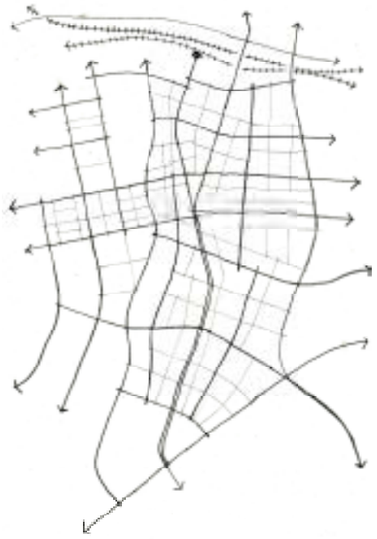


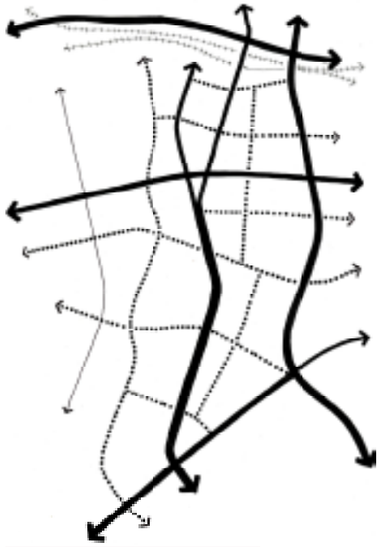
Figure 82: *Principle Three - Development of an Ecological Corridor.*
Source: *Author's Own - Research Project Presentation*

5.15 URBAN DESIGN COMPONENTS : Movement Network



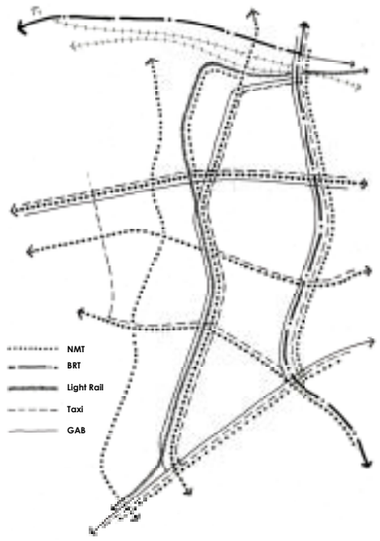
PERMEABILITY

An important place quality established by the (cadastral) STREET pattern is **PERMEABILITY** - the extent to which an environment allows people a choice of routes through and within.
Carmona. M; Tiesdell. S; Heath. T; Oc. T (2010) - Public Places, Urban Spaces. The Dimensions of Urban Design.



MOVEMENT HIERARCHY

Movement is the lifeblood of Urban systems.
Dewar. D; Todeschini. F (2004) - Rethinking Urban Transport after Modernism.
Streets and sidewalks - the main public places of a city, are its most vital organs - *Jane Jacobs.*
Therefore **MOVEMENT HIERARCHY** as an element of urban structure and urban space, needs to be developed with people in mind as opposed to cars.



MODAL SPLIT

"The one thing we need to solve our transportation problem is to stop thinking that there is one thing we can do to solve our transportation problem" - *Robert Liberty.*
An important part of creating efficient, integrated settlements is using different modes of (public) transportation to play the role that they are best equipped to play and integrating these.
Dewar. D; Todeschini. F (2004) - Rethinking Urban Transport after Modernism.

Figure 83 - 85: *Diagrammatic representation of movement-related urban design components associated with site structure.*
Source: *Author's Own - Research Project Presentation*

Figure 86: *Three dimensional representation of primary movement networks.*
Source: *Author's Own - Research Project Presentation*

OVERALL MOVEMENT NETWORK

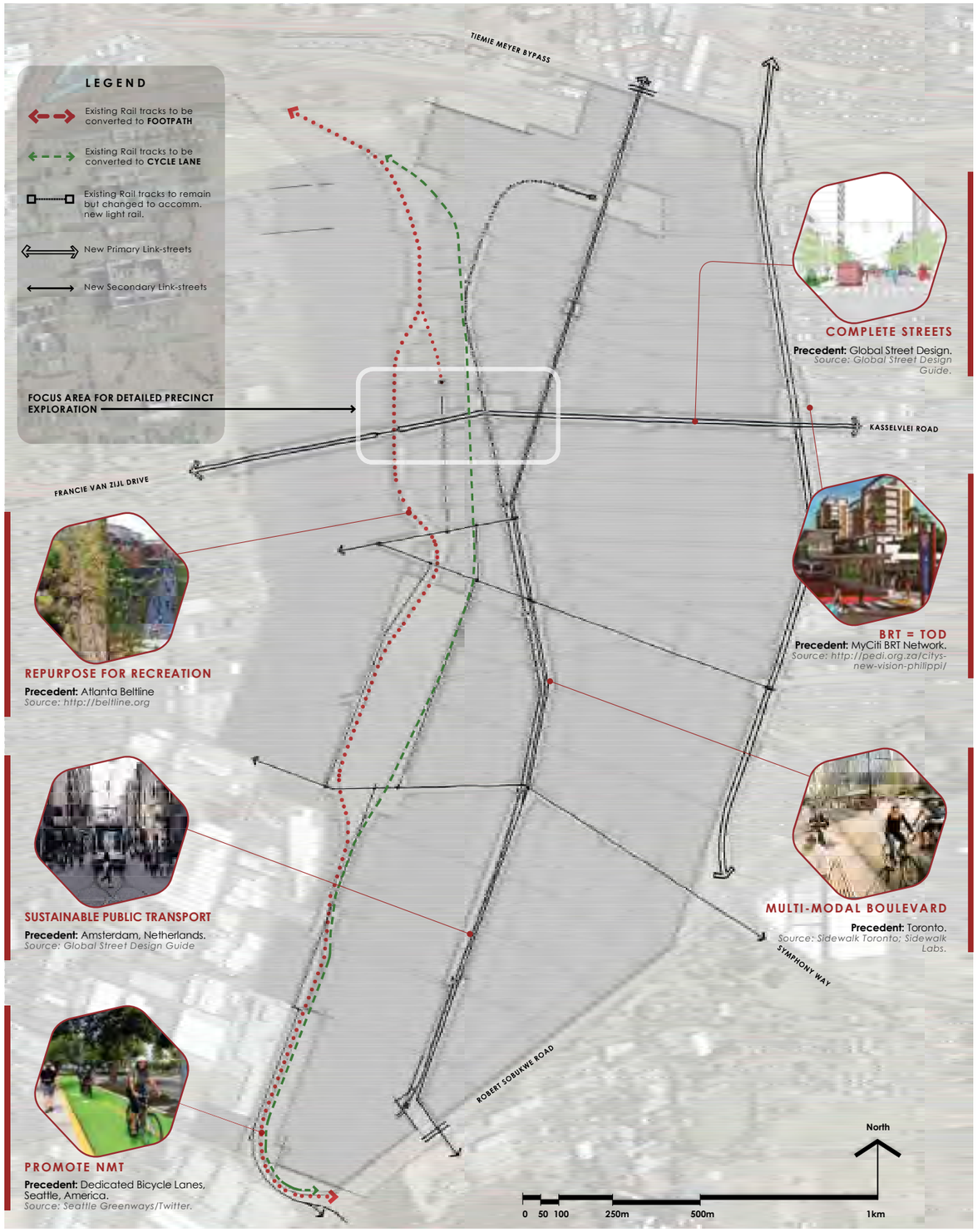
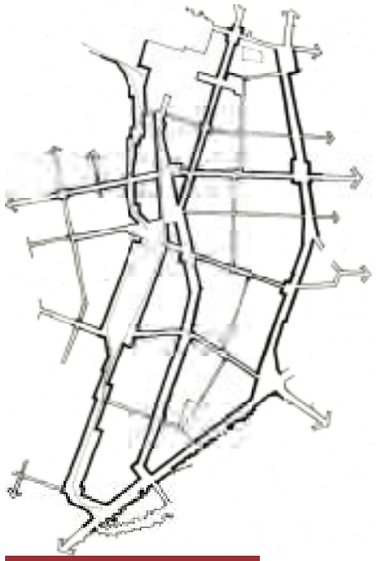


Figure 87: *Design Intervention - Overall Movement Network + Precedent to show characteristics of various movement components.*
Source: *Author's Own - Research Project Presentation*

5.16 URBAN DESIGN COMPONENTS : Spatial Structure

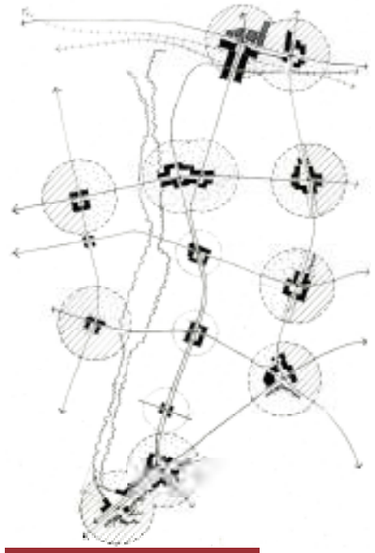


MAIN PUBLIC SPACES

Conceived as a **PUBLIC SPACE NETWORK**, urban block structures open up possibilities and can provide coherence and 'good' urban form without necessarily being overly deterministic about architectural form or content (use).
Carmona. M; Tiesdell. S; Heath. T; Oc. T (2010) - Public Places, Urban Spaces. The Dimensions of Urban Design.

GREEN STRUCTURE

The importance of, and the approach to **GREEN STRUCTURE** is based on the premise / concept of achieving continuities of green space to promote self-maintenance, biodiversity and habitat selection, forming a sustainable ecological corridor throughout the settlement.
Dewar. D; Louw. P (2018) - Unpublished Work



GATEWAYS + INTERFACES

The entrances into settlements should be spatially announced, as should special precincts within them. This can be achieved by 'pinching' the space through the use of buildings or creating splays, thereby forming **GATEWAYS.**
Dewar. D; Louw. P (2018) - Urban Design Framework for Bergville - Unpublished Work
The surrounding context informs the approach to **INTERFACI** - whether new development or densification / intensification of the existing fabric is required.

Figure 88 - 90: *Diagrammatic representation of spatial urban design components associated with site structure.*
Source: *Author's Own - Research Project Presentation*

Figure 91: *Three dimensional representation of primary Spatial networks (Nodes)*
Source: *Author's Own - Research Project Presentation*

OVERALL URBAN SPACE STRUCTURE

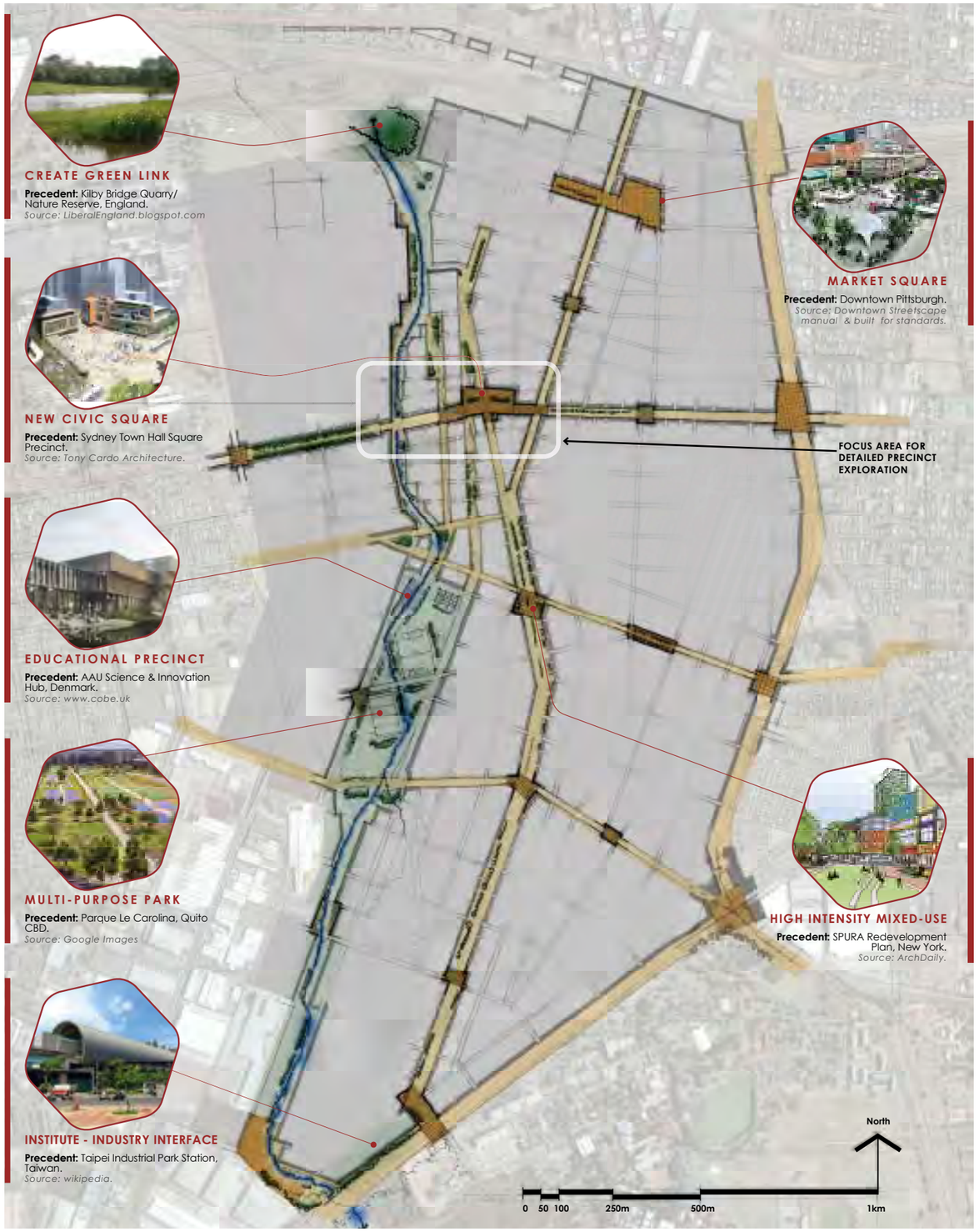
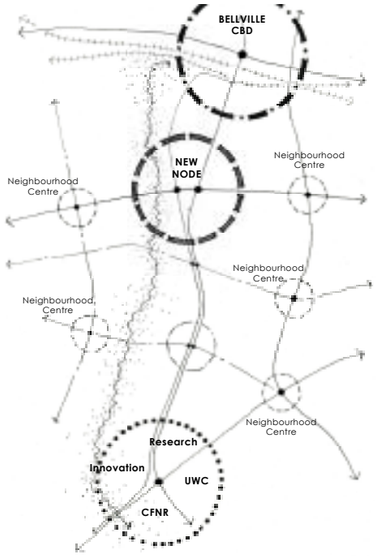


Figure 92: *Design Intervention - Overall Urban Space Structure + Precedent to show characteristics of various Spatial components.*
Source: *Author's Own - Research Project Presentation*

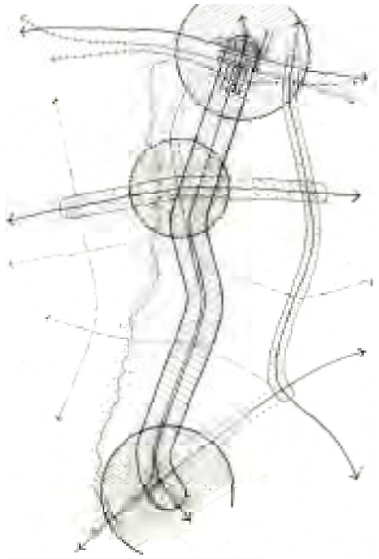
5.17 URBAN DESIGN COMPONENTS : Built Form + Urban Structure



ACTIVITY

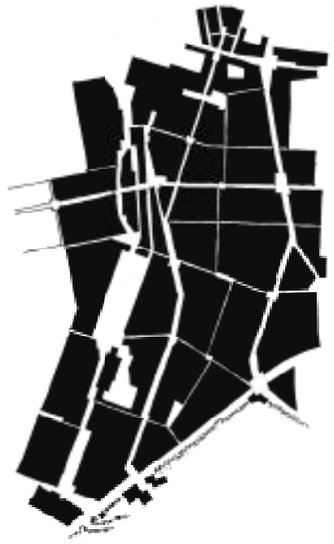
The different activities generated throughout a new development offers variety to the settlement. Variety of use is therefore key to variety as whole. - *Responsive Environments.*

The mix of uses and **ACTIVITIES** and the arrangement of these in relation to the surrounding fabric optimises the sites potential for development.
Source: Urban Design Policy: City of Cape Town.



INTENSITY

INTENSITY refers to achieving a greater spectrum of mixed land uses through increased use of space, both horizontally and vertically, within existing areas, properties and new developments. Intensity in the movement of people,goods, public transport and private vehicles is one of the structuring characteristics for settlements.
Source: Urban Design Policy: City of Cape Town.



URBAN STRUCTURE

The **URBAN STRUCTURE** diagram indicated using the Figure Ground method, shows the different patterns of urban space The morphological tissue is set up through a combinatio of existing neighbouring grid structure together with the hierarchy of movement network and the green structure.
Literature reference for Figure-ground Theory: Trancik, R (1986) Finding Lost Space, Chapter 4 - Three Theories of Urban Spatic Design.

Figure 93 - 95: *Diagrammatic representation of programmatic urban design components associated with site structure.*
Source: *Author's Own - Research Project Presentation*

Figure 96: *Three dimensional representation of potential built form with primary nodes.*
Source: *Author's Own - Research Project Presentation*

OVERALL DEVELOPMENT BUILT FORM

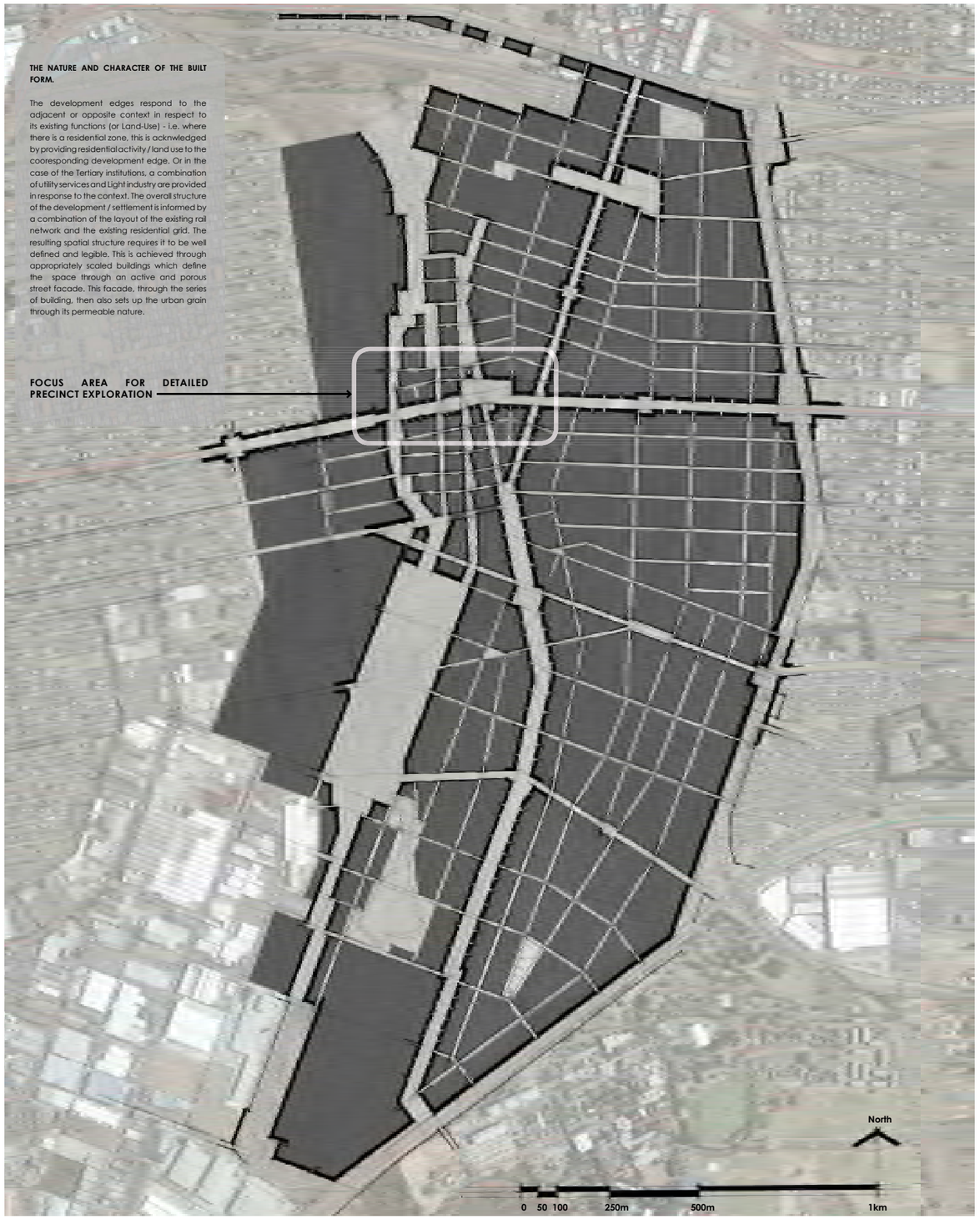


Figure 97: *Design Intervention - Overall (potential) Built Form as set up by urban structure.*
Source: *Author's Own - Research Project Presentation*

5.18 ANTICIPATED SITE ACTIVITY

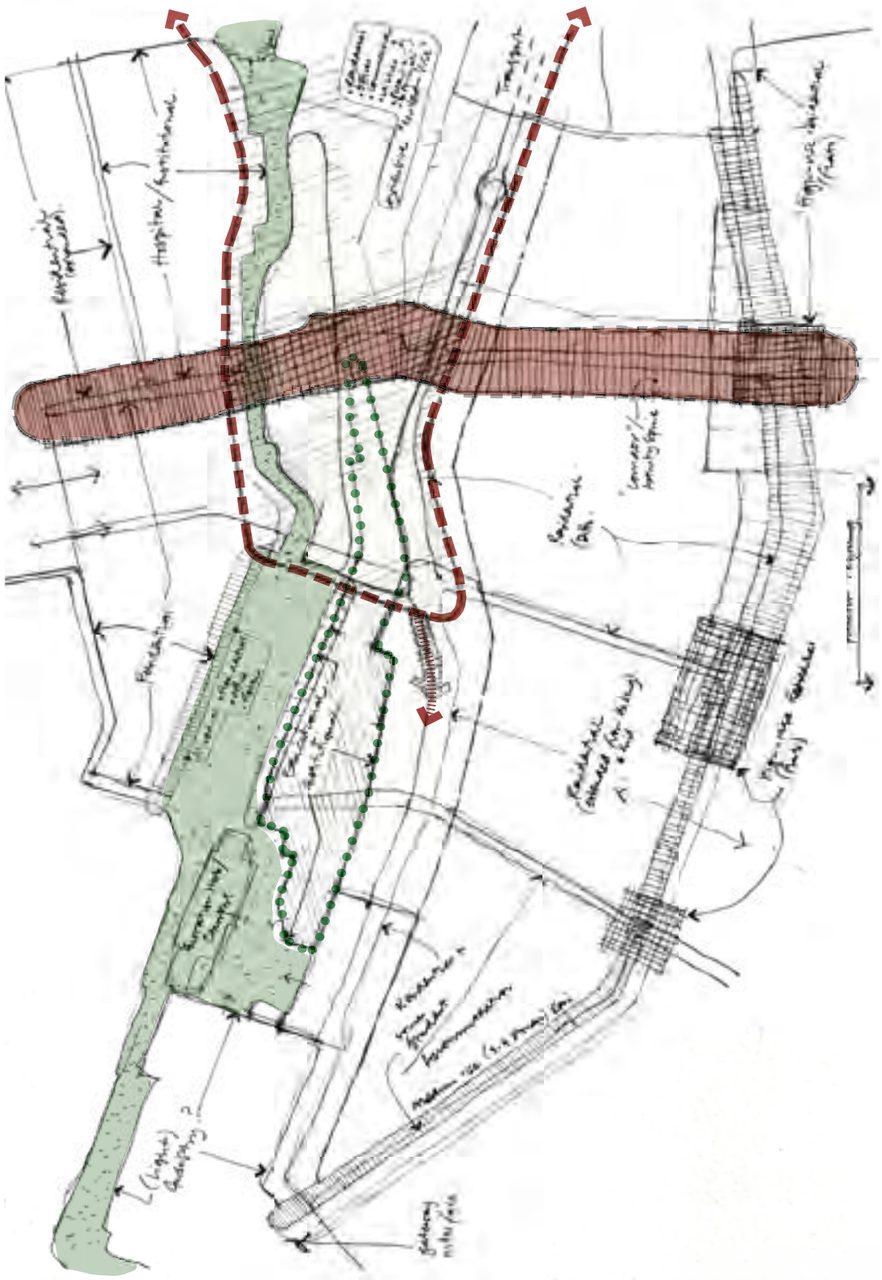


Figure 98: *Diagram Proposing Focus of Activity - Land Use considerations.*
Source: *Author's Own - Research Project Presentation*

OVERALL FOCUS OF ACTIVITY (Proposed Land-Use Vision)

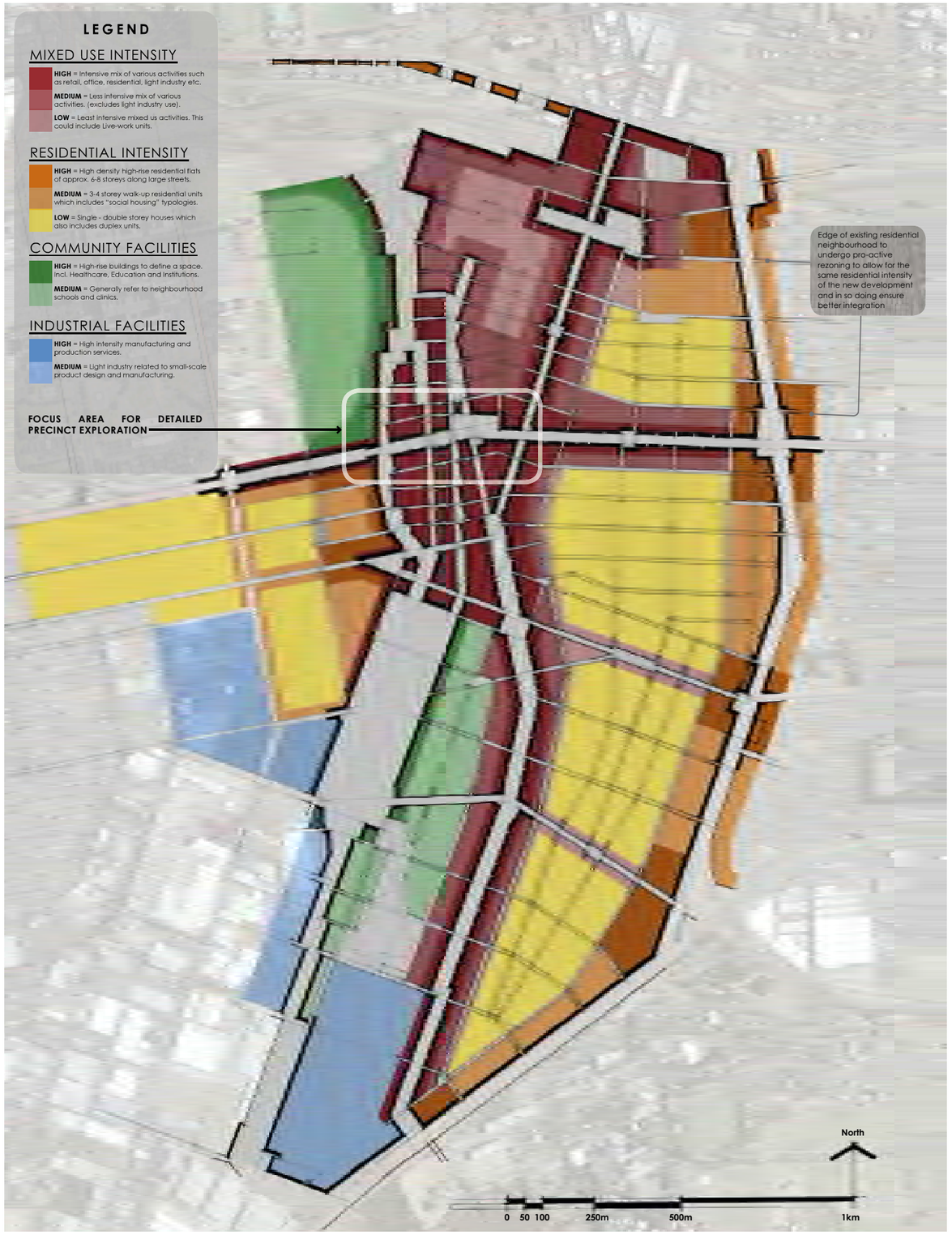
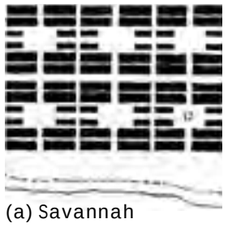
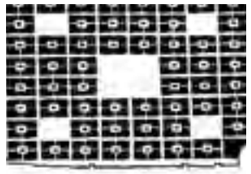


Figure 99: *Design Intervention - Overall Focus of Activity - Proposed Land Use Vision.*
Source: *Author's Own - Research Project Presentation*

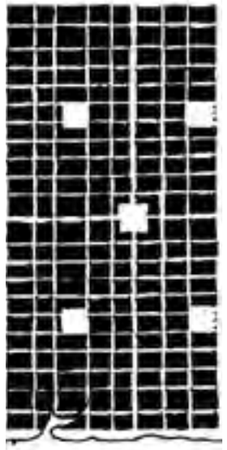
5.19 GRID AS DESIGN MECHANISM



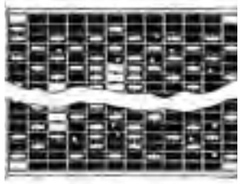
(a) Savannah



(c) Newcourt plan for London 1666

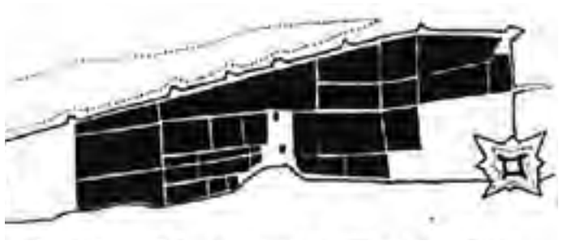


(b) Philadelphia



(d) Cobham plan for Britannia 1839

(e) Cataneo plan of an Ideal city 1567



(f) Plan of St. Augustine Florida 1770

(g) Hook plan for London 1666

Figure 100: *Comparative Grid Plans.*
Source: *Diane Brand (2004)Surveys and sketches: 19th-century approaches to colonial urban design, Journal of Urban Design.*

What made towns possible socially was an invention we are so familiar with that we tend to take it for granted and forget it is there:
the urban grid.

The structure of the urban grid considered purely as a spatial configuration, is itself the most powerful single **determinant of urban movement**, both pedestrian and vehicular.

The urban grid through its influence on the movement economy is the fundamental source of the **multifunctionality** that gives life to cities.

The grid translated into the **street pattern** establishes the main elements of the **public space network**, and is also a key element in the broader concept of the capital web. In turn, the public space network facilitates and accommodates the overlapping realms of 'movement space' and 'social space'.

The pattern of urban blocks and the public space network, plus the basic infrastructure and any other relatively permanent elements of an urban area, constitute the above-ground elements of David Crane's 'capital web'...which is constituted by important **movement routes** and **public buildings**.

It is therefore considered that **transport infrastructure** can be a powerful generator of new settlements and arguably also for restructuring of existing settlements.

We therefore find ourselves unavoidably led towards a theory of the general formation of the site through the functional shaping of its space by **movement.**

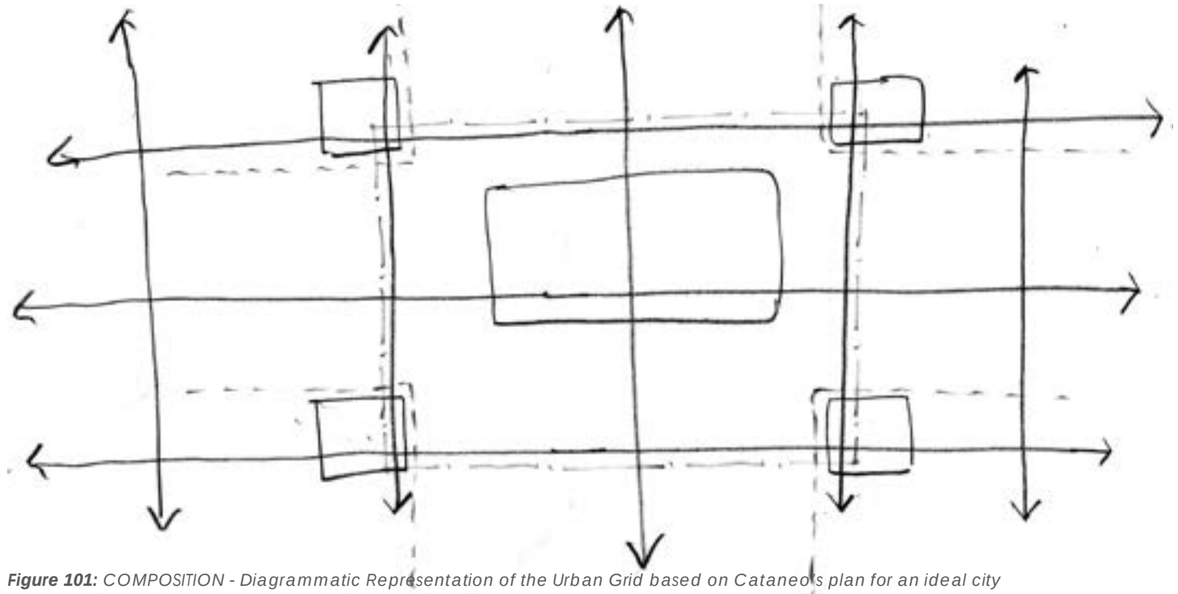


Figure 101: *COMPOSITION - Diagrammatic Representation of the Urban Grid based on Cataneo's plan for an ideal city*
Source: *Author's Own - Research Project Presentation*

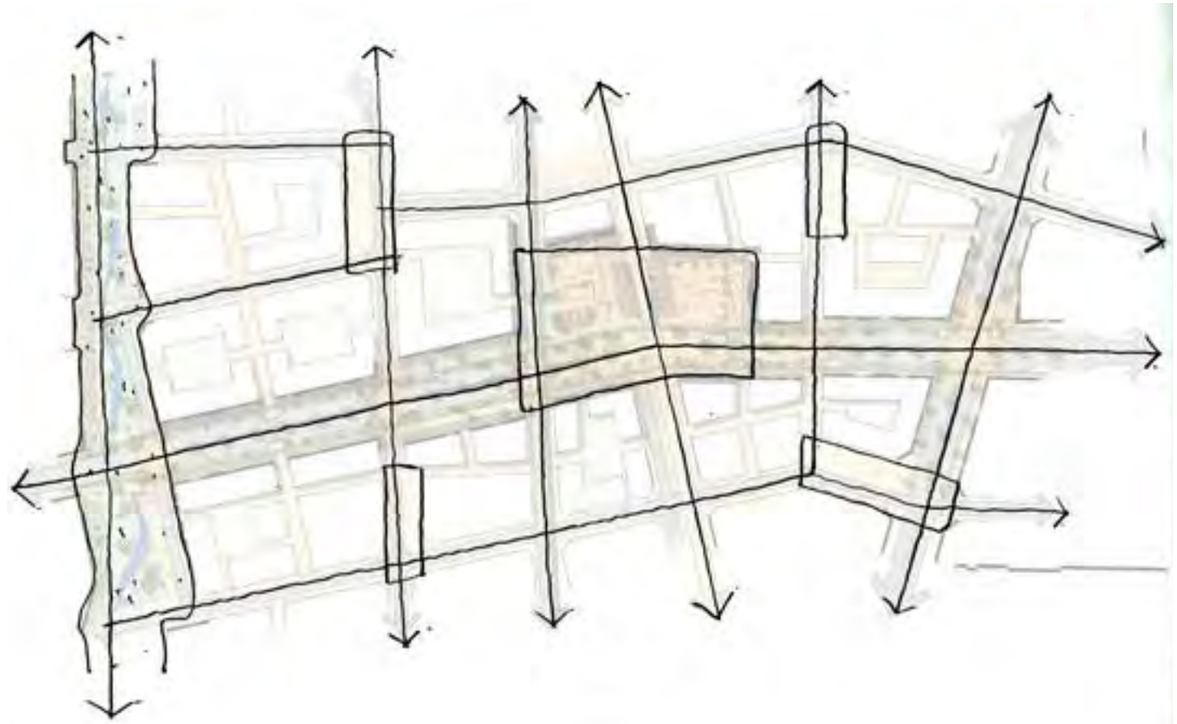
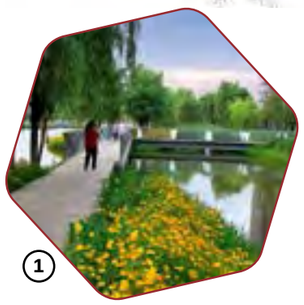


Figure 102: *CONFIGURATION - Diagram of the Urban Grid applied to the site at Precinct scale.*
Source: *Author's Own - Research Project Presentation*

NORTH

0 5 10 25 50 100m

Figure 103: *Detailed Precinct Plan*
Source: *Author's Own - Research Project Presentation*



1

GREEN CORRIDOR

Precedent: Qian'an Sanlihe River Ecological Corridor, China.
Source: www.landezine.com

2

PEOPLE-FRIENDLY STREETS

Precedent: Prague, Czech Republic.
Source: http://emerging-europe.com

3

"ACTIVE" FRONTAGE / TRANSPARENCY

Precedent: George R. Brown Convention Centre, United States of America.
Source: Google Images

4

LANDSCAPED PUBLIC INTERFACE

Precedent: The Towers & Merriman Square, Cape Town.
Source: Square 1 Landscape Architects

5

MULTI-MODAL STREET

Precedent: Berlin Streets.
Source: www.newbuild.club/berlin-streets

6

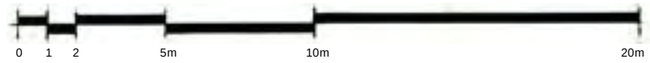
DEDICATED CYCLE LANES - NMT

Precedent: City location unknown
Source: www.wheelzine.com

5. Bellville ReBorn

SECTION THROUGH MAIN STREET AND SQUARE

Figure 104: *Cross Section through Main Civic Square + Street..*
Source: *Author's Own - Research Project Presentation*



5.20 3D REPRISENTATION - New Civic Square.

Figure 105: *Bird's Eyeview looking East over Civic Square.*
Source: *Author's Own - Research Project Presentation*

Figure 106: *Bird's Eyeview looking North West over Civic Square..*
Source: *Author's Own - Research Project Presentation*

5. Bellville ReBorn

Figure 107: *Bird's Eyeview looking North over Civic Square.*
Source: *Author's Own - Research Project Presentation*

6. CONCLUSION

The central concern through which this research project originated is grounded in the global concern that cities are urbanizing at a rapid pace. As the world continues to urbanize, sustainable development depends on the successful management of urban growth. Urbanization in and of itself is not negative. However there are negative effects of it when left unchecked. These include, but are not limited to uncontrolled, low-density sprawl, increasing unemployment rates and additional strain on infrastructural capacities. These, coupled with modernist urban planning and apartheid, as is the case with Cape Town, has resulted in an unsustainable city structure and form.

If we want to revers this and enjoy the benefits of urbanization, then management of urban growth needs to ensure access to infrastructure.

It is on the backdrop in infrastructure that this research project aimed to explore the idea of transformation - both infrastructure transformation, as an element and the transformation of settlement through infrastructure, as a mechanism for design - and then to see what implication this might have on the structuring or restructuring of urban environments.

Admittedly there is not one single solution that will solve all the cities problems that have come about through urbanization. Urban infrastructure is but one mechanism through which settlements and cities are generally planned and of this, TRANSPORT INFRASTRUCTURE forms but one type that may be explored to address the concerns of the city.

With transportation being the infrastructural backbone around which Cape Town has come about, it made sense to look to this infrastructure type as a starting point for some solutions. In addition: since infrastructure & specifically transport infrastructure was also used to structure the apartheid city, the notion of infrastructure transformation together with large pockets of land which still act as barriers, are fundamental to the restructuring of the city.

To “kick-start” such a transformation, which will take time, a series of “quick-win” actions for more immediate impacts need to be identified and implemented.

This research project therefore introduced possible ways in which to start envisaging a new way of settlement [Trans]formation.

Figure 109: *Man’s Eye-view looking East from inside Civic Square.*
Source: *Author’s Own - Research Project Presentation*

Figure 110: *Man’s Eye-view looking West from inside Civic Square.*
Source: *Author’s Own - Research Project Presentation*

Figure 108: *Man’s Eye-view (from balcony) looking South-West from inside Civic Square.*
Source: *Author’s Own - Research Project Presentation*

Figure 111: *Man’s Eye-view (from balcony) looking North-East from edge of Civic Square.*
Source: *Author’s Own - Research Project Presentation*

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Appendices

PLAGIARISM DECLARATION

I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.

I have used the Harvard / Humanities convention for citation and referencing. Each contribution to and quotation in, this essay/report/**project**/paper:

BELLVILLE REBORN: Exploring Infrastructure [TRANS] formation as a mechanism to design sustainable environments - the Case for Bellville,

from the work(s) of other people has been attributed, and has been cited and referenced.

This **research project**:

BELLVILLE REBORN: Exploring Infrastructure [TRANS] formation as a mechanism to design sustainable environments - the Case for Bellville, is my own work.

I have not allowed, and will not allow, anyone to copy my work.

Signature: Signed by candidate

Ruan Mills
MLLRUA001

Date: 30 January 2019

Application for Approval of Ethics in Research (EiR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

APPLICATION FORM

Please Note:
Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analysing data. The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook** (available from the UCT EBE, Research Ethics website) prior to completing this application form: http://www.ebe.uct.ac.za/ebe/research/ethics1

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant		Ruan Mills
Department		Architecture and Planning and Geomatics
Preferred email address of applicant:		18 Laindon Street, Lansdowne, 7780
If Student	Your Degree: e.g., MSc, PhD, etc.	Master of Urban Design
	Credit Value of Research: e.g., 60/120/180/360 etc.	60
	Name of Supervisor (if supervised):	Julian Raxworthy and Matteo Fraschini
If this is a researchcontract, indicate the source of funding/sponsorship		Click here to enter text.
Project Title		Water Sensitive Urban Design

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

SIGNED BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Ruan Mills		**19 Jun 2018**

APPLICATION APPROVED BY	Full name	Signature	Date
Supervisor (where applicable)	~~Click here to enter text.~~ JULIAN RAXWORTHY		~~Click here to enter a date.~~ 22/06/18
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section1; and for all Undergraduateresearch (Including Honours).	~~Click here to enter text.~~ PROF. BECKEDORF		~~Click here to enter a date.~~ 27/7/2018
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.			

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