FUTURE-PROOFING THE URBAN LANDSCAPE

Green Infrastructure as a Primer for Resilient Urban Development

by

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DECLARATION

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

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(Signature of Candidate)

7 October 2015

DEDICATION

Synergy:
To the ideas, moments and people
that inspire possibility beyond
an individual measure of perception.

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ABSTRACT

Many forgotten and resurfacing emerging theories in the field of urbanism are starting to recognise high-performance landscapes and green infrastructure as an essential urban element toward more resilient urban development. This report, entitled ‘Future-proofing the Urban Landscape: Green Infrastructure as a Primer for Resilient Urban Development’ addresses the question of whether Green Infrastructure can become the primary structuring element towards achieving more resilient development, and how this structure influences public place-making.

The strategy is tested on a the Frankenwald site, one of the last remaining greenfield sites in Johannesburg. The proposed development comprises of guidelines and an in-depth phasing strategy for development and intermediate natures that add long-term value towards future-proofing the city.

The document establishes that green infrastructure is a highly relevant subject to consider for the planning of future cities. As a discourse it adds value to the profession of urban design and questions the urban designer’s capacity to offer more productive landscapes and assist in protecting and enhancing the ecosystem services of cities.

The multi-layered nature of priming for green infrastructure services make available a variety of natural elements to be exposed and designed by means of meaningful place making.

CHAPTER 1

Overview

INTRODUCTION
BACKGROUND TO STUDY
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This chapter introduces the dissertation topic and gives broad spectrum summary of the work to be undertaken in the document. It provides a basic understanding of the field of study, the normative practices and the current climate within which the research questions are positioned.

INTRODUCTION

In essence, this document seeks to find an integrated approach to increasing resilience in urban contexts. It draws on aspects from various disciplines within the built environment, including urban design, ecological planning and engineering. It proposes an integrated approach to prime the built environment to function as an urban entity, and a functioning ecology; through the implementation of green infrastructure as the primary structuring element. It argues that green infrastructure, as a structuring element for urban development, can improve livability in the face of predicted existing and future escalating conditions of resource depletion and food shortages, and yet uncertain environmental impacts by means of resource provision and the enhanced availability of ecosystem services to sustain a more resilient livelyhood.

Green infrastructure is mainly focussed around using natural systems to assist in and replace storm water systems of traditional grey infrastructure. Water is a limited resource and is essential to life. Green infrastructure assists in the on-site management of storm water through strategies that promote aquifer recharge, filtration and recycling water. This results in a minimal return into an already over-capacitated traditional grey infrastructure system. With the aid of green infrastructure making water an available resource, and using gravity fed supply methods, it becomes possible to start cultivating additional resources like agriculture, forestry and fishery. The development enables the provision of a range of ecosystem services. Strengthening and connecting fragmented ecosystems and enhancing existing systems with high-performance strategies, enables species biodiversity in the surrounding development. Producing food and utilising local resources aid in a more sustainable development with decreased food miles and limited expended energy.

Green infrastructure provides an integrated open space and infrastructure network to serve as a structuring element for more resilient development. Resilience is the ability of a system to bounce back from a destructive force. By making resources available locally, and allowing it to function somewhat independently from its larger surroundings, the system becomes inherently more resilient.

For a green infrastructure to be implemented successfully, an integrated approach is called for. The strategies below show how to incorporate green infrastructure into urban development by means of a test site. As natural elements take longer to mature, this calls for a staggered phased approach to development. This also allows for intermediate uses to occur in many areas. These aid in building the community and character of the development. By priming the environment with green infrastructure, providing ecosystem services and encouraging intermediate use, the strategy provides many contextual informants to develop a sense of place and should result in authentic place making.

The document introduces the subject matter with a list of brief explanations:

FUTURE-PROOFING

Cities today face several powerful, prevailing trends in international development. The environment is under threat from rapid urbanisation, climate adaptation and continually increasing natural disasters. The United Nations expects 80 percent of the world's population to live in urban areas by 2050. (UN WUP 2014). At the same time, environmental degradation and climate change from excessively resource-intensive development have at least doubled the incidence of natural disasters in just a few short decades. (Millennium Ecosystem Assessment, 2005)

Future-proofing considers the current degrading state of the environment and anticipates its future entropy. It attempts to provide a more resilient future environment by enhancing biodiversity corridors and providing access to ecosystem services, thereby mitigating anticipated future stresses and risks facing the environment.

In the context of this document, future-proofing deals with the urban pressures of development within the urban context, and the natural resources that support human- and other organism-functioning within the urban ecology.

The method of future-proofing discussed takes its lead from the multi-disciplinary integration of the knowledge of systems that structure the urban environment. These systems, enhancing and contributing to the natural system, hold the potential to enable more resilient cities in the face of projected and uncertain future conditions. They strive to provide the most adaptable environment to tolerate future scenarios and absorb the stresses exerted upon it. For the rest of this investigation, the idea of future proofing will be represented by the concept of resilience.

THE URBAN LANDSCAPE

The term landscape has been used specifically in this context to describe the urban environment as an assimilation of systems and influences that can be read together as a whole. A landscape encompasses the physical elements of landforms as well as the ecological functions of the environment and the human elements of built form. It also takes into account the metaphysical aspects of place-making and identity in response to climatic conditions, historical settlement patterns and cultural practices. The landscape provides a living backdrop for daily life. The question arises of whether enhancing the landscape as a resource that can provide an enabling environment for growth and urban development.

The practice of understanding a landscape is derived from a 'systems approach' methodology, which interrogates the elements of the urban environment at different scales. It considers the feedback mechanisms of these systems and their effect the overall landscape.

The term 'urban landscape' also makes reference to the recent field of study of landscape urbanism (and subsequently ecological urbanism), which is based on the premise that the landscape is the medium of the urban realm that can best structure development.

GREEN INFRASTRUCTURE

Green infrastructure refers to strategies employed to enhance ecosystem services to attend to human needs in established settlements. It also has the capacity to improve or replace certain existing grey infrastructure systems in a manner that benefits the local ecology. Green infrastructure operates within a system of networked links on the principle of synergy. It is often most closely associated with engineering urban hydrological systems. In the nature of this project, green infrastructure presents itself primarily in the form of soft infrastructure systems related to the provision of water services for means of irrigation, sustaining urban agriculture, allowing for resource provision in terms of food production, forestry livestock and fishery.

PRIMER

A primer, by definition, is a preparatory layer applied to ensure that subsequent layers adhere better to the base material. A primer also enhances the effect of subsequent layers and prevents deterioration and aims to increase the value and longevity of the desired outcome. The anticipated increased value relates to more liveable, walkable environments and urban form with the capacity to absorb future change.

RESILIENCE

The Intergovernmental Panel on Climate Change defines resilience as: “the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation and the capacity to adapt to stress and change.” (IPCC AR4, 2007)

Within the context of cities, “resilience comes from the interplay of vulnerability and adaptive capacity”. Cities experience shocks from “changes in the climate, environmental degradation, shortage of resources, failed infrastructure or community strife due to inequality. Exponential population and economic growth are placing so much pressure on resources that resilience urgently needs to be rethought” as cities are becoming more vulnerable. (Resilient Cities, 2014)

The aim of this document is to illustrate some of the ways in which cities can become more resilient to function more self-sufficiently and allow for a lower dependence on maintenance.

URBAN DEVELOPMENT

Urban, in this context, relates to towns or cities characterised by a dense population and vast human-built features. Cities play a vital current and future role in global sustainability. Within the current context of growing rates of consumption and population, and the loss of biodiversity.

The natural environment, in contrast to the urban environment, is becoming increasingly fragmented and threatened by expanding low rise development. The current trend in settlement patterns consists primarily of low-density development scattered across the landscape with high pressures on inadequate transport systems. Urban development currently is energy intensive and relies heavily on resources being brought in and waste being taken out. Urban development is an open cycle. The interventions in this document showcase an integrated urban fabric where biodiversity corridors support and inform the urban grid, land use and density.

Development refers to growth and expansion, but in this scenario, more importantly, to constituting a new state in a changing situation. Development alludes to the opportunity to change the current context and plan more resilient futures. “Any effective agenda for confronting global climate change, biodiversity loss, and a host of other environmental challenges must necessarily include cities as the key element.” (Beatley. T, 2000). Sustainable development patterns are discussed in more depth in the document. Although the project describes a specific vision to envision future growth, the feedback loop requires always analysing and adjusting the framework within future needs that might be presented.

Fig. 1.1. Summary of theoretical concept by author after Stan Allen Taichung Gateway Project

PLACE MAKING

Place making refers to the design of places that have an inherent identity, local vernacular, and belong to a specific context. One which makes use of local materials and where structures enhance or point to specific natural features. The aim of place making in this document is to develop places with unique character which showcases the nature of the surrounding environment and make use of the engrained elements throughout the site to make a place specific public environment and develop a didactic language throughout the development.

BACKGROUND TO STUDY

The background to the study is twofold. The interest in the topic arises out of the author's academic background in architectural studies and landscape architecture with an extensive component in ecological planning and a keen understanding of systems thinking, particularly related to natural systems. Throughout previous explorations, a consistent pattern of interest in place-making within the urban environment has always been prevalent, specifically focussed on the ability of well-considered public environments to facilitate human interchange and build communities. The contextual global issues cities are bound to encounter in the face of climate change; rapid predicted rates of urbanisation; the perception of the automobile centred, low density sprawled lifestyle; as well as the socio-political context of public life and integration that is taking place in South African cities; supports the personal interest.

Within the field of study of Urban Design, the author has come to some curious observations with regards to the interface between landscape architecture and urban design. They are as follows:

The structuring principles behind planning approaches vary considerably, and there is often not a clear role or protocol in terms of the integration as to how the natural environment could inform urban development. Many designers fail to understand the urban environment as an ecological system. This results in missed opportunities with regards to creating truly integrated and site-specific place; as well as massive costs in terms of bulk earthworks and infrastructure. The sense of place gained from an understanding of regional identity often gets lost in translation between scales.

There is an active discourse; most recently under the themes discussed in Landscape Urbanism, Ecological Urbanism and Sustainable Urbanism (both academically and professionally), that has investigated nature vs. urban dichotomy.

Although the area of interest has actively grown since the 60's, there is not yet a comprehensive overall understanding of the range of measures that could be implemented to affect change in the urban environment. Various professions are attempting to facilitate the multidisciplinary and interdisciplinary nature of integrated design within a field-wide reference framework. Understanding integrated design processes is largely based on ideas grounded in 'systems thinking' approaches and widely applicable network theory.

The role of the Urban Designer as 'Principal of Design Integration' needs to be further explored and understood in the professional realm. The Urban Design professional should have an overall understanding of all design professions involved in city and place making. The Urban Designer emerges with the skill of being a "specialist in the general" (Dewar. D 2011, UDISA Conference, Johannesburg) having the unique insight of putting all of the pieces together. Urban designers should thus gain a comprehensive understanding of the underlying natural systems of an urban environment as one of the primary components necessary to facilitate the development of resilient cities.

The existing values that influence the idea of the South African space-culture (land ownership and freestanding houses on erven) result in inefficient building footprints and lack of densities to support walkable environments (lowest common denominator). They also require stronger environmental consideration. A superficial lifestyle approach to housing development breed sameness and does little to facilitate social integration. Most of our environments are unsustainable in terms of primary access on foot, and 'public spaces' are often exclusionary and privately owned and managed. The pressures of providing housing as a basic need often do not consider the essential ecosystem services that are necessary to support them.

Environmental needs are the most fundamental, in terms of provision of services, and their value should not be played down against the misperception of their worth. As a species, we are perpetuating loss. The rate and type of urban developments that are still very desirable in the South African context result in poorly managed resources and the loss of natural environments, and ultimately reduced biodiversity. More biologically diverse systems have a higher resilience and are subsequently more efficient in dealing with, and adapting to change.

We need to enable greater biodiversity in our urban environments through integrated development in order to accommodate change and future-proof the city. Green infrastructure affords us the opportunities to prime future urban development for resilience and retrofit our existing cities. The economic value of green infrastructure in terms of initial costs should be measured by means of its worth in long term value and contribution to infrastructure management and ecosystem services.

The time frame from inception to maturity for natural systems differs vastly. Where natural elements only really start to grow after the completion of a project; a building project effectively starts to decay once it has been completed and immediately goes into a maintenance cycle. Resourceful methods of building or maintaining up-keep need to be considered moving forward. This gives insight into the time scale for development. It allows for building up the green structure first and allowing development to occur in a mature ecosystem that is better equipped to absorb and provide materials for the process moving closer to a full cycle process.

DOCUMENT OUTLINE

This dissertation aims to act as a means to address some of these observations by means of showcasing the value of green infrastructure as planning tool and a strategy for resilient urban development; as well as to illustrate the potential for integrated environments to result in identifiable quality public place-making as one of the core elements of future cities.

This study tests the hypothesis of whether green infrastructure can be used as a primer for resilient urban development, in response to ecological, social and economic pressures urban environments are currently facing.

Chapter 1 introduces the dissertation topic and gives broad spectrum summary of the work to be undertaken in the document. It provides a basic understanding of the field of study, the normative practices and the current climate within which the research questions are positioned.

Chapter 2 takes a look at the different theories applicable to the field of research, mostly in the field of Urban Design and Landscape Architecture. It discusses the general principles to achieving resilient environments.

Chapter 3 discusses green infrastructure and the ecosystems services that humans gain from them. It illustrates means of creating value in intermediate developmental context and how ways of priming the landscape can result in richer environments.

Chapter 4 discusses the benefits of green infrastructure and proposes a strategy for the implementation of green infrastructure in unban contexts using network theory.

Chapter 5 introduses the site, discusses the reason for its selection, gives an overview of the larger scale hydrological network and draws out the elements that could better inform the design based on its natural qualities.

Chapter 6 familiarises the reader with the existing framework that has been planned for the area, as well as highlighting some of the principles that informs it.

Chapter 7 This chapter reviews how the different design informants discussed in previous chapters informs and shapes the design.

Chapter 8 offers guidelines to the development processes and considerations to designing with green infrastructure.

Chapter 9 illustrates how development could be phased in terms of developing green infrastructure and proposes the minimum intervention that could add the most value to the site.

Chapter 10 answers the research questions and concludes the document.

RESEARCH STATEMENT

More resilient urban environments can be facilitated through critical analysis of the existing environmental context and urban principles focussed on increased liveability. Development can, in this context, not be seen as an instantly implemented solution, but needs to take into consideration the time different aspects of a system need to develop and establish. As the biological features of the environment take longer to develop than built form, place-making should be based on establishing natural environments first, which are later populated by urban form.

Environments offer a range of ecosystem services that can facilitate more resilient development. Living and non-living infrastructure should be considered at the same time as growing natural environments, as a holistic system to support future use.

Green infrastructure can be seen as a primer, as it becomes a structuring element to guide development towards facilitating more robust environments. The integration of green infrastructure in the initial phases of design and implementation, and the intermediate use of the surrounding environment can result in more cohesive public place-making with identity specific to its context.

RESEARCH QUESTIONS

1. What are the principles of a resilient urban environment?

2. How do we derive relevant contextual informants that can assist in structuring resilient development?

3. How can green infrastructure inform the development of urban landscapes towards resilient environments appropriate for foreseeable future living conditions?

4. How can green infrastructure act as a guideline to public space making?

5. What is the value of using green infrastructure as a primer for development?

VALUE/ OUTCOMES

- This research proposes an integrated approach to future city planning that is focussed on place-making and quality environments.
- It highlights the importance of natural elements in the urban environment and showcases their capacity to increase the resilience of the urban environment.
- It serves as a reference for urban designers to better understand natural aspects of environments.
- It investigates appropriate forms of green infrastructure that can become catalytic in transforming the public environment and increasing land value through using green infrastructure as a primer.

CHAPTER 2

Theoretical framework and literature review

URBAN DESIGN DISCOURSE

ANALYTICAL FRAMEWORK
ECOLOGICAL PLANNING
GREEN URBANISM
LANDSCAPE URBANISM
ECOLOGICAL URBANISM
SUSTAINABLE URBANISM
SUSTAINABLE URBANISM CASE STUDY

PRINCIPLES FOR RESILIENT URBAN DEVELOPMENT

This chapter takes a look at the different theories applicable to the field of research, mostly in the field of Urban Design and Landscape Architecture. It discusses the general principles to achieving resilient environments.

ANALYTICAL FRAMEWORK

URBAN DESIGN DISCOURSE

Many streams of theory on developing sustainable environments are currently available in discourse. They address various aspects of the challenges currently being faced by urban environments relating to resource depletion, degradation of the environment and moving towards more symbiotic natural/ urban conditions. However, few of them give a general overview of all of the urban and ecological systems present in the urban landscape and often focusses on small scale interventions. The literature chosen in this section provide some guidance on various aspects discussed towards resilient environments and ecological methods. The term ‘natural’ is used to refer to the ecological strategies while ‘urban’ refers to human settlements and city making strategies.

All of the theories selected have developed out of a response to urban environments where built form seems to have grown unabated and negated the natural and spatial quality of environments. These types of urban environments are also automobile dependent; low-density developments that have resulted in a loss of identity and community, poor livability and scattered functionality across the urban environment.

The theories discussed are as follows:

- Ecological Planning Method
- Green Urbanism
- Landscape Urbanism
- Sustainable Urbanism

Fig. 2.1. Cover of ‘Design with Nature’

ECOLOGICAL PLANNING

Ecological planning came to be a very convincing argument for guiding development in the nineteen-sixties with the work of Ian McHarg and the release of ‘Design with Nature’ (McHarg, I. 1969).

McHarg advocated the ‘Ecological Planning Method’, a value-based system of ecological resources which positions urban development on least valuable areas of natural and cultural resources. The method has had great success in planning large-scale infrastructure networks to minimise landscape fragmentation and conserving natural resources. It is the backing of the value based data sets that are currently still used in GIS and planning procedures.

With its rigid scientific approach, ‘Design with Nature’ was extensively criticised as being “the final nail in the coffin” (Treib, M. 1999) for design practices in landscape architecture. He wrote extensively on the magic of place-making where nature and the built environment become seamlessly integrated, although these theories did not transcend as strongly and attribute to the “disagreement over the nature or his legacy”. (Whiston Spirn, A. 2000)

In McHarg’s words: “Ecological rectitude is a precondition of good landscape design but is by no means a sufficient condition. A place can be cleansed of pollution without in any way becoming a beautiful landscape” (McHarg, I. 1969). By this statement, he explains that ecological intervention may not necessarily result in any designed form, but should be considered in the design. ‘Design with Nature’ gives an in-depth understanding of the functionality of natural systems and how to derive value from reading the landscape.

The ‘ecological inventory’, also known as the ‘layer cake’ formed the basis of all of McHargs’ interventions. It consisted of mapping the inherent value of the site by its: climate, geology, hydrology, soils, vegetation, and wildlife. The method has been attacked for relying on scientific methods too much, in opposition to design, and for being “unnecessarily comprehensive and too elaborate and expensive to undertake in most professional projects” (Whiston Spirn, A. 2000)

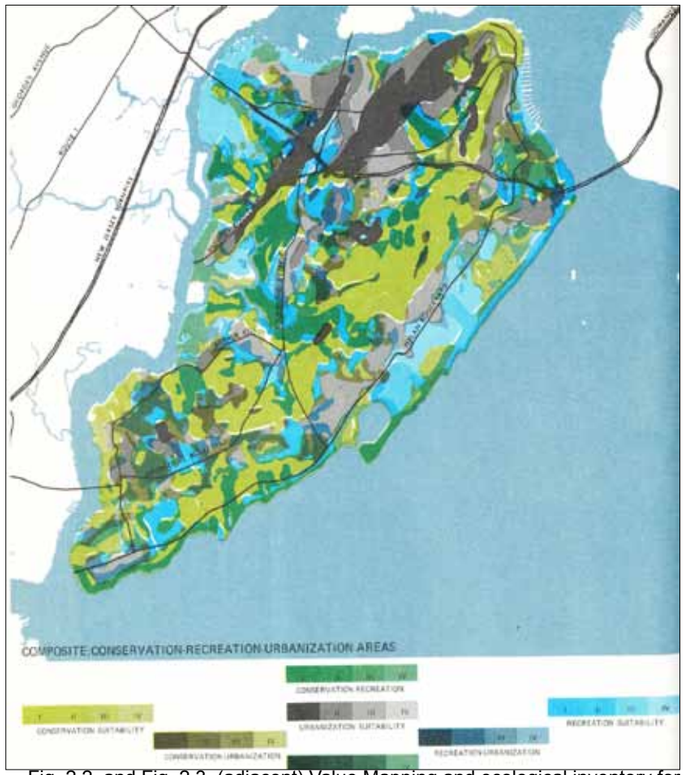
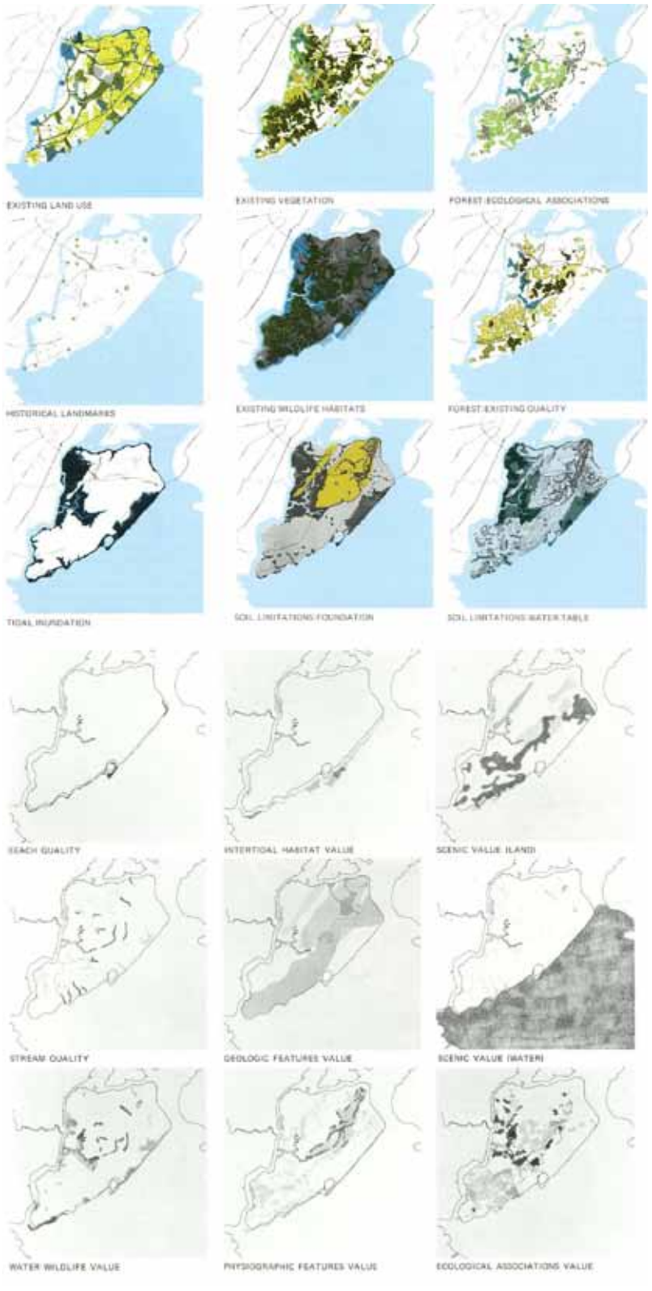


Fig. 2.2. and Fig. 2.3. (adjacent) Value Mapping and ecological inventory for Staten Island, Design with Nature, 1969

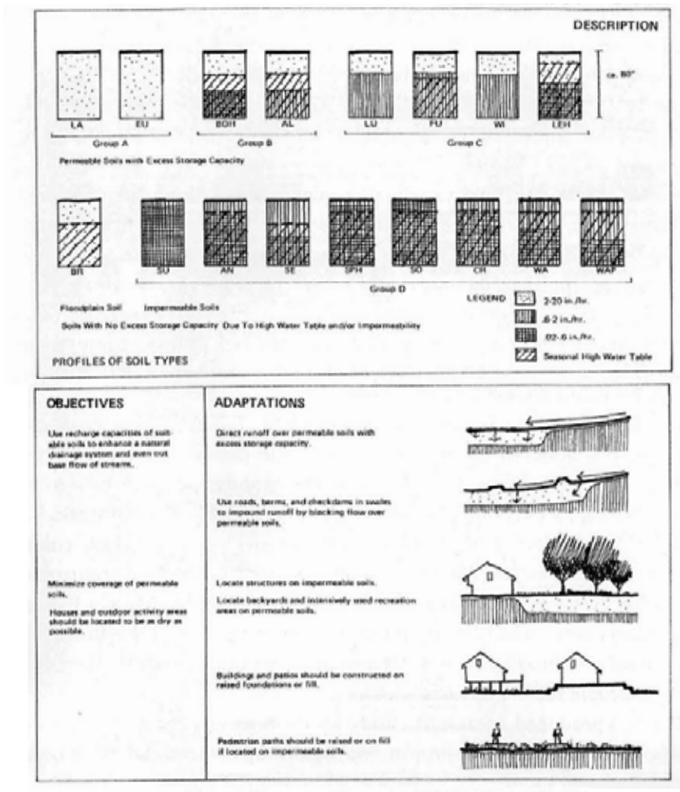
‘Design with Nature’ is still one of the most coherent attempts towards understanding natural systems in the design profession and many schools still teach the ‘Ecological Method’. It makes for interesting reading to follow the lineage of McHargs students that are now behind some of the leading theories and developments in spatial planning



THE ECOLOGICAL INVENTORY - AN EXAMPLE

Excerpt from Ian McHarg, Landscape Architecture, and Environmentalism (by Anne Whiston Spirn, 2000)

An ecological inventory by McHarg’s firm, WMRT, for the site of Woodlands New Community, North of Houston, Texas, in the early 1970s, identified flooding, storm drainage, and groundwater recharge as overriding issues. The client wanted to build a new town in the midst of a pine and oak forest, but the site’s soil and groundwater conditions were such that a conventional drainage system would have lowered the water table and destroyed the forest. It would also have caused flooding downstream and led to ground subsidence beneath Houston. These regional effects, in particular, would not have been identified with a less comprehensive approach to studying the site. McHarg And the staff at WMRT proposed a “natural Drainage system” that would enhance groundwater recharge, abate flooding, protect water quality, and sustain the forest. This Innovative solution emerged from the situation of practice- the environmental challenges posed by the site, the pragmatic demands imposed by the client, and the values, theories, and methods of the landscape architects.



7. *Design recommendations linking goals and implementation were termed “adaptive strategies.” (from Anne Whiston Spirn,* Woodlands New Community: Guidelines for Site Planning *[Philadelphia: Wallace McHarg Roberts and Todd, 1973])*

IDEAS TAKEN FORWARD

This investigation draws upon the rigid nature of terrain analysis, layering and deriving value from site analysis; using the natural features of the landscape to inform the best fit principles for various urban elements, including appropriate land use for slope gradient, orientation, siting, location of roads and green spaces enhancing natural corridors. The proposed framework to follow does not go into the amount of in-depth investigation required to do specific site tests such as geological reports, hydrological studies and water quality, heritage impact reports etc. however the relevance and integration of these are noted for a fully integrated urban fabric. The study is however based on these multidisciplinary interventions required to engage in such studies. As a result, the proposal presented in this document remains rather flexible and open to change and adjustments which would arise out of such studies.

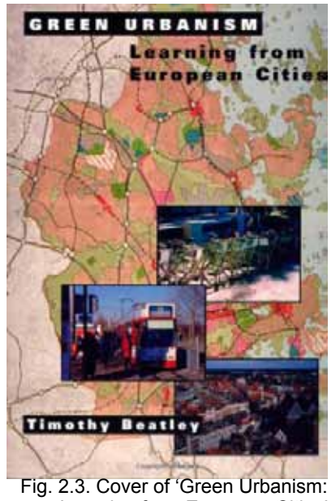


Fig. 2.3. Cover of 'Green Urbanism: Learning from European Cities'

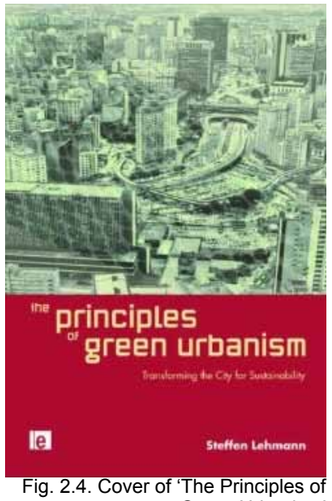


Fig. 2.4. Cover of 'The Principles of Green Urbanism'

GREEN URBANISM

Green Urbanism is a very strict model for zero-emission and zero-waste urban design, It has become largely popular with the writings of Tim Beatley in 'Green Urbanism - Learning from European Cities' (2000) and acclaimed zero emissions developments such as Bed Zed. Green Urbanism promotes compact urban development, by using the principles to retrofit post industrialised cities and suburban areas.

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Green urbanism has been defined as "the practice of creating communities beneficial to man and the environment. It is an attempt to shape more sustainable places, communities and lifestyles and consume less of the world's resources" (Beatley, T. 2000). Steffen Lehmann has elaborated on the definition by adding that "green urbanism is interdisciplinary, combining the

Green Urbanism has been referred to as one of the most inclusionary theories towards sustainable development.

The principles need to be configured for the site, scale and context of each project. To begin to understand the diverse adaptability of the principles, Lehmann has arranged them according to Maslow's hierarchy of needs. What follows is a summary of Lehmann's 'Principles of Green Urbanism.' (Lehmann, S. 2011)

1. ENERGY, WATER AND FOOD SECURITY

To achieve more sustainable cities, urban designers must understand and apply the core principles of Green Urbanism in a systematic and adapted way. These principles can be effective in a wide variety of urban situations, but they almost always need to be adapted to the context and the project's scale, to the site's constraints and opportunities. It is an approach to urban design that requires an optimization process and a solid understanding of the development's wider context and its many dimensions before the designer can produce an effective design outcome.

Fig. 2.5. The three pillars of Green Urbanism, and the interaction between these pillars. Lehmann, 2007.

2. SOCIAL SUSTAINABILITY AND A HEALTHY COMMUNITY

The districts and cities where the Principles of Green Urbanism have been applied and integrated in every aspect are urban environments that respond well to their climate, location, orientation and context, optimizing natural assets such as sunlight and wind flow, with a healthy microclimate, and are self-sufficient energy producers, powered by renewable energy sources.

Such developments eliminate the concept of waste, as they are based on a closed-loop ecosystem with significant recycling, reusing, remanufacturing and composting, and have high water quality due to practicing sensitive urban water management through integrated landscape, gardens and green roofs to maximize urban biodiversity and mitigate the urban heat island effect. They apply new technologies and easy accessibility and mobility, are well interconnected, and provide an efficient low-impact public transport system, making use regional and local materials and apply prefabricated modular construction systems to create a vibrant sense of place and authentic cultural identity, where existing districts are densified and make use of urban mixed-use infill projects.

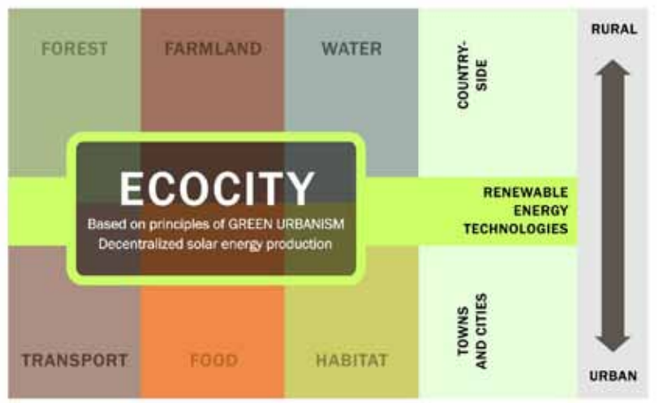


Fig. 2.6. The holistic concept of Eco-City has again a balanced relationship between the urban (city) and the rural (countryside). Lehmann, 2008

These communities are more compact around transport nodes (`Green TODs'), with a special concern for affordable housing and mixed-use programs, which respond appropriately to site conditions in terms of ventilation and orientation.

They have a local food supply through community gardens and urban farming and which achieve high food security and reduced `food miles', and use multi-disciplinary approach, best practice for urban governance and sustainable procurement methods.

3. PRINCIPLES OF GREEN URBANISM

Lehmann expands on the ideas mentioned above by describing the "15 guiding principles of Green Urbanism, for local action and a more integrated approach to urban development". they are listed below:

Principle 1: Climate and Context
Principle 2: Renewable Energy for Zero CO2 Emissions
Principle 3: Zero Waste City
Principle 4: Water
Principle 5: Landscape, Gardens and Biodiversity
Principle 6: Sustainable Transport and Good Public Space
Principle 7: Local and Sustainable Materials with Less Embodied Energy
Principle 8: Density and Retrofitting of Existing Districts
Principle 9: Green Buildings and Districts, Using Passive Design Principles
Principle 10: Liveability, Healthy Communities and Mixed-Use Programmes
Principle 11: Local Food and Short Supply Chains
Principle 12: Cultural Heritage, Identity and Sense of Place
Principle 13: Urban Governance, Leadership and Best Practices
Principle 14: Education, Research and Knowledge
Principle 15: Strategies for cities in developing countries

Fig. 2.7. The outlined 15 principles of Green Urbanism aim to guide urban designers and decision-makers. Lehmann, 2008.

4. PASSIVE AND ACTIVE DESIGN PRINCIPLES FOR MATERIAL AND ENERGY-EFFICIENT, CLIMATE-RESPONSIVE BUILDINGS AND CITIES

Lehmann further describes, in-depth, green building practices and strategies for energy efficiency and offers a case study of Hammarby Sjöstad in Stockholm, illustrated below through images and descriptions from Lehmann (2008).

Fig. 2.8. Example of Green Urbanism in practice: The green district Hammarby Sjöstad in Stockholm, built 1995-2008 on land formerly used by the port (to be fully completed in 2018). It is widely accepted as a best practice model for sustainable urban development, having included in its urban development innovative principles of water and waste management and reduction of car dependency. Image: courtesy City of Stockholm, Sweden. Lehmann, 2008.

Fig. 2.9. Stockholm's green district Hammarby Sjöstad includes on-site energy generation with solar cells and green roofs, as well as principles for sensitive urban water management. Image: courtesy City of Stockholm, Sweden, 2008. See also: http://urbantheory-hammarbysjostad.blogspot.com/ for further information on this green district. Lehmann, 2008.

Although the Principles of Green Urbanism are very comprehensive, it does not specifically align itself with any spatial development models or strategies towards place-making. The books offer an impressive collection of case studies that support the principles. Green Urbanism could perhaps most effectively contribute to Urban Design as a checklist of design considerations towards more resilient development.

IDEAS TAKEN FORWARD

To apply the ideas of green urbanism to a specific intervention requires the skills of a team of various professionals, as the literature can be interpreted in various ways depending on the understanding of the professionals involved.

The document takes into account all of these principles, at a high level, in its design development and proposal. The principles also apply at various scales that would have to be designed into detail plans for specific sites and management plans going forward. Each principle should be pulled through the design from regional to site scale for maximum integration potential. This process would require a design professional, quite possibly an urban designer, to oversee all levels of intervention to make sure that this goal is achieved.

Urban designers are ideally suited to this role due to their spatial understanding of principles over scales, and their ability to integrate information from various faculties into a cohesive plan.

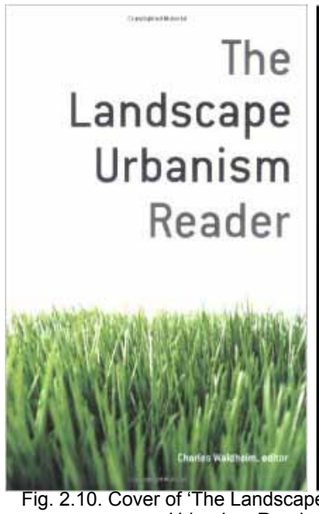


Fig. 2.10. Cover of 'The Landscape Urbanism Reader'

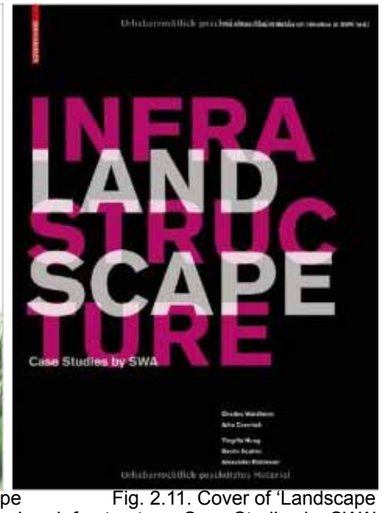


Fig. 2.11. Cover of 'Landscape Infrastructure- Case Studies by SWA'

LANDSCAPE URBANISM

Landscape Urbanism is an urban planning theory arguing that the best way to organize cities is through the design of the city's landscape, rather than the design of its buildings (Waldheim, C. 2006). It also states that the landscape has a greater ability to facilitate uncertain future conditions than the urban form. This is further developed in Ecosystem Services and the idea of Resilient Urbanism.

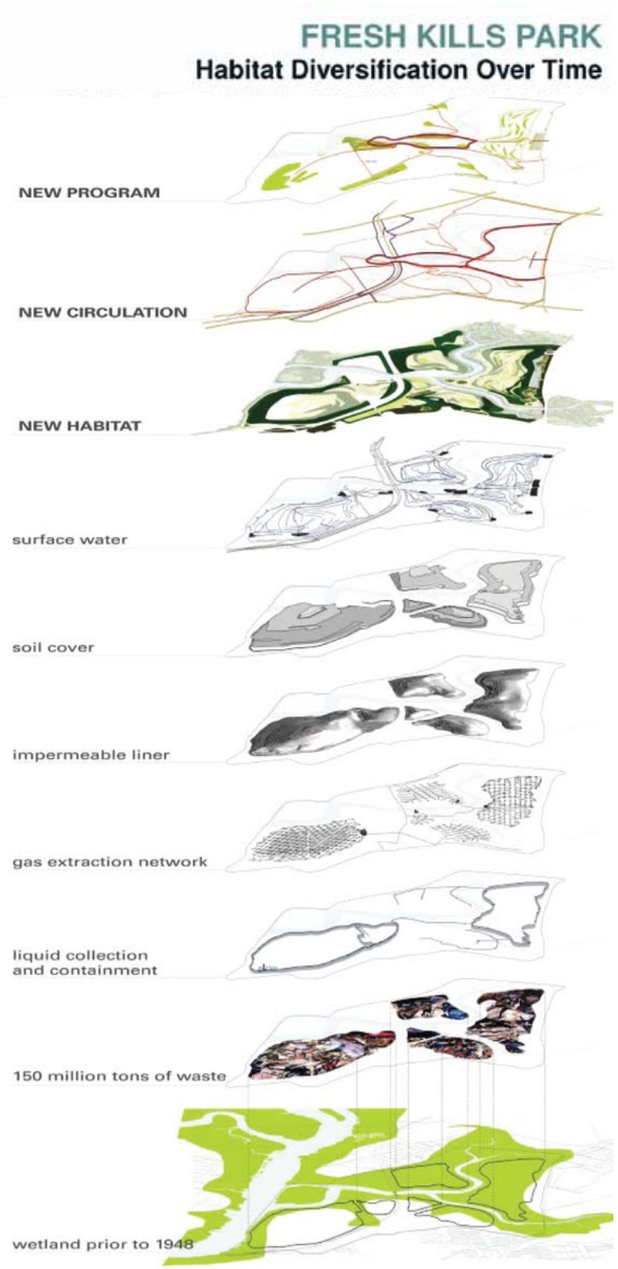
Landscape urbanism proposes "a disciplinary realignment currently underway in which landscape replaces architecture as the basic building block of contemporary urbanism." This is because "for many, across a range of disciplines, landscape (environmental and cultural) has become both the lens through which the contemporary city is represented and the medium through which it is constructed" (Waldheim, C. 2006). Through this process, the landscape is assessed culturally, environmentally and historically, and specifically the opportunities that it has to offer its users, and the design is them conceptualised around these principles.

Landscape urbanism has recently been criticised for not giving strong enough guidance to urban development and thereby being too open ended with regards to building development. The value that has become apparent from implemented urban design projects is the capacity that landscape has to create value in terms of place-making and land-banking and focus on the extensive systems diverse phasing strategies that occur over time.

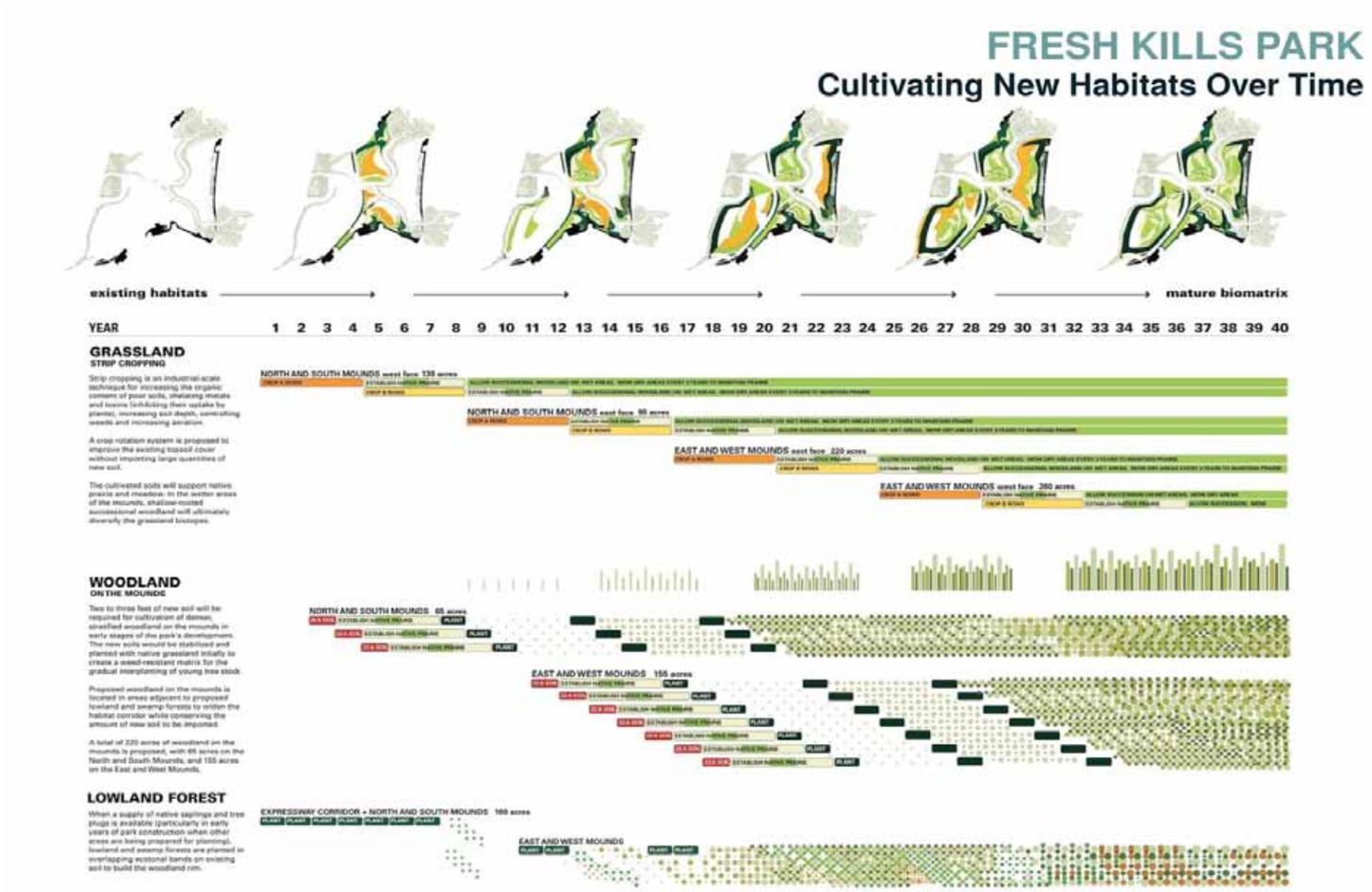
In recent criticism on the challenges of implementation, David Eisen (2011) concludes the following: "Landscape urbanism's inspiring rhetoric and compelling forms provide a strong, poetic evocation of a more sustainable way to build. However, if both the formal and practical ideals are to be implemented, they need to be harnessed to a more prosaic set of tools, such as building codes, zoning ordinances and engineering calculations. Designers will need to team up with scientists, sociologists and engineers if sustainable design solutions are to be pushed beyond the commonplace".

The success of Landscape Urbanism has been in bringing to light the processes and performance qualities of the 'natural component of city making and implementing these projects in urban contexts. Landscape Urbanism has become widely popular for its graphic representation of processes over time from habitat diversification to phasing and implementation.

Fresh Kills is one of the seminal projects of Landscape Urbanism discourse, designed by James Corner Field Operations. It proposes the phased restoration of a landfill with the ultimate goal of reconnecting the city through public space. This project adequately showcases the focus on phased development of ecological habitat diversification, and the open-ended nature of the urban form aspects of urban design.



the images on this page are from the competition for Fresh Kills, submitted by James Corner Field Operations. A massive projets built ove a landfill. It aspires to reconect the city and rehabilitate the landscape primarily through interventions in open space.



Environmental & Ecological Aspects

The processes of landscape are illustrated through complex matrixes that show how the environment matures over time and grows to improve the site in terms of livability and visualinterest for both people and other living organisms.

5 Main Goals from the Lanscape & Habitat Plan

- Cultivate a diverse, resilient landscape that is a natural asset to the region in terms of ecological connectivity, water and air quality improvement, biodiversity and sustainability;
- Create meaningful habitat for the region and the estuary by building wildlife corridors linked to existing natural resources, taking into account not only plant life but also bird, mammal, fi sh, crustacean, insect and microbial communities;
- Organize the park internally around existing natural resources and local opportunities for enhanced habitat creation;
- Design and stage ecological improvements so that the parkland can be understood and enjoyed in each phase of its development as a legible "landscape in process," designed to promote successional diversifi cation over time;
- Integrate ecological improvement plans with ongoing landfi ll management operations to increase benefi ts, reduce public expenditure and enhance site sustainability.

The project phasing proposes timeously giving more access to the spaces as the environment is upgraded.

IDEAS TAKEN FORWARD

This investigation relies on landscape urbanism theories to a large extent in that it usesthe landscape to inform and structure its main principles. It also includes integrated infrastructure solutions that more rigidly secure the landscape of the environment within future planning, thereby addressing some of the shortcomings of landscape urbanism. The investigation takes guidance from the sustainable urbanism and green urbanism theories in terms of developing urban grid and form.

The landscape urbanism movement has shed a lot of light on the natural processes and habitat creation over time. In consideration with urban development phasing a comprehensive plan should be set up for these two elements to develop alongside one another. This also allows for the opportunity to grow landscapes and increase the environmental value and then later develop within a mature, sought after environment.

Growing strong biodiversity corridors prior to development also has added advantages of establishing ecologies and providing a wide range of ecosystem services.

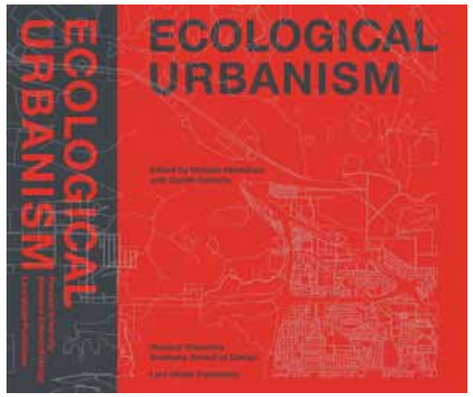


Fig. 2.15. Cover of ‘Ecological Urbanism’

ECOLOGICAL URBANISM

The Manifesto for Ecological Urbanism proposes the development of multi- dimensional sustainable human communities within harmonious and balanced built environments. Ecological urbanism recognises the difficulties of the prescriptive nature of Sustainable Urbanism and proposes utilising and enhancing the existing ecological assets at hand, as a systems based approach to urban development.

The manifesto goes further to claim the following:

“We need to view the fragility of the planet and its resources as an opportunity for speculative design innovations rather than as a form of technical legitimation for promoting conventional solutions. By extension, the problems confronting our cities and regions would then become opportunities to define a new approach. Imagining an urbanism that is other than the status quo requires a new sensibility – one that has the capacity to incorporate and accommodate the inherent conflictual conditions between ecology and urbanism. This is the territory of ecological urbanism.” Mostafavi, M 2010.

Ecological urbanism is mainly being propagated by Harvard University where the a conference turned into a book and a movement. The theory of ecological urbanism proposed once again taking cognisance of the ecological systems in the environment and designing with the ecology at the forefront of development. The environmentally conscious design development hopes to bring about more sustainable futures.

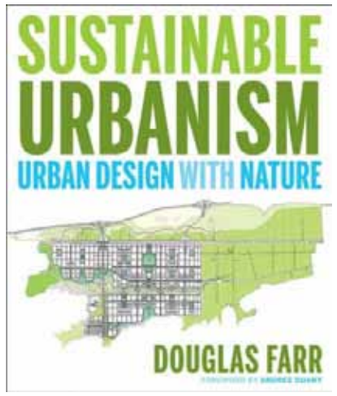


Fig. 2.16. Cover of ‘Sustainable Urbanism, Urban Design With Nature”

SUSTAINABLE URBANISM

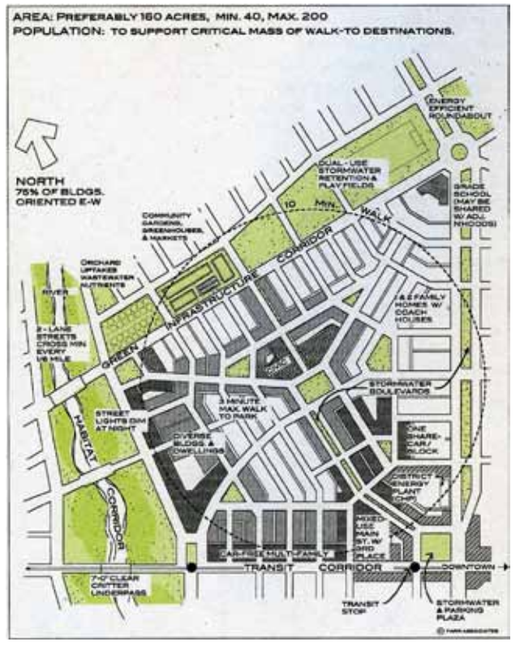
Sustainable urbanism considers the opportunity for the redesign of the built environment into sustainable clusters of urbanism with higher quality environments. It positions itself ecological in a context that sees man as part of the natural system, and that this is a condition that needs to be accommodated by design.

Sustainable urbanism grows out of three late 20th Century reform movements that have transcended McHarg’s antisocial environmentalism to highlight the benefits of integrating human and natural systems. The smart growth, new urbanism and green building movements. The Sustainable Urbanism movement proposes an amalgamation of these movements into a design philosophy towards the creation of sustainable human environments.

Sustainable urbanism promotes walkability and transit-served compact environments coded with high-performance buildings and infrastructure that allow direct access for humans to nature, and through its compact form, greater connectedness overall. It emphasises the connection of neighbourhoods to greater districts and the strong need for connections through a network of streets. It relies highly on the New Urbanist principles of place-making to achieve human-scaled environments.

“Sustainable Urbanism aims to close the loop by eliminating the environmental impact of urban development by providing all resources locally. It is aimed at setting up self-sufficient local hubs. It employs the ecological planning network to facilitate habitat linkages and ecological buffers as edges to contain development pockets. The urban form is organised in a similar manner to the ecological networks, with dense pockets of development linked by public transport networks to a central economic hub” (Farr, D. 2007)

The ‘Sustainable Urbanism, Urban Design with Nature’ book by Douglas Farr, makes a compelling case for the urgency of a more sustainable livelihood, with an excessive study into the low-density, automobile supported American Lifestyle. It includes a section on ‘Implementing Sustainable Urbanism’ which has many guidelines for policy-making and community interaction and also offers a section on principles, referred to as ‘Emerging Thresholds of Sustainable Urbanism’. The book closes with a number of case studies which reinforce the writing, categorised according to different development conditions, namely infill and greenfield sites. The adjacent diagram, taken from the book, effectively illustrates the principles of Sustainable Urbanism. The diagram below shows the sustainable neighbourhood.

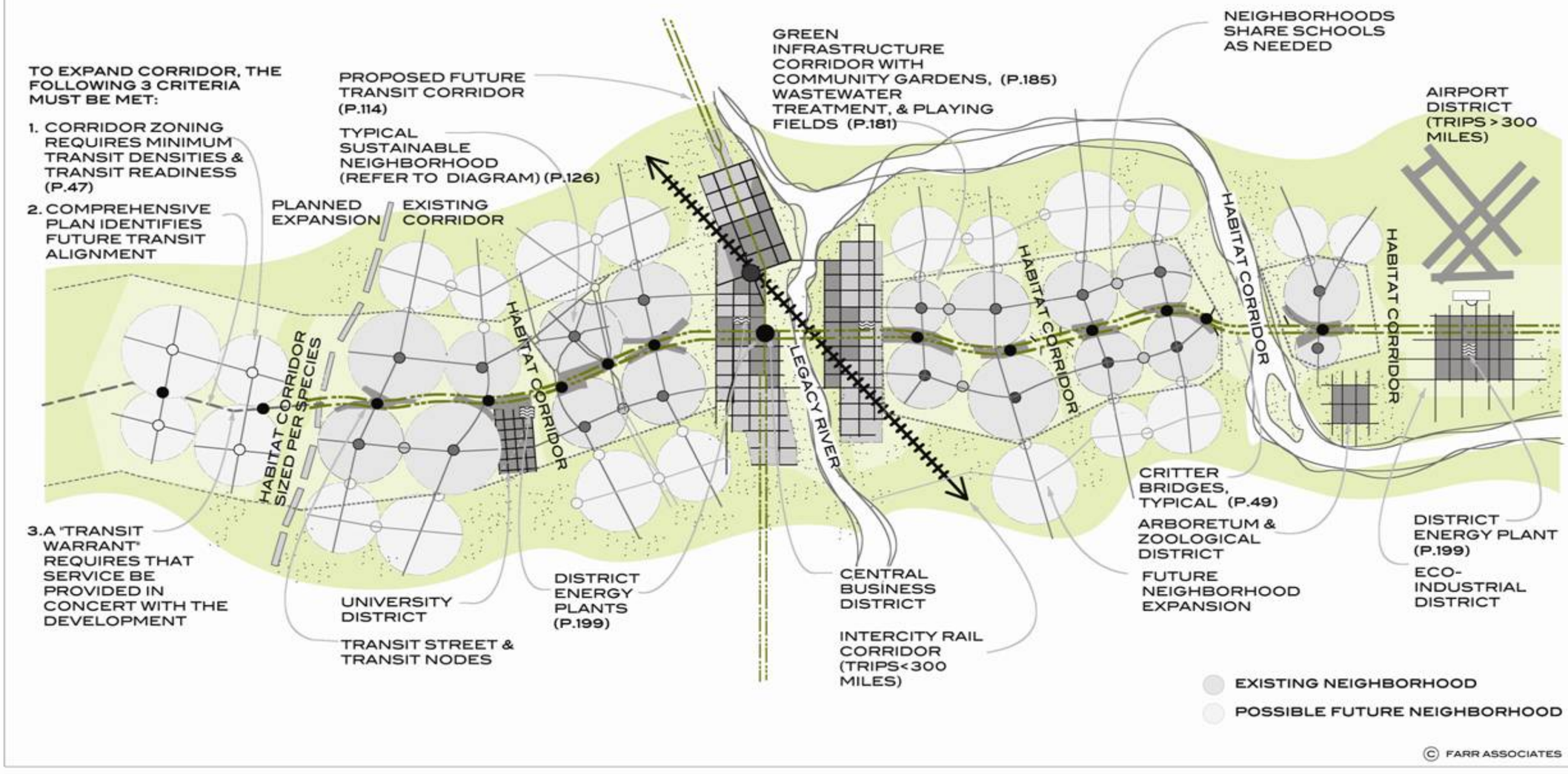


CORRIDOR DENSITY: NECESSARY TO FREE PEOPLE FROM AUTOMOBILE DEPENDENCE. MIN 7 DWELLING UNITS PER ACRE (DU/A) TO SUPPORT BASIC BUS SERVICE HIGHER PREFERRED FOR BETTER SERVICE & MODE (15 DU/A TROLLEY) 22 DU/A LIGHT RAIL (P. 111)

CORRIDOR LAND USE MIX: TO ACHIEVE A 1:1 JOB - HOUSING BALANCE

NOTE: THIS DIAGRAM IS SIMPLIFIED. DEPENDING ON TRANSIT AVAILABLE, OTHER CONFIGURATIONS OF THIS DIAGRAM ARE EQUALLY VIABLE.

DIAGRAM ON PAGE 113.



A SUSTAINABLE CORRIDOR (BUILDING BLOCKS OF A SUSTAINABLE REGION)
V1.1

Fig. 2.17. Sustainable Corridor, Douglas Farr, 2007

SUSTAINABLE URBANISM CASE STUDY

The following text and images are from Taichiung Gateway Project- A New Synthesis of Park and City, Stan Allen in New Geographies, Volume 0, 2009.

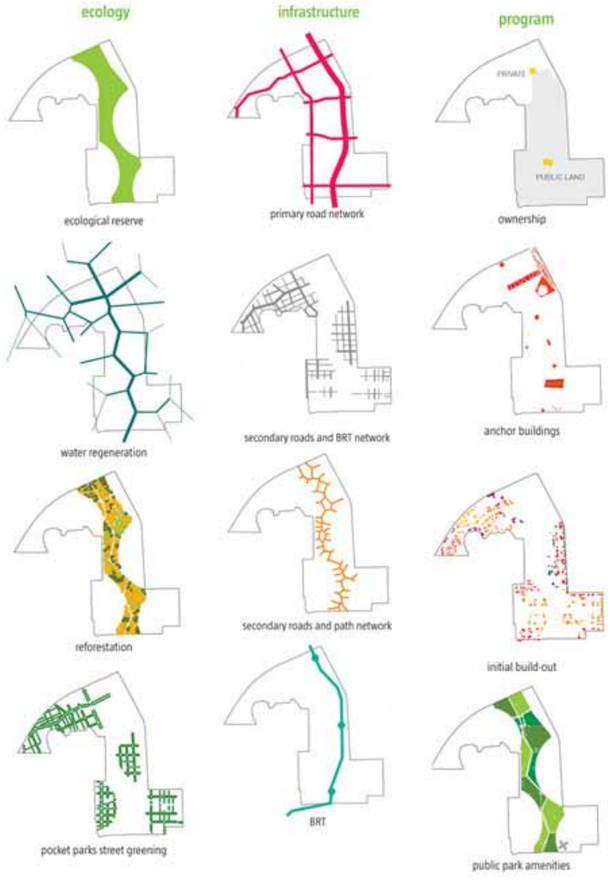
The city today is much too complex for unitary strategies or rigid ideological statements. It requires a pragmatic mix of techniques that parallels the multiplicity of the city itself. The Taichung site is large enough to support a diverse programmatic ecology, and we deploy – without apology – an eclectic sampling of techniques, new and old. We have learned from the experiments of landscape urbanism and landscape ecology, yet we can also make use of new strategies that are (for some) uncomfortably close to New Urbanism. The roadways and civic platforms appeal to ideas of infrastructural urbanism, while the architectural strategy in the large buildings, though stylistically distinct, is not so far from Aldo Rossi's idea of the architecture of the city. The Taichung project is a highly specific response to a particular set of circumstances, but by virtue of its scale and complexity, it can also serve as a test case for a new toolbox of urban strategies for the twenty-first century.

Stan Allen Architects received the mandate to transform Taichung's decommissioned municipal airport into the city's new cultural district. The 250-hectare site is currently an urban void located at one of the main growth corridors of the city. What to do with such an immense opportunity for urbanism? Out proposal creates a single unifying element that incorporates as many program elements as possible: circulation, green space and natural ecologies, new cultural institutions, and research facilities, as well as major public attractors such as the convention hall and the new dome. The new parkway infrastructure defines a zone of intense design investment while strategically opening up edges of the site to existing urban development pressures.

The shape of the park is clear and becomes a recognisable icon that represents an optimistic future for the city of Taichung. The design foregrounds active green space, creates sites for new cultural institutions, and solves the major circulation issues. From a development perspective, the curving shape of the new park creates four neighbourhoods, each with a distinct identity: Canal District, Cultural District, Academic Corridor and College Town.

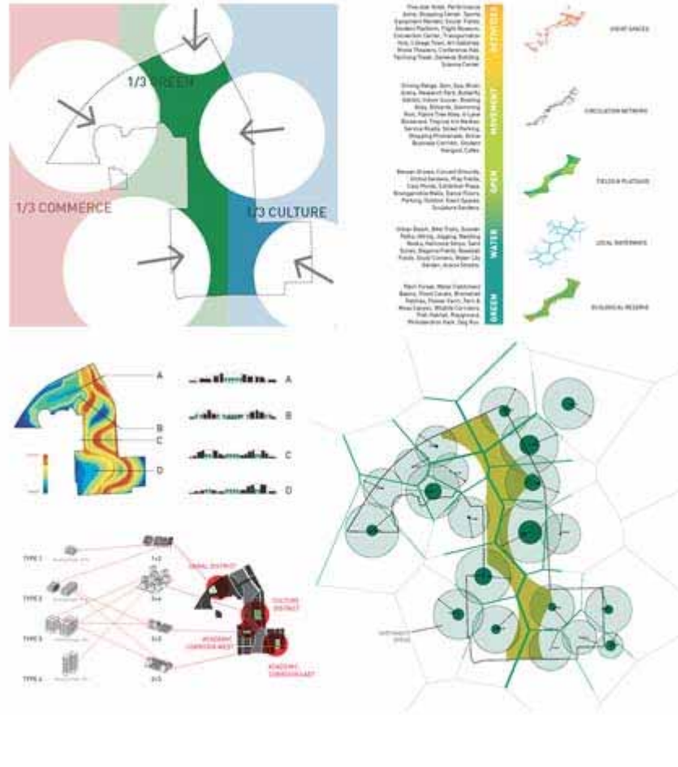
Taichung's recent urban growth has destroyed the connection to its traditional canal network and natural water systems. A restored hydrological network offers an opportunity to rethink site ecologies and create new public space.

The design and execution of both the park and the surrounding neighbourhoods will adhere to an integrated and sustainable landscape strategy based on water and habitat restoration.



TAICHUNG GATEWAY PARK PROJECT

PROJECT: Taichung Gateway Park City; **LOCATION:** Taichung, Taiwan, R.O.C.; **ARCHITECT:** Stan Allen Architect, Princeton, N.J.—Stan Allen (principal in charge); Carlos Arnaiz (associate partner and project designer); Benjamin Cadena, Marc McQuade, Rosalyne Shieh, Frank Mahan, Ryan Neiheiser (project team); **ENGINEERS**: Arup—Trent Lethco, Susan Lim (traffic); **CONSULTANTS:** Arup—Trent Lethco, Susan Lim (planning); Scape—Kate Orff, Daniela Fernanda Serna Jimenez (landscape); Drangonpolis—Carol Wang, Christina Liao, Ritchie Huang, Jing-Yao Chang (local planning); David Tseng (architecture and urban design adviser to the City of Taichung); **CLIENT:** City of Taichung; **SIZE:** 620 acres; **ESTIMATED DATE OF CONSTRUCTION:** 2009



ANALYTICAL FRAMEWORK

PRINCIPLES FOR RESILIENT URBAN DEVELOPMENT

Many common threads follow through the literature in a call for more resilient environments. Most obviously is the need for integrated planning between natural and urban systems, the idea that environments can function on a multitude of levels to different ends requires a multi-disciplinary consideration. In terms of phasing and providing for future developments, it is to be considered that environments function in the intermediate times and cam provide an abundance of ecosystem services. As this group of theories is known for being rather open ended and lacking guiding principles, certain aspects are drawn through in the document. The site responsiveness and knowledge of natural systems from the Ecological Method, the integrated theoretical considerations of Green Urbanism, the phasing strategies and options for intermediate landscapes and inherent open space value from Landscape Urbanism, the consideration of the ecology as a system to be designed for, and the development clustering strategies and implementation of high performance strategies from Sustainable Urbanism.

For the purpose of the document, the author has compiled a summary of principles (based on the principles and structure of 'Sustainable Urbanism' by Douglas Farr, 2007) as a coherent design oriented guidance to be used to assist in the design of resilient development later on in this document.

1. Increasing sustainability through density

Transport supportive densities

- Increase density along transport corridor
- Intensify densities around station precinct
- Mitigate stormwater run-off with high performance infrastructure

2. Sustainable corridors

Transit corridors

- Promote TOD districts
- Multiple development projects
- Mix of uses
- Walkable network of streets
- Design that supports urban living and transport choices

Biodiversity corridors

- Large, high quality, and well-connected habitat patches capable of supporting sustainable populations of native and rare species
- Well-designed habitat corridors to connect otherwise isolated larger remnant habitat patches
- Wide and vegetated buffers to minimise edge effects on habitats and protect water quality and stream quality

3. Sustainable neighbourhoods

- Neighbourhood as the building block of the transport corridor
- Served with a high-intensity transit mode
- Fitted with high-performance infrastructure
- Mix and density to support car-free housing
- Habitat and infrastructure greenways give neighbourhood edges

Identifiable Neighbourhood

- Centre with public outdoor environment
- A well-defined outdoor room with walkable catchment 0f 400m
- Integrated network of streets with a block side 100-175m
- Special sites anchoring the neighbourhood: parks, greens, squares, plazas, playgrounds

Complete neighbourhoods

- Diverse pedestrian destinations
- Distribution through walking catchments
- On street parking and car-free neighbourhoods
- A variety of housing options
- Neighbourhood retail: corner shops and neighbourhood centres
- Walkable neighbourhood
- Complete streets

4. Biophilia

- Parks or high-quality open spaces within a 3min walk of every dwelling
- 650sq.m minimum park size
- 2000sq.m neighbourhood park size
- Parks bound on at least two sides by public right of way
- Variety of park types: sports field, greens, square, plaza, community garden
- Green infrastructure elements: detention basin, bio-retention rain garden, bio-retention swale, permeable paving, green roof
- Food production: individual and community-based- gardens, greenhouses, orchards, aquaculture

5. High-performance environments (buildings and infrastructure)

Complete streets

- Support for compact neighbourhood-oriented development
- Walkability in neighbourhoods and mixed-use areas
- Multimodal (transit, cycle, walking, driving) choices
- Improved compatibility with adjacent uses
- Provision of high-quality public space for activity and aesthetic
- Enhanced quality of life
- Protection of environmental quality
- Universal access

IDEAS TAKEN FORWARD

The investigation makes use of the ecological planning network principle borrowed from sustainable urbanism to integrate infrastructure. Further to the design principles, and only partially included in the document, for a realistic project to be implemented on site; the policy making and community integration guidelines should be further investigated. The document has touched on some of these interactive community strategies in its intermediate phasing. Sustainable urbanism also considers the larger regional scale and the development of self-sufficient clusters of development. The idea of clusters of development are taken into the development proposal and offer mixed use densities linked to a transport network and supported by amenities, as per the principles for resilient urban development. The principle of the ecological corridor network is further developed into green infrastructure networks in the development proposal to follow.

CHAPTER 3

Green Infrastructure Analytical Framework

This chapter discusses green infrastructure and the ecosystems services that humans gain from them. It illustrates means of creating value in intermediate developmental context and how ways of priming the landscape can result in richer environments.

INTEGRATING URBANISM, ECOLOGY AND GREEN INFRASTRUCTURE

Ecosystems are made up of natural resources and biodiversity that sustain urban life and economic activity. They regulate air and water, provide essential inputs for self-employed farmers and multinational suppliers and help protect urban infrastructure from environmental degradation and extreme weather. In most cases, critical ecosystem services are not well understood, unappreciated and undervalued to the point of being considered free or largely taken for granted.

“Infrastructure networks refer to the physical and technological assets that enable city residents to access and use essential goods and services like energy, water, food, transport and telecommunications. To improve resilience, designs for infrastructure networks are advised to incorporate: redundancy, flexibility and diversity and the ability to fail safely’ - Resilient Cities: Climate Adaptation & Urban Development

Green Infrastructure can increase the capacity of environments and systems to support human development. It also looks at innovative systems of creating enhanced and engineered living systems to facilitate greater development.

Drawing from the theory presented in the previous chapter, this chapter discusses the overarching theory of green infrastructure and the mechanisms by which it can be achieved. The end products of ecosystems services are enhanced by the introduction of a green infrastructure network. This network brings ecosystem services closer to human users, as well as introducing enhanced biodiversity corridors that allow for more regular engagement with the natural environment, in an integrated manner. The principles of ecosystem services are further described below.

Fig. 3.1. Ecosystem services for Humas use
Stock Image

ECOSYSTEM SERVICES

“The term ‘ecosystem’ describes a dynamic complex of plant, animal, and micro-organism communities and their non-living environment, interacting as a system. Ecosystems encompass all organisms within a prescribed area, including humans” (Barbier, E. 2011). Ecosystem functions include processes that link organisms with their physical environment and the processes that link organisms to each other, indirectly influencing flows of energy, water, and nutrients. These processes in total describe the functioning of ecosystems.

Ecosystem services are the contributions, direct or indirect, that ecosystems make to the well-being of human populations (Barbier, E. 2011). Ecosystem processes and functions contribute to the provision of ecosystem services; however, they are not essential to ecosystem services. They describe processes that can carry on independently of whether or not humans benefit from them. These relationships generate ecosystem services only if they add to human well-being. The contribution to human well-being can be physical well-being or psychological gratification. Thus, ecosystem services cannot be defined independently of human values. Adapted from Capitalizing on Nature: Ecosystems as Natural Assets by Edward B. Barbier, 2011.

Fig. 3.2. Ecosystem services for physical and phsycological well-being
Government Avnue, Company Gardens, Author 2009

The origin of the modern concern regarding ecosystem services is be said to date back to an 1864 publication in which various ecosystem services are recognised. (Jansson, A.2012)

The general definition of ecosystem services describes the “conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life” (Daily, G. 1997) Ecosystem services are the link between human systems and natural systems. They operate on the premise that people rely on nature in that nature supports lives and livelihoods through the goods and services that ecosystems provide. To create sustainable livelihoods and resilient cities, strategies need to be developed to care for, and better integrate them into urban contexts.

In the current context, cities need to be able to bounce back from increasingly extreme conditions and natural systems offer an excellent opportunity to provide resilience to cities.
There needs to be a focus on development that aims to improve quality of life and human well-being. Principles and qualities that create the kinds of quality environments and the strategies that can assist in better-integrating ecosystem services into urban livelihoods need to become more pronounced.

The Millennium Ecosystem Assessment (2005) categorises ecosystem services into four overarching types of services: provisioning, cultural, regulating and supporting services. *"Provisioning services include food, fibre, fuel, genetic resources, medicines, freshwater, grazing.*
Cultural services include spiritual, education, aesthetic, sense of place, social relations, heritage, recreation and ecotourism. Regulating services are air dispersion and mixing, water supply, flood attenuation, erosion control, factors limiting the spread of disease, natural pest control, and pollination.
Supporting services: soil formation, primary production, nutrient cycling, and water cycling".
It becomes evident that our environment supports basic and more specific human needs and need to be recognised as such. Natural systems provide irreplaceable services to people. It has become necessary to minimise destruction of ecosystems and the subsequent loss of biodiversity. The supply of ecosystem services needs to be increased while reducing demand on them, increasing efficiency and improving equity of their use.
To ensure sustainable development; particular attention needs to be paid to the most vulnerable ecosystems that are at the highest risk. Basic needs rely on 'free' ecosystem services for livelihoods and to supplement their assets base. They are most vulnerable to changes in access to, use of, and quality of these ecosystem services.
"Investing in ecosystem-based enterprises ensures higher economic resilience (better able to face economic risks), better social resilience (better able to work together for mutual benefit) and the ecosystems can become more biologically resilient (more productive and stable)" (World Resources Institute with UNEP, UNDP, World Bank. 2008: Roots of Resilience: growing the wealth of the poor). By reintroducing ecosystem services to urban areas, it starts to effectively build resilience into neighbourhoods by ensuring that people have the means to become more self-sufficient.


Fig. 3.3. Ecosystem services by water provision to lifestock
Stock Image

ECOLOGICAL SCARCITY

Ecological scarcity has become a problem worldwide. Economies and societies are being threatened by a variety of constraints caused by natural resource scarcity. This resource scarcity varies from limited availability of fossil fuels to fishery and food and water supply. The environmental consequences are dire: the degradation of critical ecosystems, such as coral reefs, tropical forests, freshwater systems, mangroves and marine environments have all suffered biodiversity loss. By making people more aware of their environment, they start to see first-hand the effect urban living has on the environment, and by giving them access to these services they can start to become actively involved in shaping their environments and futures.

BIODIVERSITY LOSS AND URBAN DEVELOPMENT

With the rapid rate of urbanisation that has occurred over the last fifty years, ecosystems have been modified more extensively than in any documented historic period. The ecosystems have been affected mostly due to urban development, food production and resource extraction. - Millenium Ecosystem Assesment Synthesis Report, 2005. This has resulted in a substantial and largely irreversible loss in biological diversity, ecosystems, and the ecological services that they provide. Over the next fifty years, it is predicted that "the rate of biodiversity loss is also expected to accelerate, leading to the extinction of at least 500 of the 1192 currently threatened bird species and 565 of the 1137 mammal species". Dirzo and Raven 2003. There is a growing concern about the consequences of biodiversity loss for the provisioning of ecosystem services and it has been clearly shown that "biodiversity does indeed have positive effects on many ecosystem services". (Balvanera et al., 2006; Díaz et al., 2005). By ensuring green corridors, ecosystems can become less fragmented and facilitate the movement of species and resources more effectively.

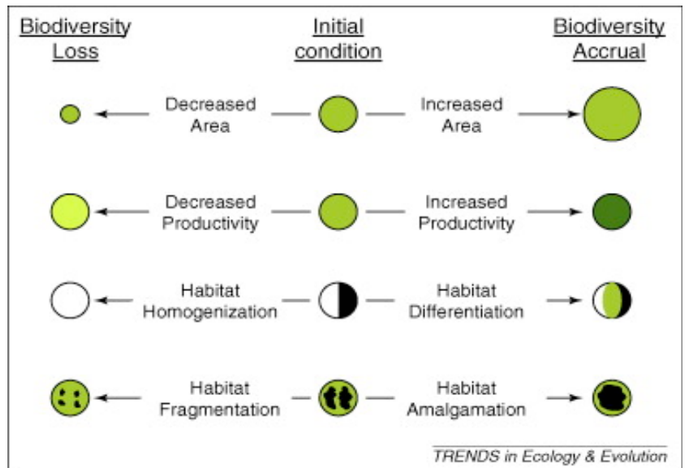
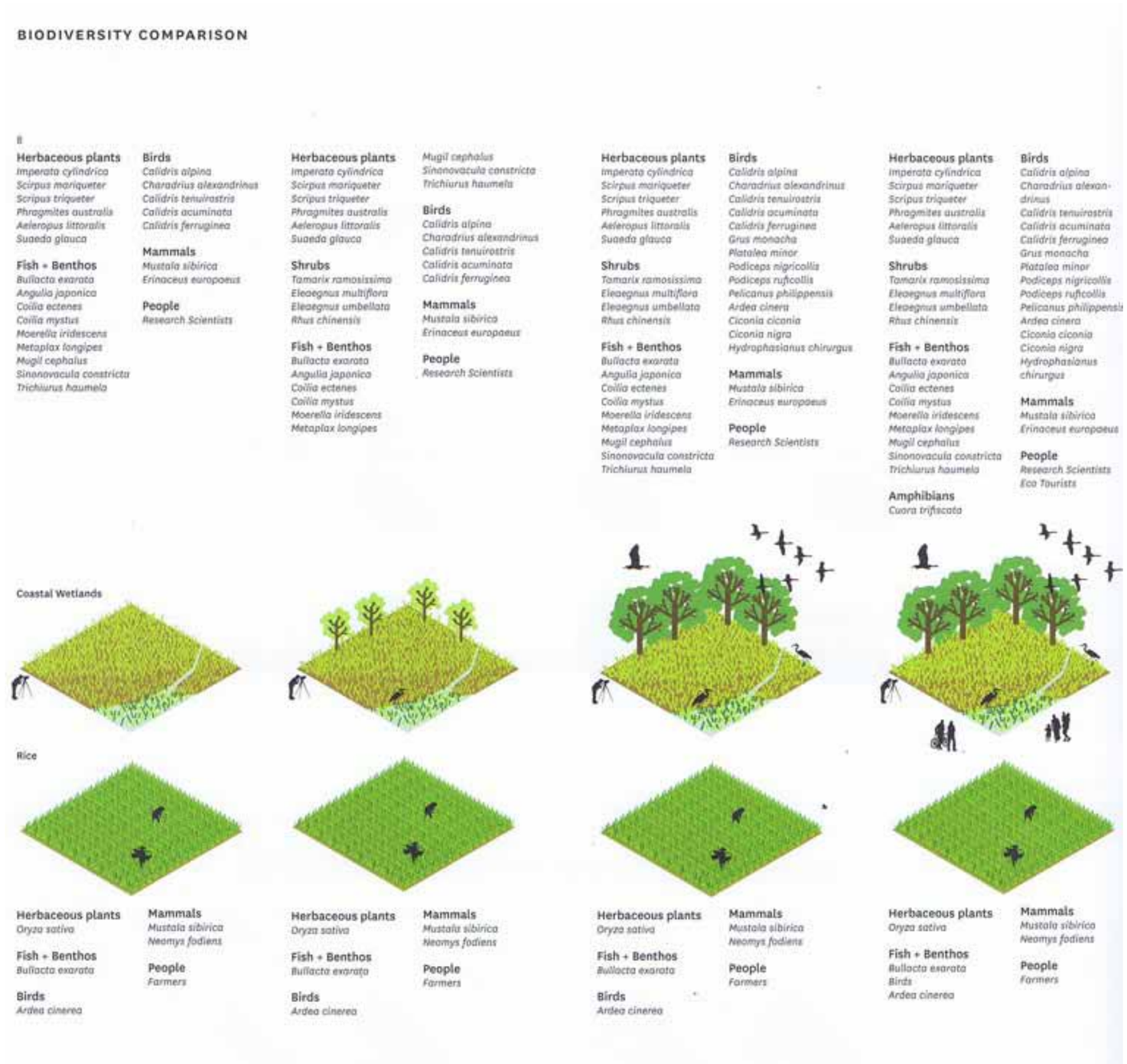


Fig. 3.4. Biodiversity dynamics following environmental change. Conditions to consider in intermediate site strategies in order to prevent biodiversity loss and encourage the growth of niche habitats.
Source: Balancing biodiversity in a changing environment: extinction debt, immigration credit and species turnover. Jackson s & Sax D, Trends in Ecology and Evolution, volume 25, Issue 3, March 2010



MILLENIUM ECOSYSTEM ASSESMENT

The Millennium Ecosystem Assessment has confirmed what has been suspected for some time: global ecological scarcity is a serious problem. Approximately fifteen out of our twenty-four major global ecosystem services have been degraded or used unsustainably, including freshwater, capture fisheries, air and water purification, and the regulation of regional and local climate, natural hazards, and pests.

The MEA has defined ecosystem service as “the benefits people obtain from ecosystems’”. This has raised a call to a multitude of disciplines to become involved in aiming to develop appropriate solutions to the problem. The loss of resources has become evident in recent years in the South African context with limited energy availability, water shortages, droughts in agricultural regions and the subsequent rise in food prices. Developing local food sources, by aid of basic resource provision, decreases the energy used to transport food and building resources, providing economies the ability to function within their means locally.

Fig. 3.5. Biodiversity comparison between a coastal wetland and a rice paddy. appropriate land use in terms of typesof open space can also drastically increase biodivesity over time. moving away from monoculture planting strategies and visualising long term benefit and habitat diversification over time.
Biodiversity Comparison, SWA Group, 2008

NATURAL CAPITAL CONCEPT

“A new paradigm is emerging in environmental economics. It views the natural environment as a form of capital asset, natural capital. Natural capital consists not only of specific natural resources, from energy and minerals to fish and trees but also interactive ecosystems. Ecosystems comprise the abiotic environment and the biotic groupings of plant and animal species called communities. As with all forms of capital, when these two components of ecosystems interact, they provide a flow of services. Examples of such ecosystem services include water supply and its regulation, climate maintenance, nutrient cycling, and enhanced biological productivity”.(Barbier and Heal, 2006)

60% of the ecosystem services are being eroded or used unsustainably, and we are thus living off the capital and not the interest. This strategy is not sustainable in the long run. It therefore becomes increasingly important to increase efforts in bringing to light the connections between the natural and urban systems, to “illuminate the connections between biodiversity, ecosystem services and human well-being in a changing world”. We need to acknowledge and find ways of mitigating the role and effects of urbanisation on ecosystems and their provisioning services. Cities and urban areas hold the capacity to affect the greatest change at multiple scales. “Material demands of production and human consumption alter land use and cover, biodiversity, and hydro systems locally to regionally, and urban waste discharge affects local to global biogeochemical cycles and climate” (Grimm et al., 2008).

BUILDING RESILIENT ENVIRONMENTS

From this chapter, it becomes evident that people are an integral part of ecosystems. If development is to be sustainable, it needs to operate within the natural limits of ecosystems. A major realisation of the Millennium Ecosystem Assessment was that future development ‘must aim at fulfilling human needs but at a smaller cost on natural systems, and that natural resources need to be accounted for as a measure of wealth.

The ability of ecosystems to recover from pressures & shocks is reduced through loss of biodiversity. The rapid loss of biodiversity may cause a sudden shift in ecosystems, from “desired to less desired states in their capacity to generate ecosystem services” (Folke et al. 2004).

Change is inevitable, and adaptive management is essential for the resilience of socio-ecological systems. The resilience to adapt to change must be catered for in the urban environment. “Urbanisation, if properly managed, potentially can aid in strengthening biodiversity and ecosystem service generation in the social-ecological landscape, thus providing arenas for social–ecological change and transformation” (Barthel et al., 2010)

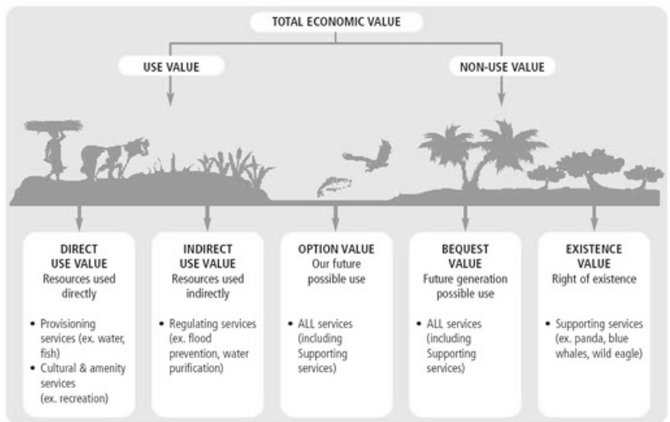


Fig. 3.6. Total economic value of Ecosystem Services
Source: Sustainability, Innovation, and Entrepreneurship, 2012

GREEN INFRASTRUCTURE AS AN APPROACH TO INTEGRATION

The concept of green ingrastructure has already been referenced throughout the document thus far. The question becomes how the natural and urban systems can be integrated to function alongside one another. Green infrastructure proposes an opportunity to deal with this. Green infrastructure aims to enhance the natural systems within an urban context while also increasing the amount and access to ecosystem services. Green infrastructure can assist in the cleaning, filtering and aerating water flowing into rivers, enabling increased biodiversity through the creation of niche habitats that serve as mini-habitats for insects and birds, mitigate urban storm water run-off and facilitating aquifer recharge for better water catchment management, assist in restoring naturalising canalised rivers and restore riparian habitats.

“Green infrastructure elements can also function as parks, greenways, and natural areas, providing public space for humans and vital habitat for animals” (Benepe, a. 2013). This facilitates the development of a quality public environment through considered design of green infrastructure principles and development strategies. Specific green infrastructure strategies with relevance to the site and the proposed development are discussed further on in the document.

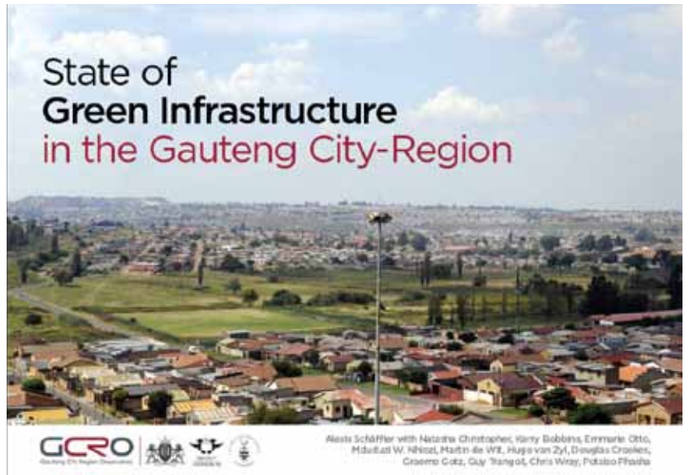


Fig. 3.7. Cover of ‘State of Green Infrastructure in the Gauteng City-Region”

THE STATE OF GREEN INFRASTRUCTURE IN THE GAUTENG -CITY REGION

"The capacity of our infrastructure to cater for a rapidly growing population and economy is a critical challenge for the Gauteng City-Region. Meeting the expanding demand for urban services in a context of resource constraints will prove difficult, especially in the context of historically inequitable, dysfunctional and sprawling urban settlement patterns. Ever larger volumes of domestic and industrial waste and growing air, water and land pollution exacerbate the challenge. When we think about green infrastructure, we used to think about big pipes, big culverts, big roads. It is time to challenge the common perception of what infrastructure is and should be. Green assets such as urban trees, parks, wetlands, natural grasslands, and the like, can be – indeed must be – thought about and planned for as infrastructure". Rashid Seedat: Head of the Gauteng Planning Commission (Schäffler, A. 2013) This adequately sets the tone for the tone of our urban environment the rest of the report goes on to detail all of the shortcomings in the planning process that currently can not give an accurate image of the state of green infrastructure.

The report does, however, bring some interesting principles to light. The report outlines the underpinning of green infrastructure as a way of understanding the soft landscape as an infrastructural element and the inherent value that it offers overstressed systems in the urban environment: *"Green infrastructure is defined as an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations. In our view, Green infrastructure is the ecological framework needed for environmental, social and economic sustainability".* Benedict & McMahon 2002 in Green Infrastructure: Smart conservation for the 21st Century. The aim of green infrastructure is to achieve multifunctionality. It performs a range of functions to society. Those functions include flood alleviation, water filtration, local food production, mitigating the heat island effect, local food production, increased biodiversity, biophilic environments and green space for people.

Green infrastructure calls for an integrated approach in its implementation as it is concerned with such a large variety of functions with spatial considerations.

INFRASTRUCTURE THAT APPRECIATES OVER TIME

Whereas traditional infrastructure systems depreciate over time, "by definition as living elements, biophysical systems provide for value that appreciates as the stock, quality, overall health and service productivity of green assets grows over time". As discussed in the previous chapter, landscape urbanism has illustrated some of the ways in which ecologies diversify over time, developing niche habitats for species. By integrating natural corridors with infrastructure services and using this as the basic structuring element, natural assets are allowed to grow over time and attain more value.

NATURAL INFRASTRUCTURE

"Natural infrastructure is the interconnected network of natural and undeveloped areas needed to maintain and support ecosystems. They also provide a wide array of environmental, health and economic benefits such as mitigating climate change impacts and sustaining clean air and water. Our Natural Infrastructure has been declining – in quality and quantity – since the start of the industrial revolution." (The State of Green Infrastructure Report)
The State of Green Infrastructure Report aims to identify some of these natural infrastructures and shows that there is a great capacity for natural infrastructure to be increased in already developed areas. Green infrastructure could be retrofitted into these areas to increase their performance and become of greater use to surrounding communities.

THE SCOPE OF GREEN INFRASTRUCTURE

The mechanisms of green infrastructure encapsulates many ideas at different scales; ranging from site techniques and structural practices for managing storm water (the New York State Department of Environmental Conservation), to practices on a larger scale, including preservation and restoration of natural landscape features (such as forests, floodplains and wetlands), and reducing the amount of land covered by impervious surfaces. Smaller scale practices include green roofs, pervious pavement, rain gardens, vegetated swales, planters and stream buffers. Some suggest that true green infrastructure is not engineered or "built," but is "natural" and in its simplest form consists of trees, plants, and soil. An argument can be made that natural systems, such as salt marshes, can provide a natural infrastructural approach to storm surge abatement, and that purely conserving can aid as a green infrastructure strategy.

LIMITATIONS

For the purpose of this investigation, the focus will be on green infrastructure in the aspect on managing water as a basic resource, the various strategies that can be introduced or improved to facilitate the movement, ecological impact and natural resources that water provides. To understand the role, cycle and scale of water within the urban environment, network theory will be the overarshing guiding framework and then be translated into an urban strategy for "Hubs, Links and Nodes"

	Traditional Infrastructure		Landscape Infrastructure
Streets	Engineering and maintaining city streets based solely on the needs of automobiles.	❶ 	Re-designing streets, streetscapes and pedestrian connections in ways that beautify and revitalize. Incorporating paving materials that offset heat island effect and help with storm water management.
Highways	Engineering and maintaining highways for peak-traffic efficiency	❷ 	Using highway corridors as opportunities for restoration of native habitat, re-vegetation, civic art, and storm water management
Waterways	Channelizing or altering waterways for storm water management or roadway development.	❸ 	Naturalizing disturbed, neglected creeks, rivers, bayous and other waterways for storm water management, public spaces, and urban wildlife habitat.
Alleyways	Identifying and using land on a utilitarian basis.	❹ 	Creating usable parks and open space as part of a larger urban plan from opportunities presented by alleyways, power line corridors, waterways and other traditional infrastructure venues.
Railways	Maintaining or converting established rail lines.	❺ 	Repurposing railway corridors for hiking and biking trails. Creating additional opportunities for parks, open space and habitat.
Parks and Open Space	Generally not considered as part of infrastructure.	❻ 	Utilizing parks and open space to nurture a respect for nature, provide recreational venues and link communities.
Urban Design	Focusing on location of structures and connections.	❼ 	Synthesizing buildings, streets, corridors and natural systems. Integrating public spaces and nature into the city.

Projects: ❶ Gubei Pedestrian Promenade: A mixed-use pedestrian-oriented open space in the midst of the densely built city. Spanning four city blocks, approximately 800 meters long and 40-80 meters wide, and is flanked by 20-story residential towers. ❷ Anaheim Regional Transportation Intermodal Center: A 16-acre, LEED-Platinum transit facility that forms a seamless gateway from Anaheim to all of Orange County, spurring economic growth and community redevelopment throughout the region. ❸ Buffalo Bayou Promenade: Converted a space intimidating to pedestrians and detrimental to flood control efforts into 3,000 linear feet of urban park that provides a prominent gateway to downtown Houston, Texas; ❹ Lewis Avenue Corridor: The resulting 'found' space was given back to the pedestrian, which resulted in 20-foot wide sidewalk zones in downtown Las Vegas, Nevada; ❺ Katy Trail: A Rails-to Trails project of a linear 4.5-mile landscaped pedestrian and bicycle trail system that runs through the most densely developed section of Dallas, Texas; ❻ Milton Street Park: A 1.2 acre urban park along the Ballona Creek Bike Trail, stretching over 1,000 feet in length (45 feet wide) in Marina del Rey, California; ❼ Ningbo Eco-Corridor: Incorporates ecological approaches such as benefits of breezes from the water, storm water treatment, reduction of urban heat island effect, sun shading by trees, restoration of ecological habitats, and improving the water quality of adjacent water bodies.

Fig. 3.8. Table comparing traditional infrastructures with green infrastructures, aslo referred to as landscape infrastructure. SWA Group, 2011

HYDROLOGY

THE LOWEST COMMON DENOMINATOR OF NATURAL SYSTEMS

Water is seen as the basis of all life forms, and also of ecological functioning, most human settlement patterns occur around some form of water source, Watercourses shape and respond to topography; topography and pedology create different natural morphologies; vegetation differs due to water, morphology, climate and altitude; and results in niche environments that support animal species. Urban growth occurs within proximity to water sources or water bodies. Urban development often has an adverse effect on natural resources and results in water pollution.

WATER IN THE URBAN CONTEXT

“Green infrastructure as part of the solution to managing that most vital and also most dangerous of all natural forces—water—will likely be an essential component of urban design for the foreseeable future.” (Benepe, A. 2013)

As the need to create sustainable, resilient cities; green infrastructure will be a way to create new multi-functional public parks and open spaces. Hyper performing landscapes needs to be considered as a strategy to reduce demand and increase the efficiency of natural resources in an urban environment.

Green Infrastructure is quickly becoming a primary tool in designing and building sustainable cities. This document sets out explore some of the ways in which this could be achieved, focussing specifically on the green infrastructure as a structuring element for urban design and investigating green infrastructure components for city building and space making in the urban realm.

Examples of the need to consider green infrastructure strategies takes its key from already occurring climate change in the form of changed patterns of precipitation.

Managing urban stormwater is already in a dire state as the system is often over capacity, This is visible in the drought scares and flooding that are occurring yearly. Further changes in precipitation patterns (both in intensity and variability) will increasingly require communities to control for drought and flooding above and beyond the capacity of the system. As more and more surfaces in the built up areas are made hard and impermeable, less water can percolate naturally into the soil leaving large amounts of water unprocessed with potentially high concentrations of pollutants. Thus, urban green areas are becoming increasingly important for maintaining water quality, allowing for aquifer recharge and managing water within catchment systems.

GREEN INFRASTRUCTURE AS A PRIMER

Green infrastructure is inherently linked to the natural environment and the landscape scale from a regional to site scale, the nature of the size of this scale allows for large interventions over time that can have an overall positive effect with minimal maintenance, and will still appreciate in value.

Whereas traditional infrastructure would normally prime a development, the proposal here is to give over much of the grey system functioning to the green network, with the assistance of high-performance technologies.

The green infrastructure network should then start functioning as a structuring element to guide development over time and to allow for development to exist within structured and mature green urban environments with higher quality and desirability.

The ecosystem services, as discussed previously in the chapter, would also be accomodated within his green structuring element. Essentially, the green infrastructure network (acting as the structuring element) will capture water run-off from hard urban areas and precipitation, allow for aquifer recharge, water filtration and storage, accessible to the public realm. The network also supports infrastructure to transport irrigation water for agricultural purposes, to support food production, forestry and fishing, cycling water through the environment and replenishing natural water bodies and sources.

INTERMEDIATE NATURES AND THE UNFINISHED

Coming back to the idea of green infrastructure appreciating over time; this proposed green network would act on the same premise, being able to provide more services as it starts to grow into a better connected element.

No landscape is ever really finished. The work of Michel Desvigne is a good example of this idea and will be used to explain the different scales and timeframes within which the green network could operate.

Michel Desvigne is no doubt the most high-profile French landscape architect working today. His projects are synonymous with a strong strategic and conceptual component, influenced by insights from geography. Michel Desvigne's work is about cultivation, process and change.

James Corner describes Desvigne's work in the foreword of his book 'Intermediate Landscapes' : "*What is perhaps most striking in Desvigne's work is his fascination with the unfinished. He does not seem at all bothered that a project may appear raw, young, still in development. First, there is, of course, a certain aesthetic appeal to unfinished landscapes, followed by an excited sense of anticipation of things yet to come. Especially with young landscapes where a palpable sense of growth and change is most pronounced over relatively short timeframes. His understanding of landscape as an active infrastructure suggest new ways of validating investment in landscape in cities, as these green living infrastructures can be catalysts for new forms of development and new lifestyles, new armatures for more complex forms of urbanism to grow and evolve.*"

Desvignes work uses the tool of intermediate natures to inhabit the sites. According to him, new traces are added once the main connections of a site have been established and the temporary uses start to take hold and shape the character of the site. As this network grows and time passes, new urban needs arise that, in some cases, cannot be pre-planned for. The open nature of such a green structure allows for change and adaptation within an interconnected urban grid. In its intermediate state, this growing green armature makes available the possibilities for people to

Fig. 3.9. Imagery of Campus Paris-Saclay by Michel Desvigne
Source: School Talk, Harvard GSD, 24 Apr 2013

meet, make use of the environment and ultimately add to the growing of a cultural and productive environment. As the green structure starts to shape the environment, people also shape the green structure. Desvigne describes a green network as functioning at four identifiable scales and giving identity to the environment. They are 1) amplified geography, 2) large parks, 3) a network of connected public spaces, and 4) well defined plazas. In describing the transient nature of development over time, he references Shenyang Architectural University Campus as an example of a productive use of intermediate spaces.

The case study that follows explains, to some extent, what this investigation aims to achieve in terms of priming and place making.

Priming and intermediate use principles from case study

The primary structuring element of the Shenyang campus is the serviced grid of tree planted walkways. The open greens in-between, which are earmarked for future academic building function as rice paddies in the intermediate term, maintaining a productive landscape. Further reaching parts of the campus with longer term development goals are currently being used for agro-forestry. The area has become a landscape for learning and making students aware of the agricultural processes. The produce gained from the process has become a marketing tool for the university. Well defined spaces for student gathering amidst the landscape has already been established at an early phase. The proposal to follow in this document makes use of a similar structuring element of integrated green and hard movement networks to prime the environment for development, as well as engaging in various intermediate land use patterns.

PRIMING CASE STUDY: SHENYANG ARCHITECTURAL UNIVERSITY CAMPUS

The following text is taken from TURENSCAPE Architecture/ Landscape Architecture/ Urbanism. (Turenscape.com) and is used to illustrate the concept of primimng. In this scenario, priming of future land parcels take on an intermediate use as architectural research and productive landscape.

***Project Location**: Shenyang City, Liaoning Province, China*
Project Size: 21ha
Date of Design: January ,2003-Semptember ,2003
Date of Complete: 2004
Owner/Client: Shenyang Architectural University

Project Statement

This project demonstrates how agricultural landscape can become part of the urbanized environment and how cultural identity can be created through an ordinary productive landscape. The overwhelming urbanization of China is encroaching upon much arable land. With a population of 1.3 billion people and limited tillable land, food production and sustainable land use is a survival issue that landscape architects must address.

1.The scope and challenges

In March of 2002, the Shenyang City in North China's Liaoning Province commissioned the designer to create a new, 80 hectares suburban campus for Shenyang Architectural University. Originally located downtown, the university was established in 1948 and played an important role in educating architects and civil engineers for the city of Shengyang and for the country as well. After much deliberation, the school decided the best solution was to move the entire campus to the suburbs.

2.The concept

Landscape architects working in China must address issues of food production and sustainable land use, two of the biggest current issues on China's horizon as the country moves towards modernization. The overwhelming urbanization process in China is inevitably encroaching upon a large portion of China's arable lands. With a population of 1.3 billion people, but with only 18% arable land, China is in danger of using up one of its very valuable and limited resources.

The concept of this design seeks to use rice, native plants and crops to keep the landscape productive while also fulfilling its new role as an environment for learning.

It is designed to raise awareness of land and farming amongst college students who are leaving the land to become city dwellers. In addition, the designer also seeks to demonstrate how inexpensive and productive agricultural landscape can become, through careful design and management, usable space as well.

Fig. 3.10. Main Avenue of the Shenyang Architectural University
Source: School Talk, Harvard GSD, 24 Apr 2013

3.The major features

(1)The productive campus rice paddy: not only designed to be a campus with small open platforms, spanning the landscape, the campus is also a completely functional rice paddy, complete with its own system of irrigation.

(2)Other native crops, such as buckwheat grow in rotation across the campus, annually. Native plants line pathways.

(3) The productive aspect of the landscape draws both students and faculty into the dialogue of sustainable development and food production. By situating a new architecture school within a functioning rice paddy, the design allows the process of agriculture to become transparent and accessible to all on campus. Management and student participation become part of the productive landscape. The farming processes can potentially become a laboratory for students and the faculty as well.

(4)Golden Rice became a university icon: the rice produced on the campus is harvested and distributed as "Golden Rice," serving both as a keepsake for visitors of the school, and also as a source of identity for the newly established, suburban campus.

Fig. 3.11. Agro-Foestry at the Shenyang Architectural University
Source: School Talk, Harvard GSD, 24 Apr 2013

Fig. 3.12. Lifestock grazing along the Main Avenue,
Turenscape 2003

Fig. 3.13. Special Pplaces for students to interact with the environment
Turenscape 2003

CHAPTER 4

Approach and Methodology

GREEN INFRASTRUCTURE- AN INTEGRATIVE NATURAL/ URBAN ECOSYSTEM STRATEGY
Benefits of Green Infrastructure
Principles of Green Infrastructure

NETWORKS
Network Theory - the Key to Unraveling How Nature Works
A Green Infrastructure Network
The Value of Landscape as a Medium

AN URBAN STRATEGY FOR GREEN INFRASTRUCTURE
The Public Elements of Green Infrastructure
HUBS - Parks as green infrastructure
LINKS - Streets as green infrastructure
NODES - Public squares as green infrastructure

VALUE OF GREEN INFRASTRUCTURE FOR URBAN DESIGN

This chapter discusses the benefits of green infrastructure and proposes a strategy for the implementation of green infrastructure in unban contexts using network theory.

GREEN INFRASTRUCTURE- AN INTEGRATIVE NATURAL/URBAN ECOSYSTEM STRATEGY

"Nature… must rather be treated as an ally and friend, whose ways must be understood, and whose council must be respected" Lewis Mumford after Hippocrates (McHarg, I. 1969) "Despite nature's many earlier warnings, the pollution and destruction of the natural environment has gone on, intensively and extensively, for the last three hundred years, without awakening sufficient reaction; and while industrialisation and urbanisation have transformed the human habitat, it is only in the last half of the century (20th) that any systematic effort has been made to determine what constitutes a balanced and self-renewing environment, containing all the ingredients necessary for man's biological prosperity, social cooperation and spiritual stimulation"

One would not be able to tell that this was published in 1969, as the conditions do not seem to have advanced much, and on the contrary probably deteriorated since. The need for original and innovative urban planning strategies in developing countries is becoming more apparent, partially because developing countries have a higher dependency on ecosystem services, as recalled from World Resources Institute Report: 'Roots of Resilience: Growing the Wealth of the Poor' in chapter 3. The majority of growth occurring in the next twenty-five years will be in urban areas of developing countries. Urban strategies become critical in this context to ensure quality livelihoods and cohesive form. The United Nations estimates that only 5 percent of building work currently underway in the world's cities is actually planned (UN World Urbanisation Project 2014). Green Infrastructure involves land-based strategies derived from the natural terrain, seeking to affordably promote development to meet the current needs and respond to pressures. It advocates the development of an urban landscape that will help expand its economy while providing safe and livable neighborhoods to a rapidly increasing urban population.

BENEFITS OF GREEN INFRASTRUCTURE

Green infrastructure aims, at its core, to prevent further loss of ecosystems and their associated services, specifically in natural areas. It strategises the increased quality of water systems, controlled stormwater runoff and flood control and filtration of toxins. Green infrastructure networks promote linking of fragmented open spaces to increase habitat niches and enable greater biodiversity. It aims to enhance the capacity to existing infrastructure systems to reduce long-term maintenance costs.

10 PRINCIPLES OF GREEN INFRASTRUCTURE

There are some principles that have been developed to integrate green infrastructure into existing structures. They have been coined under Green Infrastructure Planning and issued by the 'New Designs for Growth Organisation'. They have been included in this document to give an overview of the scope and considerations that need to be taken in developing, enhancing or rehabilitating green infrastructure networks. The principles are as follows:

Principle 1: *Connectivity is key: The goal of a green infrastructure plan is the creation of a network of ecological areas within a region that function as an ecosystem or watershed.*

Principle 2: *Context matters: A fundamental concept of landscape ecology is that the study of individual content areas is not adequate. Understanding and predicting change in native ecosystems and landscapes requires the study of the biological and physical factors of the surrounding areas.*

Principle 3: *Green Infrastructure should be grounded in sound science and consult a multidisciplinary team.*
(Fields such as biology, watershed management, landscape architecture, urban, rural and regional planning, and civil engineering).

Principle 4: *Green Infrastructure can and should function as the framework for conservation and development. Green infrastructure planning can help communities prioritize conservation needs and determine where to direct development in their master plans and zoning ordinances.*

Principle 5: *Green Infrastructure should be planned and protected before development. Green Infrastructure plans should set acquisition and restoration priorities and help identify opportunities to reconnect isolated habitat islands. Restoring natural systems is far more expensive than protecting ecosystems.*

Principle 6: *Green Infrastructure is a critical public investment that should be funded up front. Utilizing Green Infrastructure practices have shown to save developers and communities money. Also, Green Infrastructure should be included in any community development pro ject just as gray infrastructure - roads, sewer, water, power and telecommunications lines, and other support systems - which are designed and financed in budgets spread across time and a large pool of financial options. Coordination between jurisdictions for Green Infrastructure should be planned like any other large infrastructure projects.*

Principle 7: *Green Infrastructure affords benefits to nature and people. Green Infrastructure planning and actions benefit people, water quality, businesses, wildlife, ecological systems, and community quality of life while reducing the need for gray infrastructure.*

Principle 8: *Green Infrastructure respects the needs and desires of landowners and other stakeholders. Green infrastructure involves diverse stakeholders and can forge alliances between private, public, and nonprofit entities.*

Principle 9: *Green Infrastructure requires making connections to activities within and beyond the community. The success of green infrastructure requires bringing together people and programs engaged in various conservation and planning activities.*

Principle 10 *green infrastructure requires long-term commitment A green infrastructure plan and network design should be considered living documents that will need to be modified and updated periodically to remain relevant.*

NETWORK THEORY - A KEY TO UNRAVELING HOW NATURE WORKS

Network theory originated from a game made up by college students called “the six degrees of Kevin Bacon”, which was aimed at connecting any person in the world with Kevin Bacon. The average amount of individuals it took to connect Kevin Bacon with any other person in the world was six. This theory later gained popularity with the introduction of social networking and was called “the six degrees of separation”. Network theory consists of essentially 3 elements. They are called hubs, links and nodes. In the six degrees of Kevin Bacon version of network theory, the links would be the connections between people, where the nodes would be the people themselves. Kevin Bacon would become a hub due to his high level of connectivity.

The article by Carl Zimmer shows how network theory can be applied to ecological systems. As ecologists have begun applying this theory to ecosystems, they are gaining insights into how species are interconnected and how to foster biodiversity. Mathematicians call this intimate linkage “small-world networking” (Barabasi 2002). Ecological planning has adopted network theory to address biodiversity. As an ecology consists also of a network of movement and interchange over a surface, ecologists have adapted “Hubs, Links and Nodes” to explain the dynamics of this system. Nodes are fragmented landscapes with few links, whereas hubs are more diverse functioning landscapes. Links appear in the form of green buffers, waterways or other linear landscape features linking hubs and nodes and allowing for species movement and ecological processes to occur between them. The more connections can be established between hubs and nodes, the more effectively the network can operate and the greater the capacity for diversity becomes. In each network, most nodes are linked to only a few other nodes. But a small fraction of nodes have lots of links. These hubs shorten the paths between all the nodes in the entire network. A clustering of nodes results in hubs. Different nodes have a different amount of links making them more relatively connected to a system.

A GREEN INFRASTRUCTURE NETWORK

Green Infrastructure planning has adapted the principles of network theory to explain green infrastructure networks.
Green infrastructure is a network of natural and restored native ecosystems and landscape features. This network is made up of hubs, links, and sites. Biodiversity increases as more links are developed between ecological fragments.

CORES are environmental “natural” areas that have remained largely intact and thus un-fragmented and act as anchors for natural infrastructure. They are the origin or destination for wildlife moving through the system and provide the space for native plants and animal communities to grow and flourish. Cores come in many shapes and sizes. They can be national or state forests, regional and local parks, other publicly owned lands, or private land such as farms or forested areas.

HUBS are large areas of land that serve as the anchor of the network. A large concentration of nodes in proximity is seen as a hub. They are reserves such as state parks or wildlife refuges, manages landscapes such as state forests, and working lands such as private farms, forests and ranches.

LINKS range in size and function, depending on the land use, but they tie the whole system together, providing a connection between the hubs. These connections are essential parts of the network that help maintain the health and biodiversity of wildlife populations. Links also vary in size and will have different lengths and widths. Examples include landscape linkages or conservation corridors that can be long and wide and can include river and stream floodplains, as well as smaller greenways such as hiking and biking trails or natural ribbons along roadways.. Links tie green assets together, allowing for connectivity between hubs, nodes and other features of the landscape. This affords pathways for species movement and lays a basis for cumulative effects in the ecosystems provided by otherwise isolated or segmented green assets.

NODES are green assets of varying size that act to weave varying cores together into a more integrated system. Sites are more isolated from the system, functioning independently as stepping stones, or with weak links. They are much smaller and localized. Some examples include community parks or arboretums. • Sites can range in size from a small park or school grounds to a rain garden on the property of a private residence. They are much smaller than hubs and may not be directly attached to the larger system, however, they still provide important ecological benefits by being part of the ecosystem.

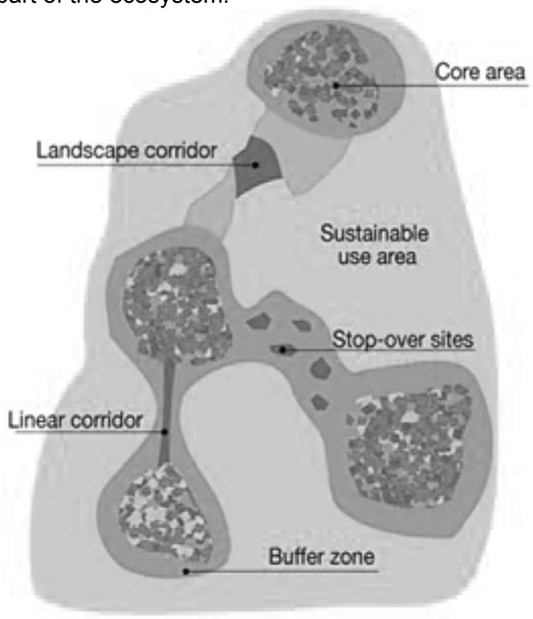


Fig. 4.1. Spatial configuration of an ecological network
Source: Living Planet: Connected Planet, Rapid Response Assessment Riccardo Pravettoni, 2011

Fig. 4.2. An ecological network for detroit by Stoss Landscape Urbanists

THE VALUE OF LANDSCAPE AS A MEDIUM

Working with the landscape as a medium can lead to a lot of enhanced value in a project. As landscape is the medium of green infrastructure, the following 8 points are introduced. They are devised by Stoss Landscape Urbanism and make a convincing "case for landscape to meet the environmental imperatives facing the city: increasing the value of vacant land, improving citizen health, and providing efficient, cost-effective, green infrastructure." (Desimimi, J. 2013)

***Landscapes are inevitable**; if you do nothing else, landscape will re-establish itself even in the most built-up areas. The many emerging and successional landscapes across the city are testament to this.*

***Landscapes are cheap** — especially relative to other forms of infrastructural or urban development. Landscapes are programmed with the ability to adapt and change to different conditions, so they can require different types and lower intensities of maintenance regimes to sustain them. They can also be tended in different ways, so that community gardeners and urban foresters alike are rendered as stewards and caretakers of public space.*

***Landscapes are productive and multi-functional.** They clean air and water and soil, they make urban environments healthier, they generate resources for food, energy, commerce, and habitat. In this way, they cultivate new kinds of urban landscapes, new kinds of urban experiences, and support a wide range of social interactions and relationships. They help build communities, they can be sites for job training and employment, and can even be economically productive.*

***Landscapes are effective grounds for research and experimentation**. They are sites in which new ideas can be safely and effectively tested for later application across the citty (think of new ways to clean large-scale swaths of contaminated urban soil, for instance).*

***Landscapes are green**. Built properly, they reduce the amount of resources necessary to sustain the city (think of soft rainwater infiltration gardens as opposed to hard pipes and treatment plants). But they also create a lush, rich image and identity for the city.*

***Landscape systems work most effectively across large scales** — even regions. So they have an ability to connect and coordinate seemingly unrelated entities As such, then, they have the potential to structure cities and regions.*

***Landscapes are enriching**; they improve the health of the environment and of the people using them, and they have positive cognitive and visual impacts.*

Fig. 4.4. The various functions of landsapes. Stoss Landscape Urbanism

***Landscapes buy time**. They change and evolve of their own accord, but they can also allow for temporary uses while other larger decisions about a site's or neighborhood's future are being decided.*

AN URBAN STRATEGY FOR GREEN INFRASTRUCTURE

How does one translate the green infrastructure network theory into a structuring element of resilient urban development? The proposed theory used network theory and the medium of landscape urbanism to propose 'The Public Elements of Green Infrastructure.'

Network theory has been adapted in this document as a strategy specific for green infrastructure in the urban environment. Using the three elements of hubs, links and nodes, the author has appropriated them for implementation in the urban context. Together hubs, links and nodes form the structuring element of green infrastructure; which is to be used in the case study of the proposed development, to show how this structuring element is capable of priming development. This strategy operates at three different scales and according to three different groups of spatial typologies.

In terms of scale:
Adapted from the Intermediate Natures discourse of Desvigne
HUBS – amplified geographies
LINKS – connected network of spaces
NODES – special sites

In terms of open space typologies:
Adapted from the Sustainable Urbanism Principles of Farr
HUBS – parks and sports fields
LINKS – streets and green corridors
NODES – greens, squares, plazas and community gardens

The public elements for green infrastructure as applicable to urban design, merge scales, typologies and functionality.
HUBS – Parks as green infrastructure
LINKS – Streets as green infrastructure
NODES – Public spaces as green infrastructure

HUBS - Parks as green infrastructure

Parks, to some extent, whether intentioned so or not, have always been a vital part of urban green infrastructure systems since they were first created. They capture stormwater and allow infiltration and aquifer recharge within a water catchment as opposed to being piped and directed into rivers and oceans. They have the capacity to filter and clean polluted water using natural landscape typologies.

Cores are to be included in this section. Although they have a more natural appearance and larger scale, their green infrastructure systems are essentially similar to those parks of more formal appearance.

Urban parks provide a source of resilience to urban environments and assist in enabling biodiversity. Hubs also include some more intermediary types of landscapes such as forests, large scale agriculture and nurseries. These types of intermediate landscapes provide habitat and eventually resources for urban development. Large parks perform better and become more biodiverse when linked with green corridors.

LINKS - Streets as green infrastructure

The normative design nature of streets is to direct storm water run-off away from the site and into pipes and culverts. Many recent strategies have been developed to assist in on-site infiltration and management. These also give opportunities for humanising streets and reclaiming them as part of the public realm. The most popular form of green street infrastructure currently being implemented is vegetated bioswales. Bioswales allow for on-site filtration and aquifer recharge. Overflow rainwater is directed towards rain gardens and attenuation ponds. This is also assisting in investing in greening through the use of street trees. Green alleys are being implemented to create more permeable surfaces. There also exists opportunity for larger linking corridors, along rivers, and green corridors through development areas.

NODES - Public squares as green infrastructure

NODES are the special public spaces in a development; they are the smaller scale hard and soft landscapes that facilitate higher density development. A less explored facet of potential stormwater management, public squares occupy large surface areas with much potential to store water and make use of didactics to educate about the environment. They have the inherent capacity to reduce impermeable surfaces and capture the storm water runoff in enhanced and enlarged landscapes.

Captured stormwater can be retained on site through an underground water storage system. This water can then be used for irrigation purposes. The play areas can be transformed into rainwater capture areas. Other strategies such as urban fields and food production could also be introduced. These are the spaces that show the inherent identity of the site and underlying infrastructure

VALUE OF GREEN INFRASTRUCTURE

Functional Landscapes are concerned with getting the most from and for green infrastructure in the planning and design of places. It is about knowing what green infrastructure can do and how it can be integrated into existing and new development for greatest economic, social and environmental benefit. It is about how the development and enhancement of green infrastructure is a key component of sustainable development and how planners and designers can use it to create successful places.

- The creation of continuously productive environments and enhanced value for development have many advantages that have been discussed in this section. Some specific green infrastructure interventions carried forward are the following:
- Minimising the carbon footprint through the implementation of urban forestry
- Growing materials for sustainable local use
- Creating a flexible framework that responds to natural systems and is adaptable to changing urban conditions
- Increased species biodiversity and creation of niche environments;
- Ensuring resilient ecosystems through the implementation of green infrastructure that function over a range of variable operational conditions
- Using vegetative strategies to increase soil productivity;
- Implementing functioning high-performance streets in urban development
- Using the topography of the environment to move resources across sites
- Ensuring established environments with sustainable infrastructure for urban development
- Increased environmental and thus economic land value through the implementation of intermediate interventions

CHAPTER 5

Site and Context

SITE
The Role of the Site as a Design Tool
Parameters for Selection
Locality
Context and Scale Comparison

ENVIRONMENTAL CONTEXT
Catchment Management Strategies
Crocodile River Water Management Area
Upper Crocodile River Sub Catchment Area

SITE ANALYSIS
TERRAIN ANALYSIS

This chapter introduses the site, discusses the reason for its selection, gives an overview of the larger scale hydrological network and draws out the elements that could better inform the design based on its natural qualities.

THE ROLE OF THE SITE AS A DESIGN TOOL

The purpose of the site is to illustrate how to develop a green infrastructure network in order to use it to prime the site for resilient development.

The selected site is a greenfield site surrounded by urban development with a high pressure to be developed. It is the area better known as Frankenwald and is largely owned by the University of the Witwatersrand, and a small area near the Gautrain Marlboro Station belongs to the City of Johannesburg.

The development strategy for using green infrastructure is not based on a specific site. It is based on generic development principles. The selection of an existing site allows for the exploration of site-specific green infrastructure principles which allows the investigation to become more specifically focussed and also allows for place-making interventions to be illustrated in light of an existing context.

It illustrates the concept of hubs, links and nodes in relation to existing conditions and alongside existing development guidance. The site acts as a test to refine the principles set out in the approach. It also allows the author to further illustrate the importance of ecological aspects, incorporate terrain analysis into development frameworks, and develop an integrated design framework over time.

PARAMETERS FOR SELECTION

The site was chosen due to various reasons. The main reason is that it is one of the last remaining greenfield sites in an urban context, and could, therefore, illustrate from beginnings, how to prime a site for development. The size of the site was a contributing factor in so far as it contains a diversity of ecologies and has the ability to provide ecological assets in its current state. The design seeks to query whether an appropriate design could result in a diversification of its ecological assets. The location of the Marlboro Gautrain Station in close proximity allows an immense opportunity for the development of transport orientated development, outlined as the anchoring strategy of Resilient Urban Development in Chapter 2.

Relatively spatially undefined development occurs on the boundaries of the site. This existing development provides various land use scenarios to respond to from an urban and ecological perspective, due to its diverse use in terms of its boundaries and the different social and economic conditions. The limited number of land owners would theoretically allow for a united vision and would make the priming of the site more valuable over time.

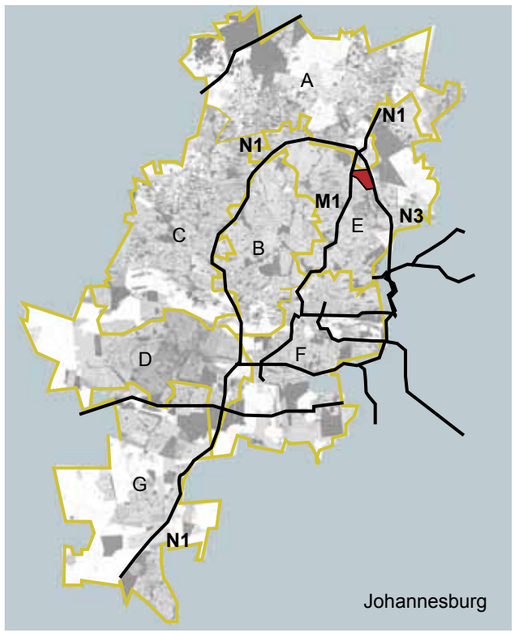
LOCALITY

The site is located in Region E, Johannesburg, Gauteng, South Africa. Region E is the economic and financial hub of Johannesburg. The site is currently mostly vacant land. The development of the site is supported by the City in order to restructure fragmented urban settlement and supply more residential land use. Development challenges include sewage leaking into rivers and streams and an already over capacity storm water system. the area experiences extremely heavy traffic.

It is bound on two sides by highways. The M1 to the east and the N3 to the west. Access to the site can be gained either off the Old Pretoria Road, in the north, joining the N1; or on Northway off Marlboro Drive in the south. The site can also be accessed from the Gautrain Marlboro Station to the south of Marlboro Drive, by beans of a pedestrian bridge across Marlboro Drive. The site is most visible from the N3, where it reads as a large tract of vacant land with a substantial stream.

South Africa

Gauteng



Johannesburg

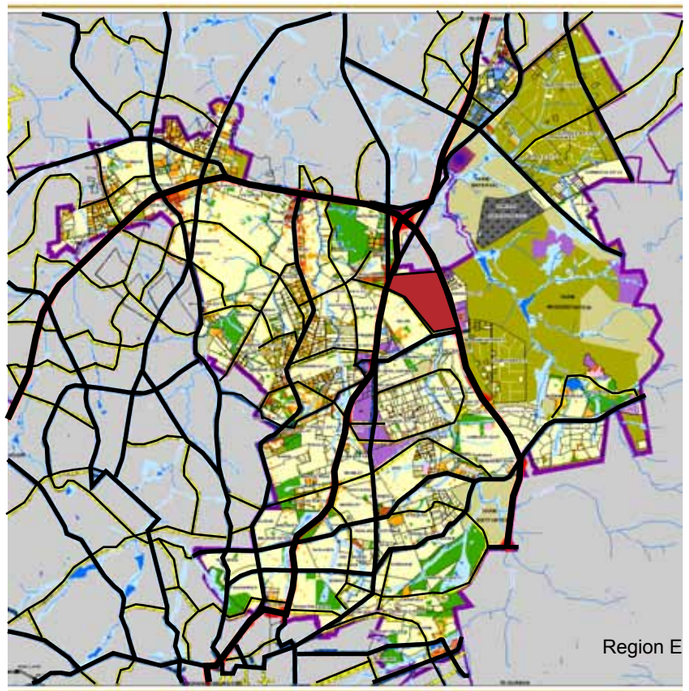

Region E

Fig. 5.1. Site location: Frankenwald and surrounds

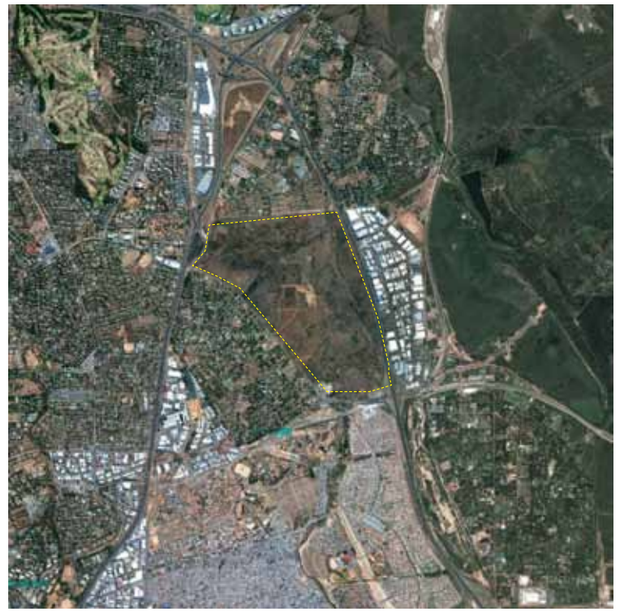


Fig. 5.2. Development surrounding the site

The Jukskei River runs through the site from south to north and passes through Alexandra before it reaches the site running under Marlboro Drive. At the point where the river enters the site it is very polluted. A smaller tributary runs into the river from the western direction and the neighbourhood of Kelvin. the confluence occurs towards the north eastern edge of the site. there is currently no access through the site.

Fig. 5.3. The banks of the jukskei river in Alexanra, upstream

ENVIRONMENTAL CONTEXT

To understand the site hydrology, the scope needs to be enlarged to see the full picture. Water Management Areas do not correlate with Municipal boundaries and, therefore, there is no holistic understanding on hydrology at smaller scales. The following text is adapted from DWAF.

WATER MANAGEMENT AREAS

Catchment Management Strategies (CMS)

The country has been divided into 19 Water Management Areas Each CMA will progressively develop a Catchment Management Strategy (CMS) for the protection, use, development, conservation, management and control of water resources within its WMA. The Department's eventual aim is to hand over certain water resource management functions to CMAs. Until such time as the CMAs are established and are fully operational, the Regional Offices of DWAF will have to continue managing the water resources.

CROCODILE WEST AND MARICO WMA

The Crocodile River is a major tributary of the Limpopo River which discharges into the Indian Ocean in Mozambique. The Pienaars, Apies, Moretele, Hennops, Jukskei, Magalies and Elands rivers are the major tributaries of the Crocodile River, which together make up the tertiary hydrological catchment with its 39 quaternary catchments. The Crocodile River itself does not form any international boundaries but contributes to the flow of the Limpopo River, which has an international river basin shared with Botswana, Zimbabwe and Mozambique. The upper portion of the catchment, south east of Hartbeespoort Dam, is located in the Gauteng Province. The north and north east corners lie in the Limpopo Province whereas the central or western sections fall within the North West Province.. The total area of the Crocodile River Catchment is 29 400 km2

Fig. 5.4. Illustrating the difference between political boundaries and WMA's

Fig. 5.5. Water Management Areas in South Africa

Fig. 5.6. The Crocodile West and Marico Catchment

UPPER CROCODILE RIVER SUB CATCHMENT AREA

The southern portion of this sub-catchment is highly developed with the large industrial, urban and semi-urban sprawls of northern Johannesburg, Midrand and southern Tshwane. The economic activity in this area generates a large portion of South Africa's Gross Domestic Product. Local water resources are insufficient to meet the water requirements in this area and therefore large volumes of water are transferred from the Vaal River System, via the Rand Water supply system, into this area. Large treated wastewater return flows are generated from these transfers which further supply other users downstream. The rest of this area, mainly north of the Magaliesberg Mountain Range, includes significant irrigation and mining activities.

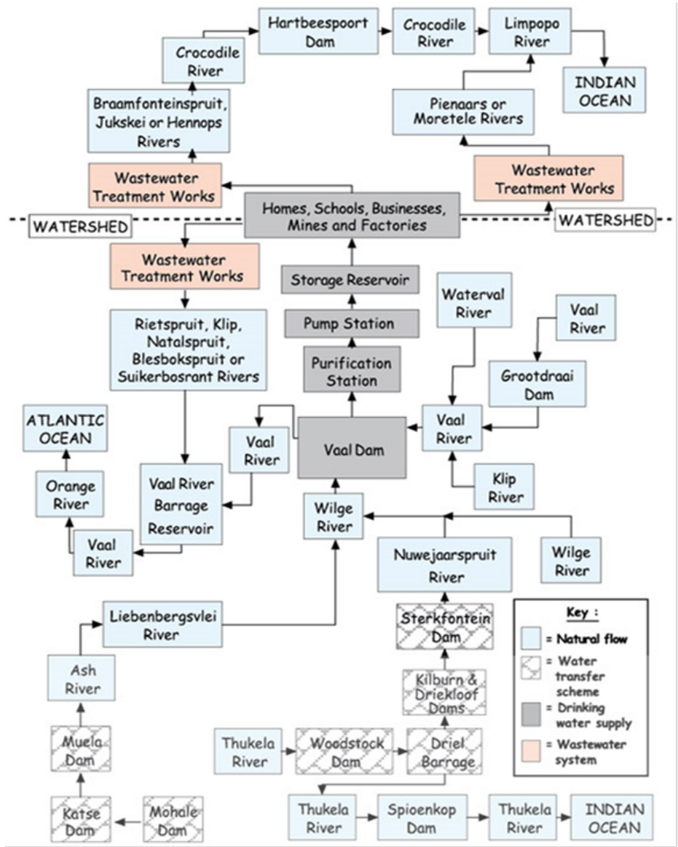


Fig. 5.7. The hydrology of the Johannesburg Watershed

MANAGEMENT STRATEGIES

The main issue relating to this sub-area is the high projected growth in water requirements and the source of supply for these requirements. The first option, water demand management, will only have a limited impact, after which additional transfers into the area will need to be considered.

The substantial return flows in the area will increase with increasing transfers resulting in a large surplus. It is important to develop a strategy that will optimise the use of this surplus, taking into account that the Vaal system is being supplied from other basins through Inter Basin Transfers. Very expensive projects will be required in future to increase the supply to the Vaal River system and the reuse of return flows in the Crocodile River (West) catchment must be considered as an option to delay costly additional transfer schemes. Some of the return flows could also be used for irrigation and establishing of emerging farmers should be considered.

The future scenarios predict that surpluses will increase in future due to increasing return flows from the Johannesburg/Tshwane area. This is based on the assumption that the increasing water requirements of the Johannesburg/Tshwane area will continue to be met from the Vaal system. It is important to develop a strategy that will optimise the use of this surplus, taking into account that the Vaal system is being supplied from other basins through Inter Basin Transfers.

Fig. 5.8. Locality of the Upper Crocodile Catchment

URBAN GROWTH

The Upper Crocodile Sub-area is mainly made up of well-established urban areas with high levels of service (Johannesburg, Soweto, Mogale City, Midrand, Centurion). Provision of better services to historically disadvantaged townships as well as new housing developments are increasing in this area. It is envisaged that this expansion of services and population growth will steadily increase in this area with the consequent increase in water requirements

WATER SUPPLY

The expected growth in water demand in the Johannesburg metropolitan area and environs will be augmented with from the Vaal River system (Rand Water) which should be able to meet these needs up until approximately 2025, after which one or more of the existing inter-basin transfer schemes will have to be expanded.

Fig. 5.8. Water transfer projects wighin the Crocodile West and Marico Catchment

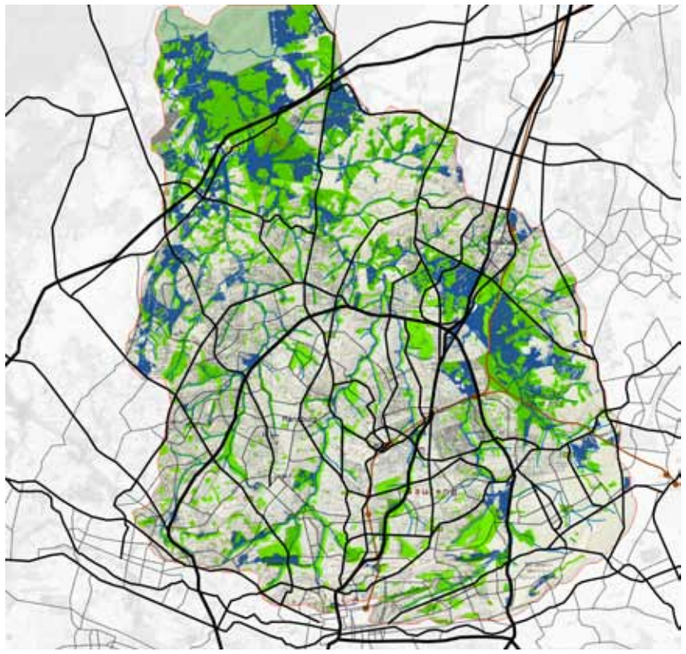


Fig. 5.9. the Upper Crocodile Catchment

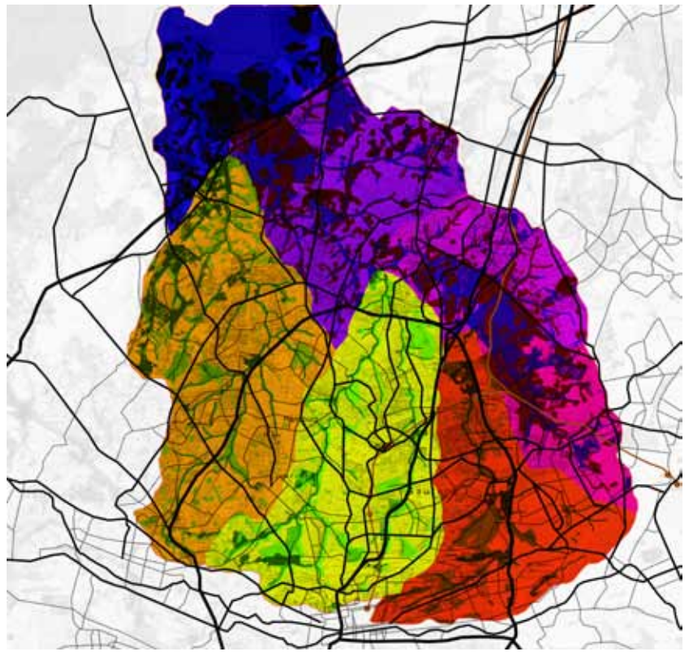


Fig. 5.10. Sub-Catchments within Upper Crocodile Catchment

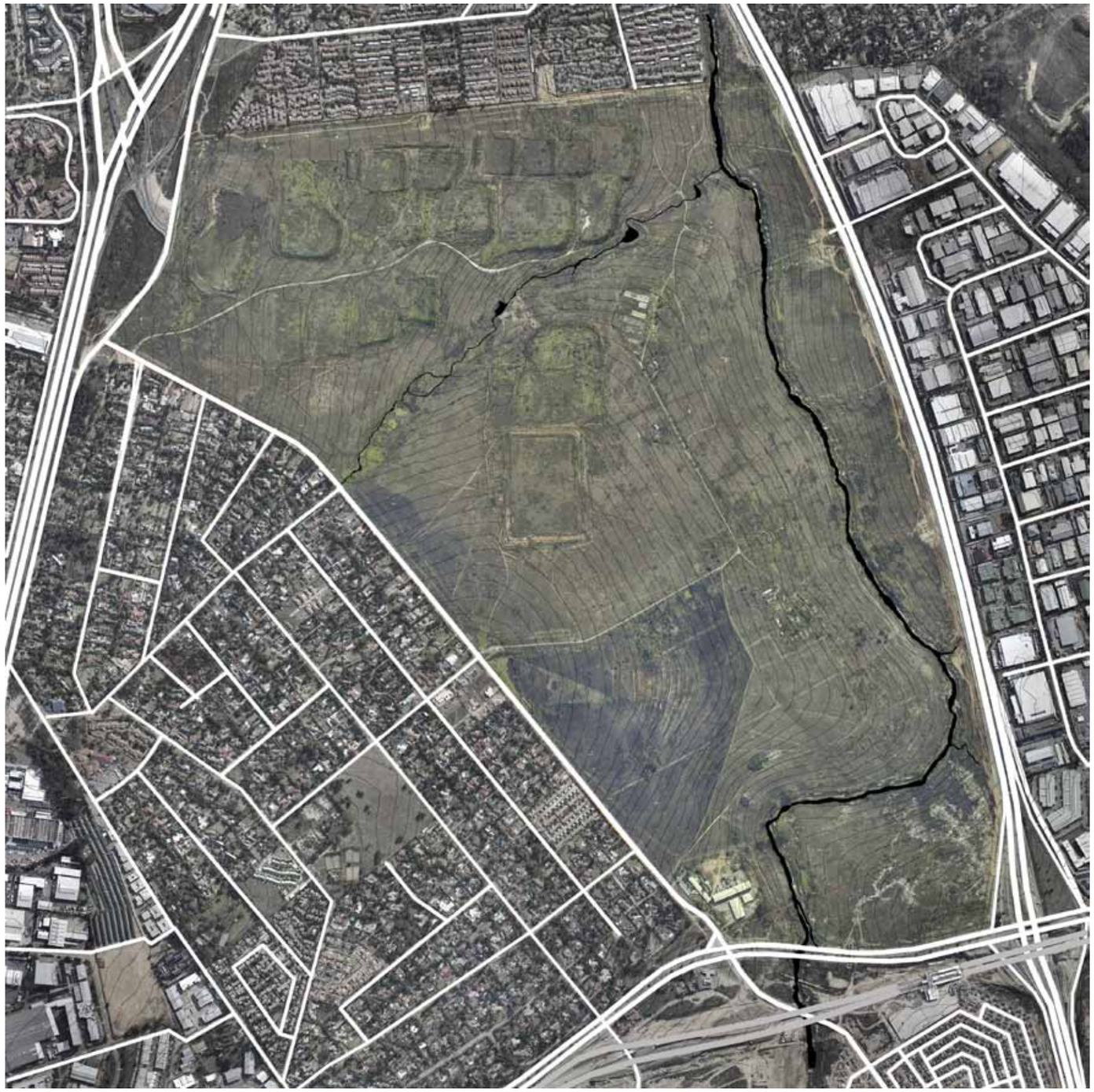


Fig. 5.11. Aerial view of site surroundings. Imagery sourced from Google Maps

SITE ANALYSIS

Frankenwald is a fragmented portion of open land surrounded by urban development of various scales and use. It holds a great opportunity to showcase green infrastructure and sustainable development strategies due to its context and the presence of the river. Rehabilitating and enhancing natural systems will form a substantial part of the green infrastructure framework.
A Site analysis for the area was completed for the Status Quo on the Marlboro UDF 2008. The following text is taken from the document.

NATURAL STRUCTURE

The area is traversed by a south-north running river with four tributaries. The main stream in the study area is the Jukskei River, with one tributary linking up in the north, while another one links up in the south. The other two tributaries link up with Jukskei River at the crossing with Marlboro Drive, in the vicinity of the Gautrain Station.

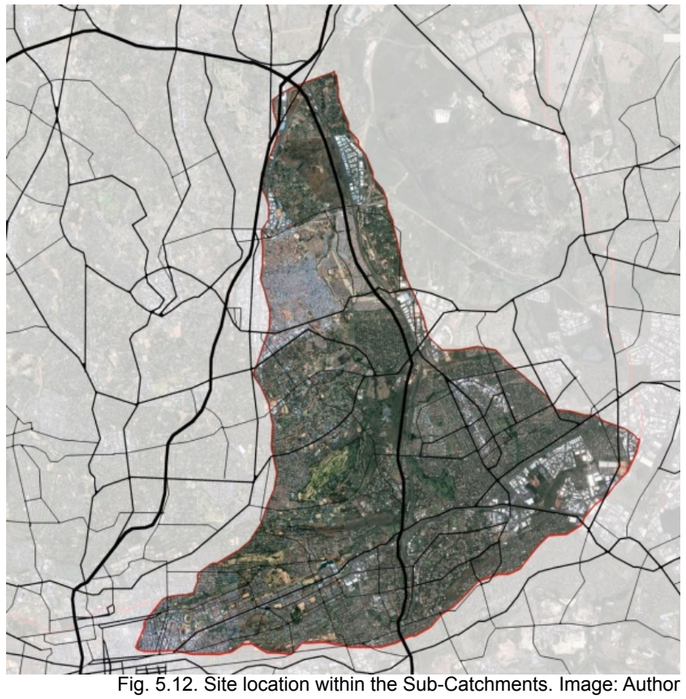


Fig. 5.12. Site location within the Sub-Catchments. Image: Author

The Jukskei River system has relatively wide flood lines. Currently these flood lines segregate communities from each other and contribute to the creation of an uncared-for image of the area. Problems facing this stream includes: littering, pollutants being released into the streams, invasion by exotic plant species, vagrancy and flooding following thunderstorms caused by stormwater run-off. The environmental policy issues pertaining to development in watercourses, the provision and management of open space apply to this area, following are the requirements that apply:

• A buffer of a minimum of 32 metres each side of the watercourse edge (or greater as is necessary to maintain ecological functioning) shall be provided adjacent to all wetlands and watercourses

• The 100-year flood-line should be respected at all times

SURROUNDING LAND USE

the Gautrain Marlboro area is located amidst large portions of vacant land to the north and east, established residential areas to the north-west and west, industrial areas to the north-east and north-west and low-income residential development to the south. The districts that surround the future node include the following:

• Farm Bergvalei (Frankenwald): This is a large vacant piece of land north of Marlboro Drive, belonging to the University of the Witwatersrand. The area just north of Marlboro Drive (approximately halfway between the road and Juskei River) belongs to the City of Johannesburg.

• Far East Bank: This is the southern district containing single RDP housing on approximately 250m erven. The Far East Bank was developed in terms of the Alexandra Development Framework that sought to provide a range of low-income housing typologies to address over-crowding in Alexandra.

• Kelvin is an established quality residential area.

• Marlboro South is a residential area in transition.

• Alexandra is a former black township with a large informal component. It has a number of issues relating to basic service provision, but, in terms of built form it has a very unique character and identity.

• Linbro Office Park: This is an established non-residential area with a relatively coarse grain of large warehouse-type industrial and office buildings.

Fig. 5.12. Built Form. Image: Author

SCALE COMPARISON

The site is a large tract of land measuring roughly 200 hectares. in the images below it has been compared to the size of some of South Africa's largest urban centres and prominent nodes in the surrounding area, the scale of the site could accommodate approximately 3 urban centres at 400m distances apart from one another.

Fig. 5.13. Relative size. Image: Author

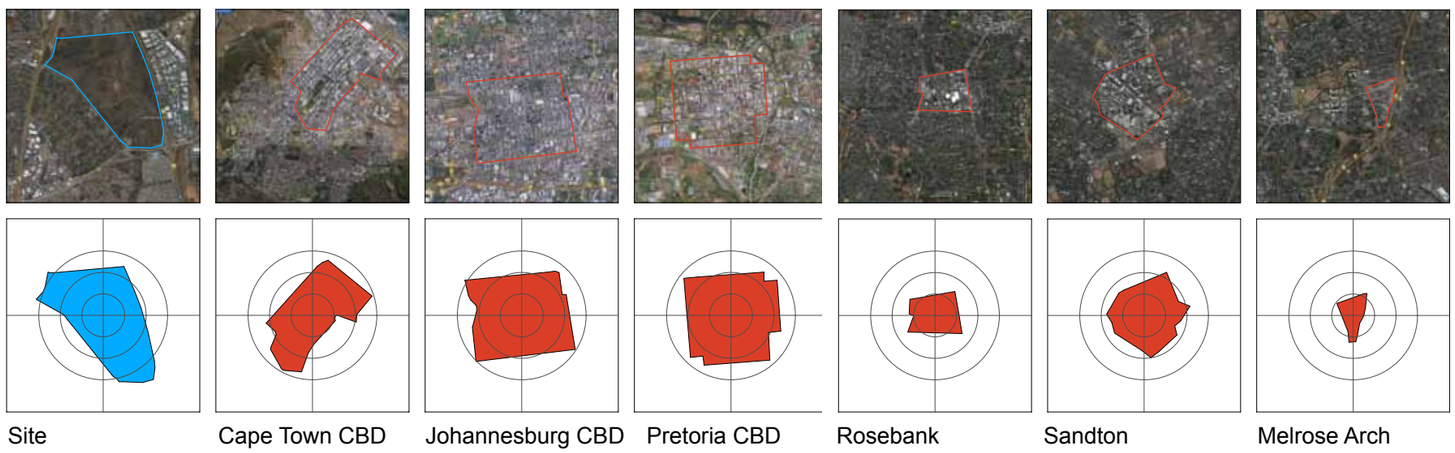


Fig. 5.14. Scale Comparison. Image: Author

MOVEMENT OF WATER THROUGH THE SITE

Much of the green infrastructure, as it is based on the management of water, is based on the movement of water through the site.
By reading the terrain analysis layers, described in more detail on the next spread, it can be established what the pathways of water through the site is, and how best to use gravity to manage and feed water through the site.
The highest points of the development site occur in the intersection where North Way meets Cone Way and on the north-western edge along the N1 Freeway. Water makes its way from higher elevations to lower elevations by means of gravity. This means that the most direct point for water to flow is from the highest to the lowest elevation. The most direct path for water to flow on the site is from these points into the river.

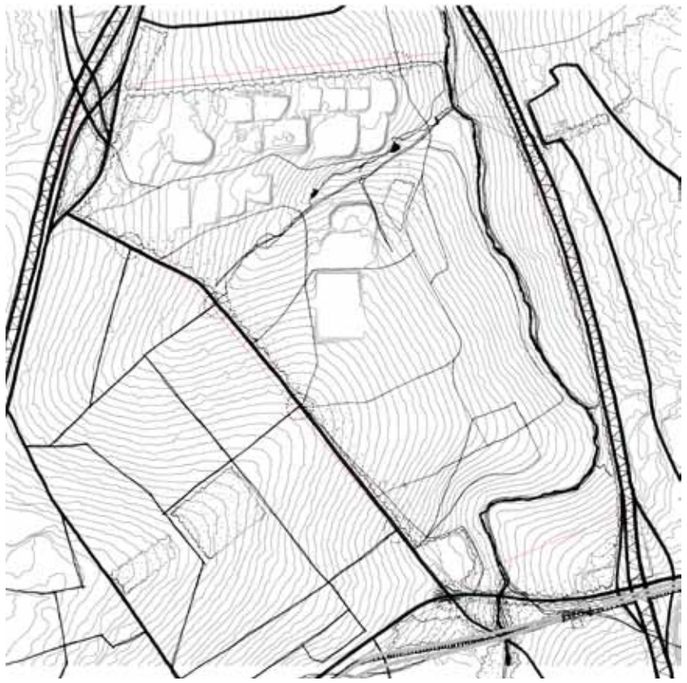


Fig. 5.16. Contours. Image: Author

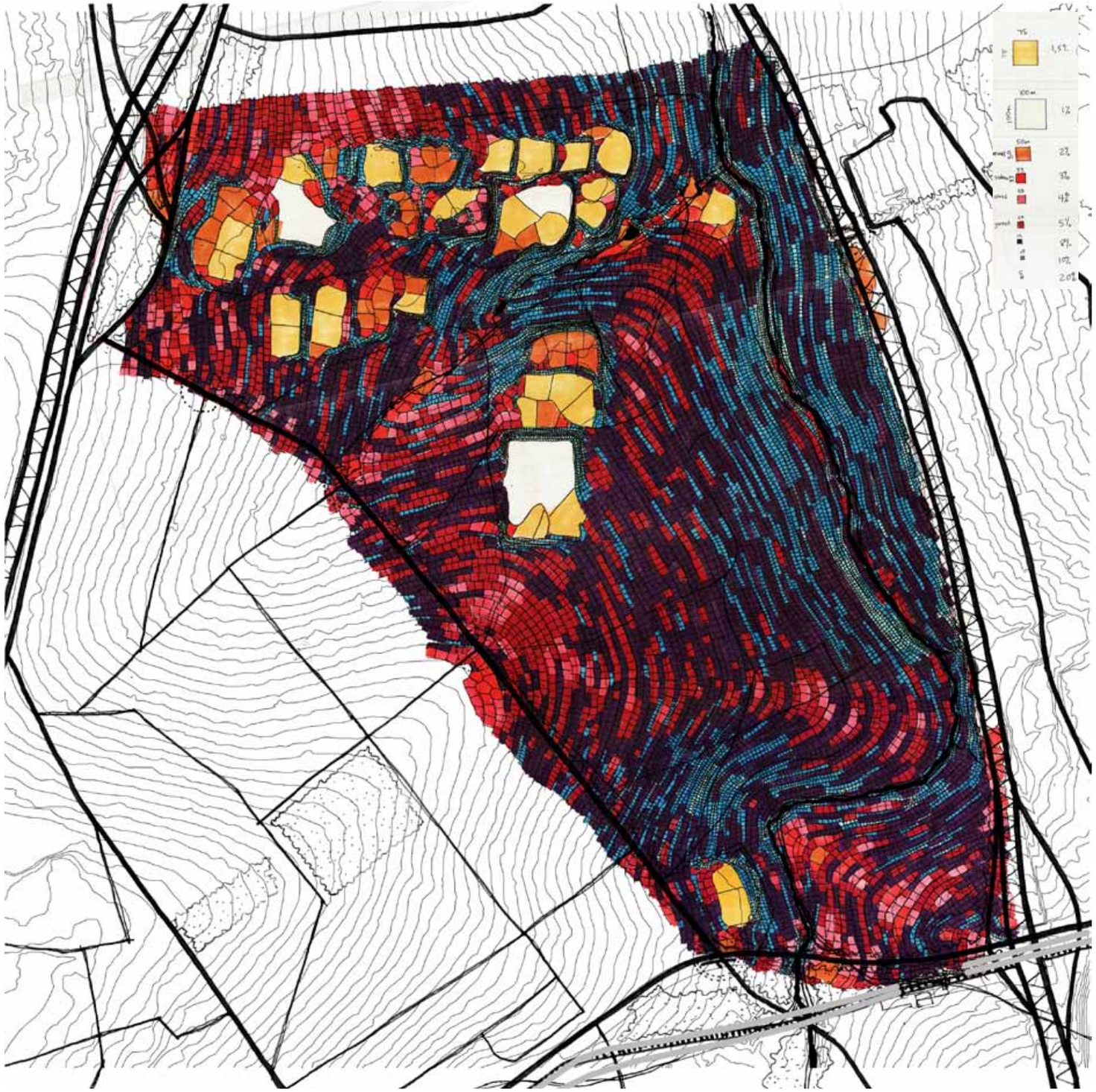


Fig. 5.15. Slope Gradient. Image: Author

Fig. 5.17. Aerial view of site surroundings. Imagery sourced from Google Maps

The Jukskei river is shown in black on the aerial image, flowing from south to north. A tributary of the Jukskei river is daylighted at the intersection of North Way and Fair Way. It flows from west to east, where it meets up with the river. A series of surface waterbodies are present on the form of dams along this tributary. Reading hydrology from the gradient map on the previous page, informs the site as follows:

Areas shown in white and yellows currently act as absorption spaces as water moves the slowest across them and has time to seep in. the areas indicated in pinks and reds are the formation of crests running through the site. In this land formation crests are also the least steep landforms. The crests are the highest points along the sites and water will naturally flow away from crests into valleys. Valleys are shown in the blue and purple colour. Steeper valleys occur closer to the river. Ideally development should veer away from these valleys.

the diagram below shows how the surface hydrology is to be interpreted in the design to follow.

Fig. 5.18. Diagram showing the presence of water in the development

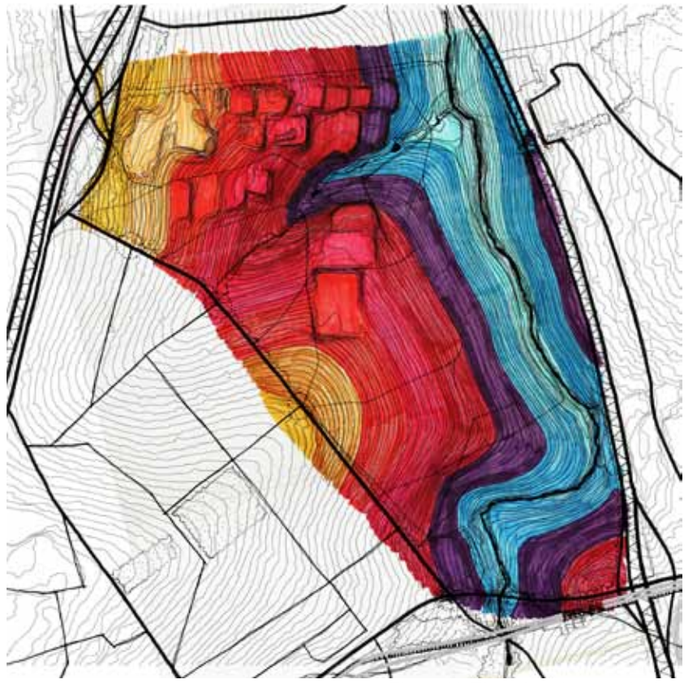


Fig. 5.19 Elevation. Image: Author

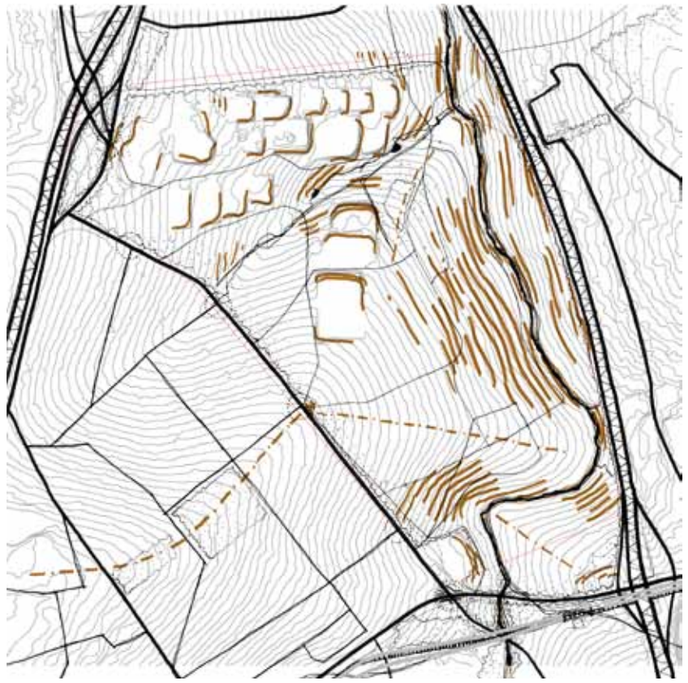


Fig. 5.20. Embankments. Image: Author

TERRAIN ANALYSIS

Elevation

Contours drawn are at 2m intervals. Bands of elevation indicate 10m drops. The drop in elevation from the Kelvin and Old Pretoria Road edge of the development to the river in 80m at its highest point (indicated in yellow). The lowest elevation is along the river bed towards the northern edge of development.

Landform

The site consists of gentle valleys and smooth crests towards the river bank. The central valley that lies between the crests is somewhat steeper and should be reserved for higher end development as it becomes more expensive to build on steep slopes. The north western area of the site has previously been disturbed and can easily accommodate uses that require large development parcels, such as office parks.

Slope Gradient

Warmer colours have less steep slope gradients, and cooler colours have more steep gradients. Flatter gradients should be reserved for large public spaces and land uses that require flat land. Steeper slopes become more expensive to develop. Steep slopes should form part of the green network as they are not buildable and also often contain niche habitats as the terrain is not so readily traversed.

Movement across site

The main movement and vehicular movement should occur along contours in a north-south direction which will allow for gentle slopes and greater universal access. The proposed boulevard should traverse as gentle a slope as possible. A fine grained pedestrian network should cross east-west through pedestrian avenues and right of way streets.

Orientation.

Most of the site is east to the north east facing on the western banks of the river. These areas are most opportune for building development.

The right bank of the river is west facing and allocated to light industrial use. The western facade of these buildings should be vegetated to screen western light. This also allows for a much more attractive view from the majority of the developable bank of the river.

The area demarcated for the Transit Oriented development around the station is mostly north facing with some west facing areas. These areas are sheltered by the depth of the valley.

Embankments

Movement routes should follow along the edges of embankments as it becomes a very expensive exercise to traverse them. a high priority of pedestrian routes and steps should traverse embankments to allow for an accessible grain of network through the site.

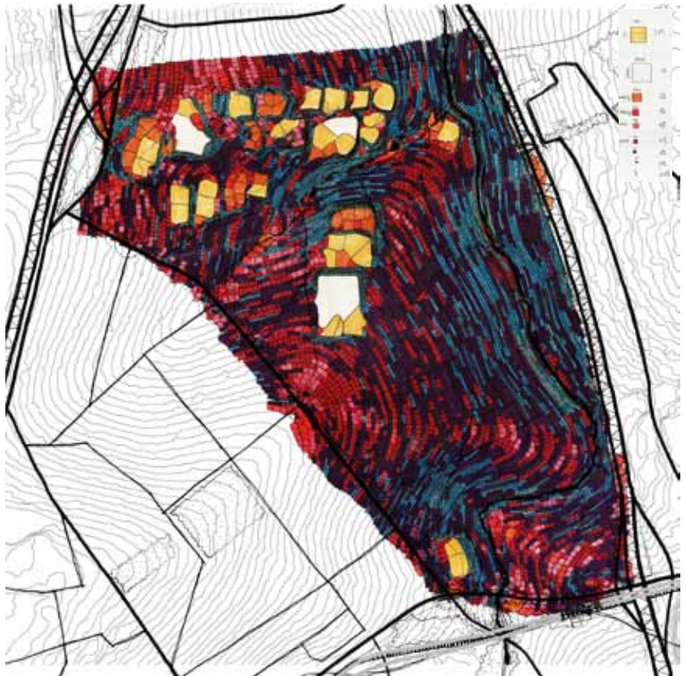


Fig. 5.21. Gradiens repeaded for reference to text. Image: Author

CHAPTER 6

Existing Guidance

DEVELOPMENT PRESSURE - GAUTRAIN

EXISTING FRAMEWORK - MARLBORO UDF 2008

Principles

Spatial Structuring Concept

DESIGN GUIDANCE

Marlboro UDF Vision For Frankenwald

This chapter familiarises the reader with the existing framework that has been planned for the area, as well as highlighting some of the principles that informs it

DEVELOPMENT PRESSURE - GAUTRAIN

The Marlboro Urban Development Framework (2008) was commissioned in response to the development of the Gautrain, a high-speed rail system connecting Johannesburg to Pretoria (to the north) and Johannesburg International Airport (in the south). The site for the Marlboro station of the Gautrain was specifically selected due to its location, adjacent to a small portion of land owned by the City of Johannesburg and the larger portion, owned by the University of the Witwatersrand. The surrounding area is proposed to become an intensive Transit-oriented development node.

The Gautrain Marlboro Station area is located in Far East Bank, an extension of Alexandra, to the south of Marlboro Drive and between the intersection of Marlboro Drive and Northway and Marlboro Drive and the N3 Highway. The immediate surroundings comprise of established residential areas to the west, the communities of Alexandra to the south and the Linbro Commercial estate and small holdings to the north east and south east respectively.

The Marlboro station has been strategically placed to become a major catalyst to unlock commercial development and opportunities within the existing development and to drive new development on the site.

New development types have been identified by the previous Gautrain Station suitability map to include commercial development towards the Marlboro Drive edge of the site, supported by high-density residential development. East-west linkages are important to implement from a regional level.

The marlboro station is one of the greatest development catalysts for the area as it gives direct regional acces to the site by means of the Gautrain and supported by the Marlboro Drive / N3 Freeway offramp.

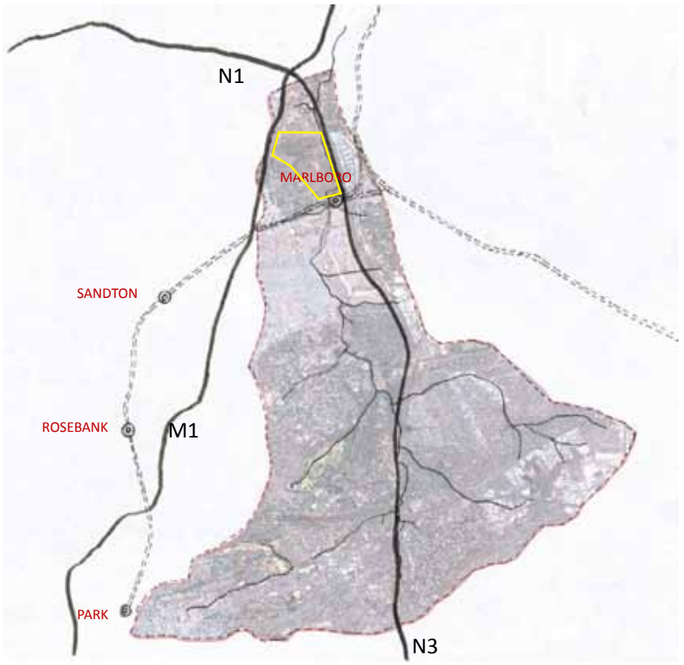


Fig. 6.1. Location of the Gautrain Stations in the surrounding area
Source Author

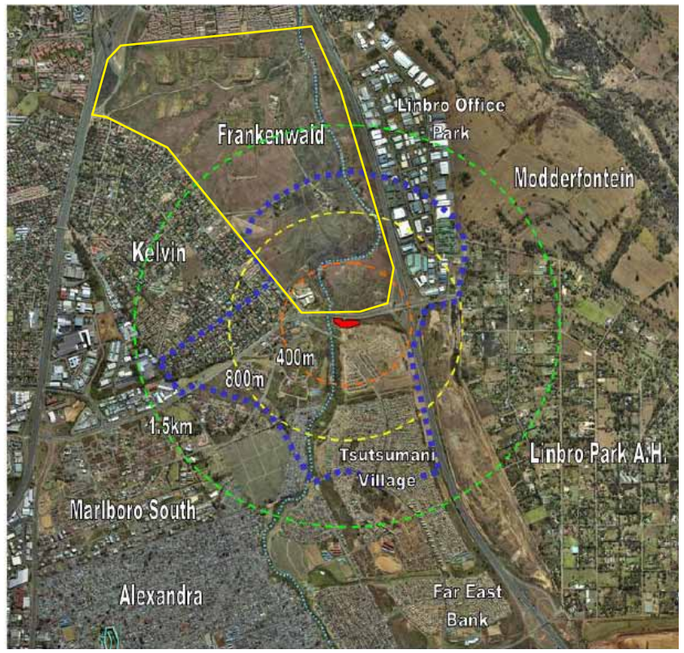


Fig. 6.2. Location of the Gautrain Marlboro Station
Source Marlboro UDF 2008

The Gautrain Station at Marlboro Station is situated at the centre point where the lines split to reach the three final destinations. It is located at a highly favorable location almost halfway between the Midrand station and the Joubert Park station in Johannesburg CBD. It is further located between the M1 and the N3, close to the north-south line of major economic thrust in the province. Above that this station's location is on the east-west movement line between the airport and the Sandton node. The area has an important role in terms of region-wide developments and activities. Due to its prominent locality between major highways and mobility routes, the Marlboro station's impact is not only local and metropolitan but reaches a provincial scale as well. If developed in the right manner, it can act as a catalyst for the spatial and economic development of the whole area. (adapted from Marlboro UDF 2008)

Fig. 6.3. Focus of the study area for the Marlboro UDF
Source Marlboro UDF 2008

EXISTING FRAMEWORK - MARLBORO UDF 2008

The study area for the Marlboro framework extends beyond the area of the proposed development site discussed in chapter 5. in order to develop a holistic framework for the site, it is important to consider the work that has arleady been done and in agreement with the growth projections of the City of Johannesburg. The objectives and principles of the Marlboro UDF (2008) forms the first layer of informants towards developing a priming strategy for the site.

The following text has been adapted from the Marlboro UDF:
The objectives of the Marlboro Urban Development Framework includes developing a more compact urban form that promotes residential and employment opportunities in close proximity to, or integrated with, each other. A diverse combination of land uses, also at the level of individual erven. Densification and integration. Optimising the use of existing infrastructure, including bulk infrastructure, roads, transportation and social facilities. Supporting and prioritising the development of viable and sustainable public transportation systems to provide access to opportunities. Ensuring viable communities with convenient access to economic opportunities, infrastructure and social services and promoting and supporting sound urban management practices.

Fig. 6.4. Surrounding context of the Marlboro UDF
Source Marlboro UDF 2008

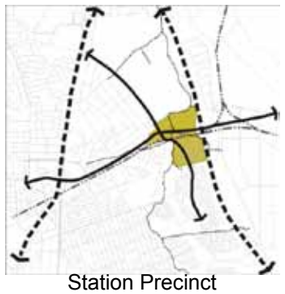
PRINCIPLES OF THE UDF

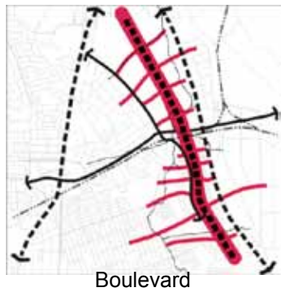
1. Compact, pedestrian-friendly neighbourhoods. Routes should be convenient, comfortable, direct and safe, both to and from all transit stations, to promote the use of transit and encourage walking and cycling.
2. Distinctive and attractive communities built around the location of the station with required facilities including open space. Use existing features in the area, such as vegetation, to maintain character.
3. Transit supportive land uses. Locate uses close to the node to support socio-economic growth.
4. Mixed-use activities, both vertically and horizontally within a city-wide transport network, emphasising local pedestrian movement. increased services and employment opportunities.
5. Increased densification and a range of housing options.
6. Reduce dependency on private cars and manage parking. Provide a variety of well-managed, integrated transport choices: parking, bus, taxi, car, rail, bicycles and pedestrian facilities.

SPATIAL STRUCTURING CONCEPT OF THE UDF

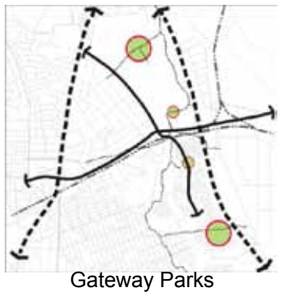
The aim of spatial structuring is to provide a robust urban structure. The spatial structuring concept is created by merging a few urban structuring elements in order to create a Gautrain Station precinct with a unique sense of place.

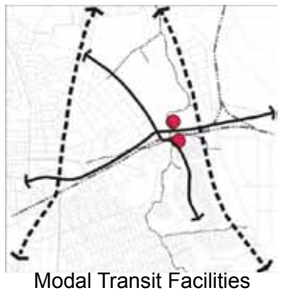
The Boulevard
This is the main structuring element along which public city life in this area occurs. It should accommodate slow vehicular traffic and provide on-street parking. Pedestrians take priority with wide sidewalks and activities fronting onto the street. Buildings should front onto the boundary line and be at least 3 storeys tall. The experience of the space on street level should be on a fine-grained human scale.
Green Belt
The south-north running river with its two tributaries provides an opportunity for a powerful structural element to be established. Although the character will be totally different (natural vs urban) from the Boulevard, it should also have a focus on pedestrians. Pedestrian and cycling routes should be provided all along the river
Gateway Parks
Gateway Parks should be established where the Green Belt crosses the Boulevard, to indicate the edge of the development. The Gateway Parks should be the focal point for nodal recreational activities. Smaller Gateway Parks should be established at the entrance into the Station Node.


Station Precinct


Boulevard


Green Belt


Gateway Parks


Modal Transit Facilities

MARLBORO UDF VISION FOR FRANKENWALD

Frankenwald in the north is mainly a vacant piece of land while the Tsutsumani Village in the south is an established residential area. The focus of interventions on the Frankenwald land should be to provide linkages to the station and to establish an extension of the station precinct in terms of focused densification and intensification. Mixed-use high-density development with high pedestrian intensity should be promoted. Diversity (in terms of use, built form, intensity and density) should be promoted on the site. The Boulevard will be the main structuring element running through the site and buildings should strive to provide for a porous spatial definition everywhere on the site. This will enhance identity and increase security, which will reduce the need for fences and walls. To achieve this, alternative building typologies should be promoted and implemented. Apart from the Green Belt a recreational function (pedestrian and cycle ways) and the mixed-use high-intensity Boulevard, other broad land use zones could be incorporated. These include a residential component that should mirror the residential character of the Kelvin area, an office park mirroring Linbro Office Park, office development along the major access road and medium density residential infill between these zones.

Land use proposals

The Station Node consists of vertical mixed-use developments where retail / restaurants are established on the ground floor. Offices on intermediary storey's and residential apartments on upper storeys. The Area of Intervention comprises the large area surrounding the Station node itself. The Farm Bergvalei (the University owned portion of Frankenwald) currently undeveloped provides opportunities to support the station with complementary land uses. For example, this farm is earmarked as the location for the development of 3000 Social
Housing Units, which will form part of the mix of uses on the landholding. The following controls are proposed for this area

- *Floor area ratio of 2,5 along the boulevard, rest 1,5*
- *Residential density 60-300 units/ha, depending on the locality and design*
- *Land use mix*
- *Vertical mixed use on Boulevard: Retail ground floor; offices, residential above*
- *Horizontal mixed-use rest*
- *Height max five storeys*

The principles proposed for development by the Marlboro UDF are very similar to the Principles for Resilient Urban Development describes in chapter 2. however, the spatial structuring differs. In the following chapter, this will be further illustrated as the Resilient Urban Development Principles are overlayed onto the design.

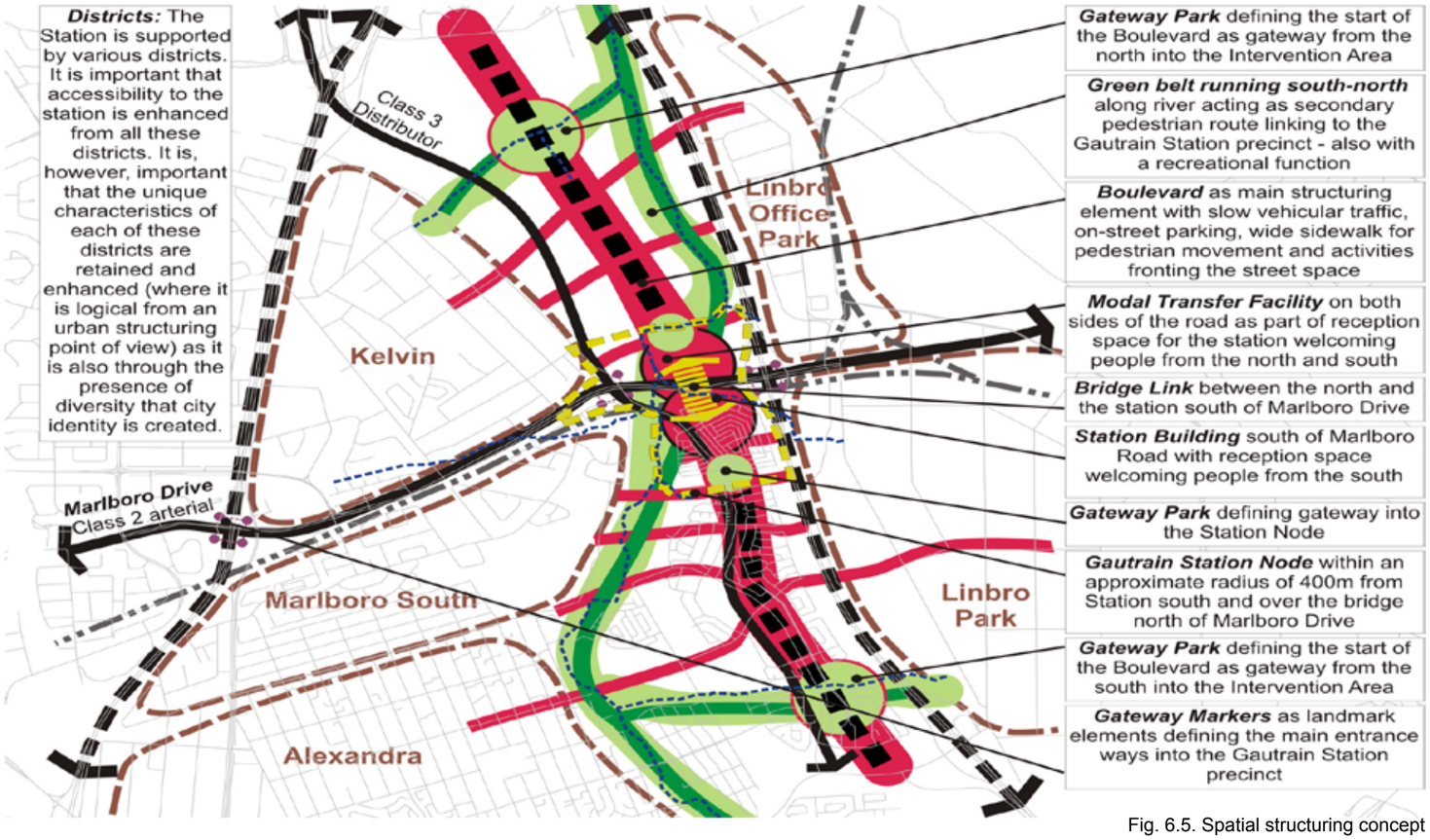


Fig. 6.5. Spatial structuring concept
Source Marlboro UDF 2008

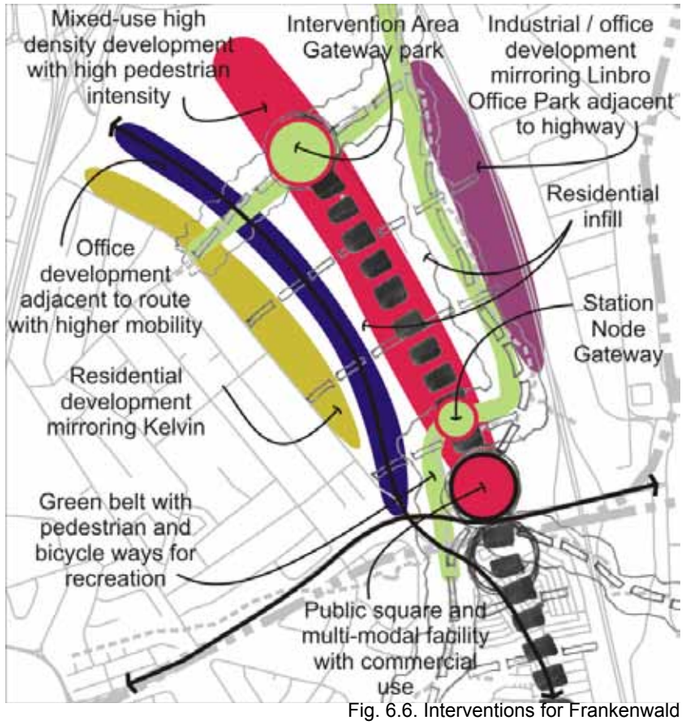


Fig. 6.6. Interventions for Frankenwald
Source Marlboro UDF 2008

CHAPTER 7

Design

DESIGN INFORMANTS
DESIGN DEVELOPMENT
TOWARDS A VISION PLAN

This chapter reviews how the differend design informants discussed in previous chapters informs and shapes the design.

THE DESIGN DEVELOPMENT MATRIX

The design development matrix indicates changes in the design as it is worked through the informants discussed in previous chapters relating to terrain analysis and resilient principles for development, and with green infrastructure principles in mind. The changes are highlighted by means of the structuring principles set up by the existing Marlboro UDF.
The green infrastructure network and interventions are described through the proposed development and their mechanisms in more detail in phasing and implementation.

PRINCIPLES TAKEN FORWARD FROM EXISTING GUDANCE

The aim of this document is not to discredit the work already done towards an urban framework for the site, but rather to use the principles already established by the existing UDF as a baseline and to enhance it by means of the theory presented to propose an integrated green infrastructure network. The spatial structuring concepts of the Marlboro UDF are taken forward and used in this chapter to highlight the major changes incurred through the principles of the theory presented.

EXISTING SITE

The existing site sets up the baseline for the existing nature of the site. The desire lines across the site indicate the main informal movement patterns present. Most of the footpaths and gravel roads indicate movement from North Way towards the Jukskei river and its tributary, and along the Jukskei river. The site is currently closed to the public and circulation is restricted to the University of the Witwatersrand. The existing green structure covers most of the site and consists of vacant land. The vegetation is Highveld grassland with some clumps of trees along the river edge. The existing movement structure is restricted and there are no public movement routes across the site. There is a powerline servitude along the northern edge of the site and informal access from the intersection of North Way and Fair Way towards Linbro park, under the N3 Eastern Bypass.

MUDF FRAMEWORK

The principles of the Marlboro UDF are redrawn by the author to read more cohesively in this exercise. The Marlboro UDF proposes a boulevard as the main structuring element, linking the Gautrain station in the south, across Marlboro Drive, towards Fife Street in the north, in the residential area of Bucchleuch. The boulevard is a pedestrian priority and public transport corridor with light vehicular traffic and a defined urban interface on street edges.
The green structure proposed by the MUDF consists of a 30m buffer along the Jukskei river and its tributary. The road network supporting the public transport boulevard proposes formalising the east-west link from Kelvin to Linbro Park and diverting the main north-south link away from North Way, to promote higher densities along the new proposed route towards Pretoria Main Road. There is a secondary east-west distributor from the point where the north-south route pulls away from North Way, along the Jukskei river and meeting the east-west connector before it crosses under the N3 Eastern Bypass. The internal network of streets is disconnected from the distributor routes.
Two gateway parks proposed in the MUDF are placed at the confluence of the Jukskei River with its tributary towards the north, and at the point where the river crosses the boulevard in the south towards the Gautrain station. The parks are proposed as focal points for nodal recreational activities.

TERRAIN ANALYSIS

The terrain analysis is overlayed with the MUDF structuring principles and analysed within their means of best fit for the existing environment.
The boulevard is adjusted to fit to the most walkable gradient along the gradient and least steep slopes. The boulevard loses some of its rigid nature and orientational qualities and becomes located further away from the Jukskei river.
The green structure widens from the MUDF proposal to include the steeper and least buildable slopes, which would also be the most expensive to construct. As per the elevation and availability of open space, green areas are also proposed along hydrological collection sites in the residential area of Kelvin and the open space around the Pretoria Main Road and the N1 Freeway.
The movement routes are adjusted along appropriate gradients. The main north-south distributor becomes located closer to the proposed boulevard.
Gateway parks are located along visual high points to increase legibility as they become visible from higher elevations. Smaller parks are also proposed around prominent natural features and steep slopes located within the larger green structure.

RESILIENT PRINCIPLES

The resilient principles are taken from the theory in chapter 2 and subsequent discourse through the document that supports resilient principles.
The boulevard is adjusted to connect to the area of high existing economic hubs in the area of Woodmead and across the N1 freeway barrier. The prior boulevard route to the Buccleuch area is proposed an accessible connector route linking Marlboro Drive to Fife Street.
The green structure is reduced to make available more developable land parcels to higher end development. Certain green areas are extended to amplify open parks across the river and along visual axis. Smaller green spaces are included closer to the boulevard to act as intermediate open spaces along routes to towards the larger green structuring element.
A fine grained urban grid connects throughout the site with vehicular movement occurring along contours and strong pedestrian links across them.
Parks celebrate a variety of natural features across the site, and also at specific points along the boulevard to signify transitions between three urban nodes for development.

INFORMANTS

EXISTING SITE

- existing use patterns
- quality of environment
- traffic assesment (mudf status quo)

MUDF FRAMEWORK

- compact neighbourhoods
- pedestrian priority
- distinctive communities using existing features for character
- mixed use
- increased densification

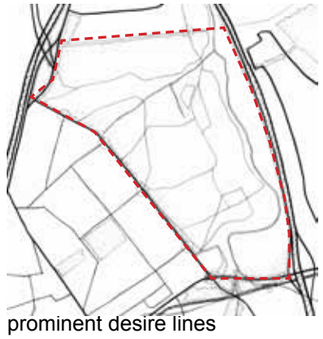
TERRAIN ANALYSIS

- elevation
- slope gradient
- hydrology
- natural features and landmarks
- orientation

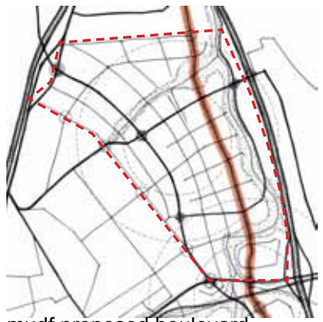
RESILIENT PRINCIPLES

- integrated networks
- pedestrian priority
- high performance landscape
- site specific opportunities

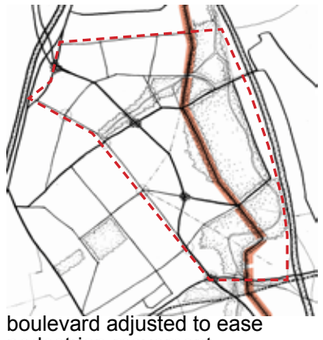
BOULEVARD



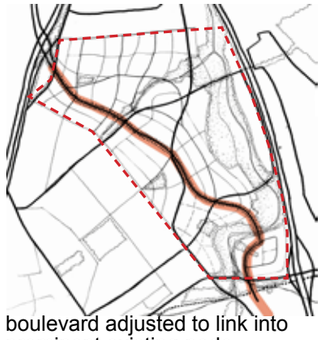
prominent desire lines



mudf proposed boulevard



boulevard adjusted to ease pedestrian movement



boulevard adjusted to link into prominent existing node

GREEN STRUCTURE

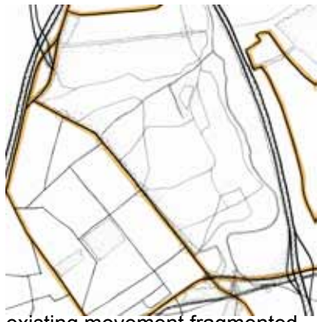
existing green structure - vacant land and polluted river

green structure 30m buffer around river and tributary

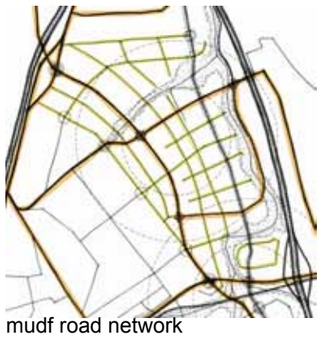
includes steeper slopes that are more developable land parcels

includes community parks and more developable land parcels

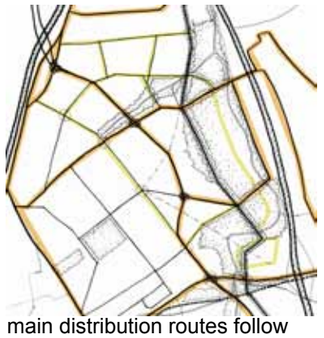
MOVEMENT



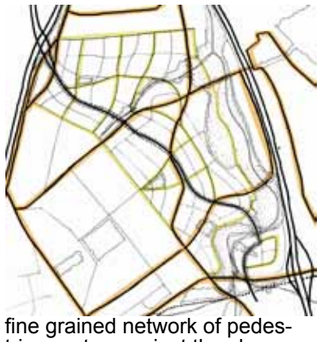
existing movement fragmented with high traffic volumes



mudf road network

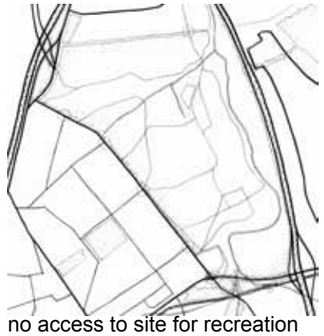


main distribution routes follow contours and eased gradients

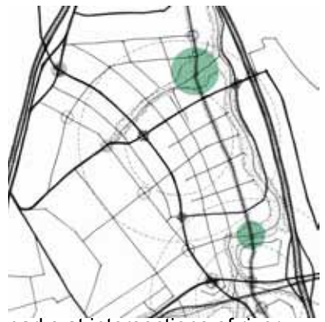


fine grained network of pedestrian routes against the slope

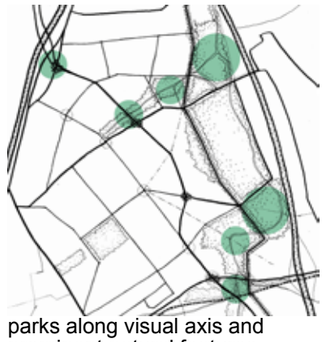
GATEWAY PARKS



no access to site for recreation



parks at intersections of river and boulevard

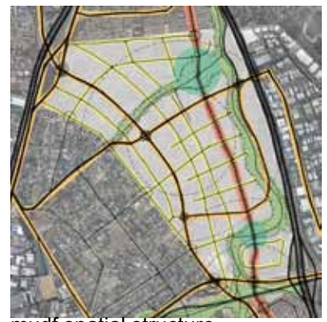


parks along visual axis and prominent natural features

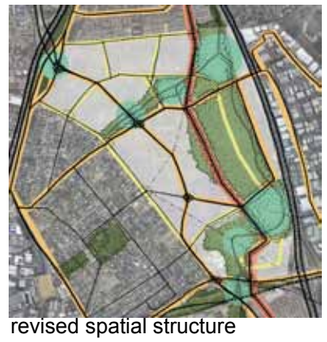
parks celebrate different niche environments

SPATIAL STRUCTURE

existing spatial structure



mudf spatial structure



revised spatial structure

spatial structure to be taken forward to detail design

CHAPTER 8

Development Guidelines

THE ROLE OF THE MASTERPLAN VISION

DEVELOPMENT GUIDELINES

- 1. Green infrastructure
- 2. Integrated network
- 3. Sustainable development patterns
- 4. Place making
- 5. Phasing over time

this chapter offers guidelines to the development processes and considerations to designing with green infrastructure.

FROM DESIGN DEVELOPMENT TO A REFINED DESIGN

This chapter picks up from the design development in the previous chapter. The previous chapter has illustrated how the design becomes refined when worked through the informants of terrain analysis and resilient principles. In this chapter, these principles are applied at a more detailed scale and refined. The design is explained by means of five development principles that illustrate various green infrastructure principles, as well as guidelines for resilient urban form. Over this spread, the structuring principles made use of in the previous chapter, namely: boulevard, green structure, movement and gateway parks; are overlaid onto the resultant proposal of chapter 7 and then again on the proposed vision described in chapter 8. It becomes evident that these structuring principles have informed the proposed design of a vision.

THE VISION

The vision plan developed in this chapter acts and a guidance mechanism for design and also to explain how green infrastructure can be integrated into urban design. It is by no means an ultimate or unchangeable masterplan vision but assists in developing a possible future scenario, backed by the principles of the existing MUDF and additional principles picked up on throughout the document. As has been discussed previously, many additional studies on site specific elements, such as suitable geology and other engineering, cultural and socio-economic studies, prepared by a full professional team, would have an influence on the development of the site.

GREEN INFRASTRUCTURE

Green infrastructure was developed as a priming theory for the site; as at the time that the study was initiated; there were disputes over development and land use. The strategy of green infrastructure would be applicable in such a scenario, as certain elements could be developed on site, structuring and organising

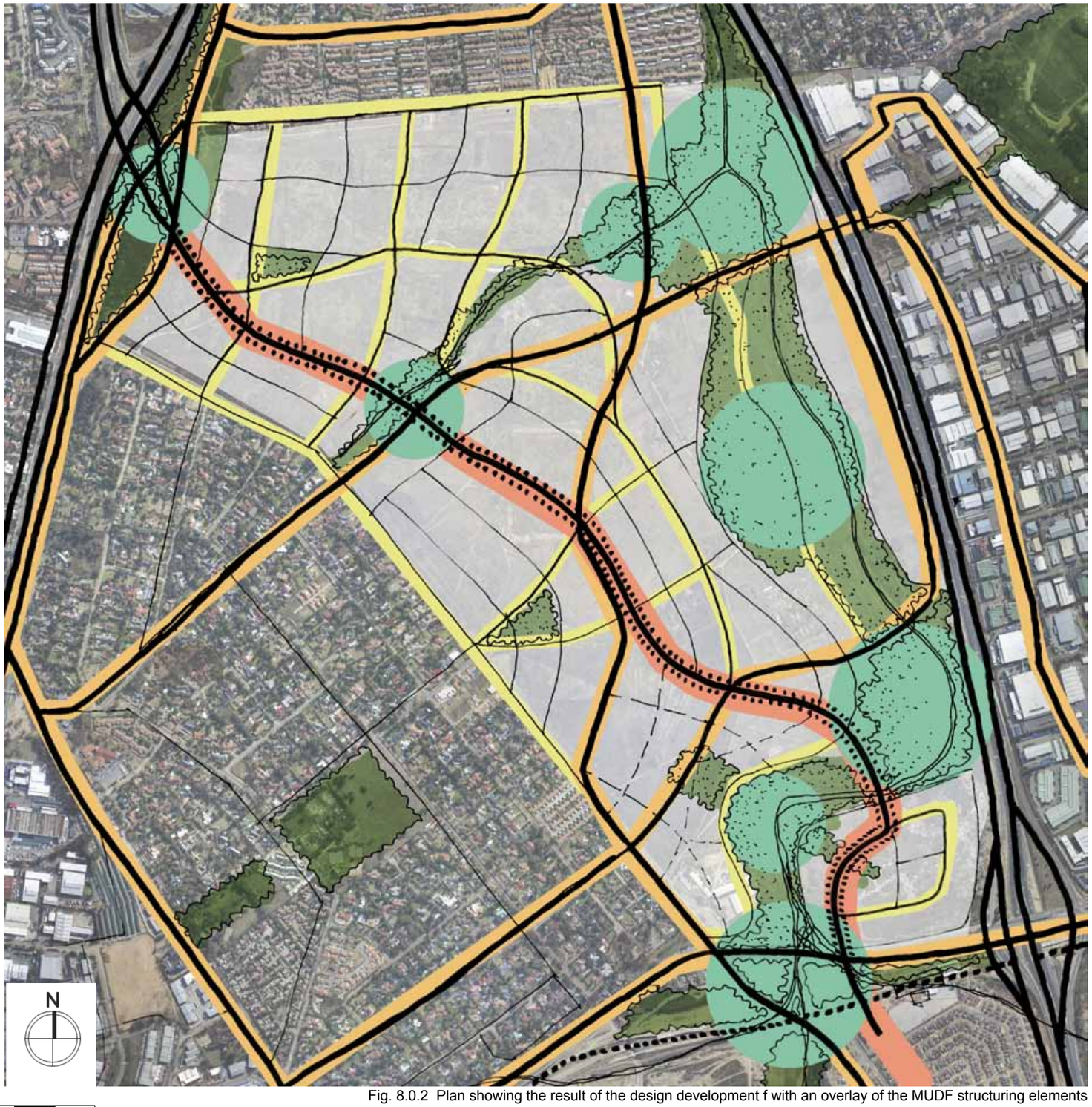


Fig. 8.0.2 Plan showing the result of the design development f with an overlay of the MUDF structuring elements

Fig. 8.0.2 Plan showing the masterplan vision for the proposed development with an overlay of the MUDF structuring elements

it through the enhancement of its natural infrastructure, ultimately adding value to future development; without developing any specific structures yet unresolved in broad scale town planning. The proposed vision suggests a future scenario which can be primed and phased to illustrate the manner in which this could be achieved. At the end of this chapter on development guidelines, there is a vision plan with a full explanation of the structural elements of the plan.

THE ROLE OF THE MASTERPLAN VISION

The role of visioning or master planning is to illustrate an option of what an urban framework based on green infrastructure as a primer can look like, and to be able to draw it apart into its minimum intervention.

DEVELOPMENT GUIDELINES

The development guidelines follow a structural logic where green infrastructure is the primary building block of development. This is then overlaid with an integrated network of movement (of people and ecology) to facilitate access and interchange across the site. Sustainable patterns of development outline self-sustainable clusters of development and their required urban form. The issue of place making is addressed through various strategies to be implemented at different scales throughout the development.

The guideline discussing phasing over time looks at different intermediate natures that can start to occupy the site and add value to further development, as well as engaging the community. The idea of phasing is further explored in chapter 9, as well as precedent illustrating how these green infrastructure interventions might start taking form.

The development guidelines set out in this chapter are as follows:

1. GREEN INFRASTRUCTURE
2. INTEGRATED NETWORK
3. SUSTAINABLE DEVELOPMENT PATTERNS
4. PLACE MAKING
5. PHASING OVER TIME

.

1. GREEN INFRASTRUCTURE

GREEN STRUCTURE

HUBS . LINKS . NODES

ENHANCED ECOLOGICAL PERFORMANCE

GREEN STRUCTURE

There are green elements that give structure and form to the city. The green structure of an area can be thought of as the natural functioning ecologies as well as the man made links and connections that give structure and define space. Many of the remaining green elements in the city have survived Johannesburg's sprawling streaks of development due to their ecological value or morphology or their ecosystem services. It is important to acknowledge the existing green network and give priority to reconnecting and maintaining links between green elements.

Fig. 8.1.1. Diagrammatic concept of green structure.

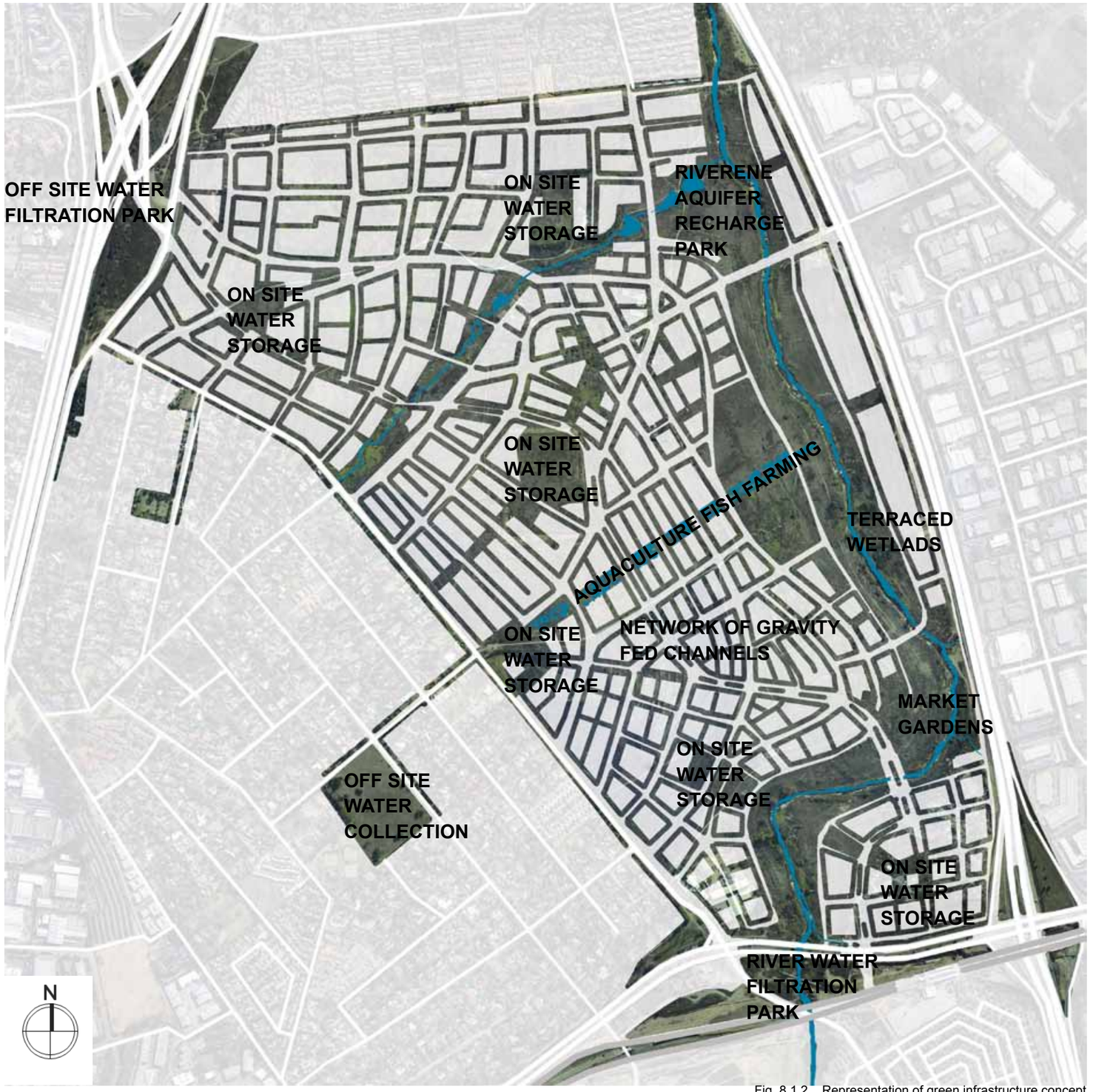


Fig. 8.1.2. Representation of green infrastructure concept

The green structure forms a local regional and greater regional fabric of greenery and water. It links into the metropolitan green network to facilitate the movement of fauna through a diverse ecological matrix. The green structure as a whole offers a multitude of functions, qualities, connections and experiences that smaller areas cannot offer. Large coherent areas of nature increase the possibility of greater biological diversity. Some strategies towards increased biodiversity are discussed further on. The green structure forms an important part of the developments identity and cultural heritage. The river will still be able to function ecologically, but with further improved performance. It will be able to offer an increased variety of ecosystem services including means to sustain local food production and fish farming. The natural heritage of the site is conserved through the response to the riverene area.

One of the main ecological functions of the proposed riverene park is the management of storm water and groundwater recharge into the system. The amount of recharge is expected to increase as the development offers a range of high performance options to deal with run off, not only from the site but also the surrounding areas. Equitable access to the green structure is promoted through an integrated network of routes to be established with the inventory on existing ecology and proposed design and diversification of habitats over time.

The green structure is set to become an attractive site for eco-tourism and best practice examples in a research context backed by specific research units of the University, located on site. A strong green structure offers a defined environment and the opportunity to structure spaces through vertical and horizontal green elements and not just built form. It furthermore helps to reduce the heat island effect, filter light and assists in reducing air pollution. The strategies to increase water quality has a larger effect on the downstream ecologies and the health of the overall catchment.

Fig. 8.1.3. Image ofthe Jukskei River.

Open Space Use

- Jukskei River and Surface Water
- Main Water Channels
- Underground Water Storage
- Water Filtration

Fig. 8.1.4. Diagram showing the presence of water in the development

Water in the urban environment

Water is the most important element to sustaining life. The proposed water running on and through the development is protected and enhanced by the green structure. Most of the open space features have an underlying ecological function. Public squares and sports fields act as underground water storage units, storing excess water during wet seasons. The water stored in these underground cells is firstly filtered through storm water swales and in some cases channelled to the storage units.

An aggressive filtration unit is located towards the south end of the development where the Jukskei River enters the site after running through the township of Alexandria. In severe cases the water would be pumped out of the river and sent through further filtration processes. A research unit linked to the University is located at this site for continuous monitoring and improvement in the system.

From the storage, water in moved through the site by means of exposed, gravity fed channels. These channels serve the entire development, providing water for irrigation and other grey water needs. The possibility of filtering drinking water should be investigated, but it is more likely to operate more successfully on a site scale, by means of rainwater harvesting and extensive filtration. As water is released from sites it is captured and intermittently, through the cycle, filtered through an aquaponic system running in the central east west valley towards the agricultural lands. The water from the cascading fishery ponds is rich in nutrients which assists in growing a local stock of fruits and vegetables.

Once the water reaches the river it has undergone several cleansing processes, releasing water of a drastically increased quality back into the system. There is also a terraced wetland filtration area to the east of the river. This us used to capture and treat runoff from light industry and the adjacent highway before entering the river system.

Human functions of the green structure

Biophilia is described as “the urge to affiliate with other forms of life” Wilson.E. 1984. The development proposal has a strong focus on connecting human beings with other forms of life.

The green structure accommodates various passive and active options to connect with their environment. The natural environment is associated with psychological and physical wellbeing. The extensive open space network proposed in the development is supported with a dense urban fabric of medium to high densities, and also aims to serve the surrounding area.

Open Space Use

- Parks
- Sport fields
- Agriculture
- Streets

Fig. 8.1.5. Diagram showing open space use

Parks:

The green structure serves people in many different ways. Larger coherent areas offers various forms of passive recreation and the closest connection to the natural environment that urban development could offer. The river parks area offers walking and cycling trails that are a welcome break from the dense urban areas. Large open areas also welcome eco tourism, especially bird watching activities with a positive economic impact on development.

Fig. 8.1.6. Example of a river park environment.

Sports fields:

The green structure includes active recreation in the form of sports fields. Fields are located adjacent to larger green corridors and also take on some of the natural functioning. Sports fields in the development are proposed as shared facilities between communities, schools and clubs. Linking sports fields with the green structure allows for lower maintenance input as the surrounding areas are encouraged to remain more natural as opposed to manicured and mono planted.

Fig. 8.1.7. Example of a integrated sports field in the green structure.

Agriculture:

Agriculture plays an extensive role in the intermediate development of the area. Local food production is emphasised as an economic income stream, and ultimately to sustain the extent of the development and some of the surrounding areas. grazing as a method of fire contro and maintenance is also encurages in intermediate phases with the presence of some lifestock at fully realised vision status.

Fig. 8.1.8. Example of small scale agriculture.

Streets:

The green structure defines the urban environment by means of streets linking various larger environments and completing the network. Green elements are present in the street structure in several ways, ie, spatial definition through street trees, water delivery by means of gravity fed channels, storm water mitigation through bio-swales, and addition ecological movement through street greening.

Fig. 8.1..9. Example of astreet as a green corridor.

ENHANCED ECOLOGICAL PERFORMANCE

Green infrastructure principles have been carried through the proposed design development specifically to ensure the spatial and ecological logic of the placement of green infrastructure interventions in the move towards a high performance landscape capable of exceeding the ecological function of the site as an open piece of land. The strategies discussed in this section could surely be expanded upon in the context various professional fields. The strategies discussed here involve mainly mitigating storm water, increasing water quality, local food production and increased consolidated and species diverse ecological habitats to enable greater biodiversity .

Green Infrastructure Elements

- Cascading aquaponics ponds
- Water channel feeder routes
- Water storage sites
- Groundwater recharge parks
- Water filtration parks

Fig. 8.1.10. Diagram showing green infrastructure elements

Water Filtration Parks and Treatment Wetlands

Sustainable drainage systems comprise a wide range of solutions intended to deal with storm water planning, design and management in urban environments with an equal emphasis on the environmental, social and landscape aspects as well as on hydrological and hydraulic ones. Their function is to prevent, reduce and delay rainwater discharges into the sewer system or other receiving water courses trying to mimic natural catchment processes.

The development deals with filtration systems by means of water treatment wetlands in areas where water is captured for use throughout the site, and through the use of filtration swales where water is released back into the system.

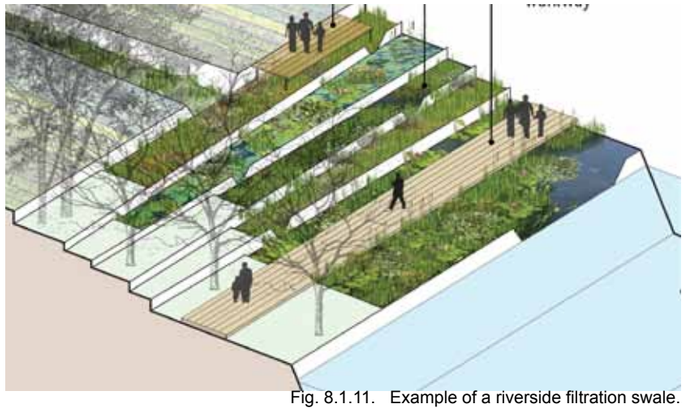


Fig. 8.1.11. Example of a riverside filtration swale.

Filtration swales work by means of moving water through a series of gravity operated planted swales which slow down the movement of water while the vegetation traps organic and mineral particles. The swales make use of the existing slope of the site except in the case of the eastern edge of the river where the requirements for prepared sites allow for the design of a combined treatment landscape.

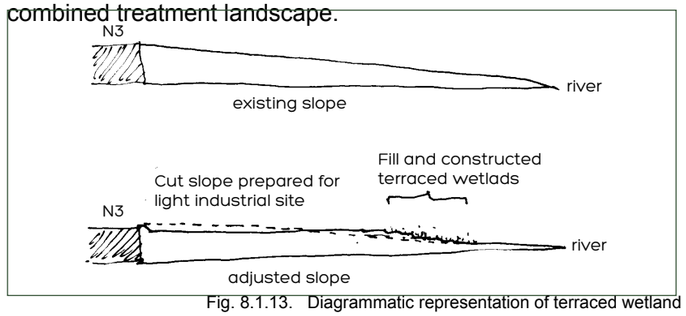


Fig. 8.1.13. Diagrammatic representation of terraced wetland

Fig. 8.1.14. Example of a wetland park.

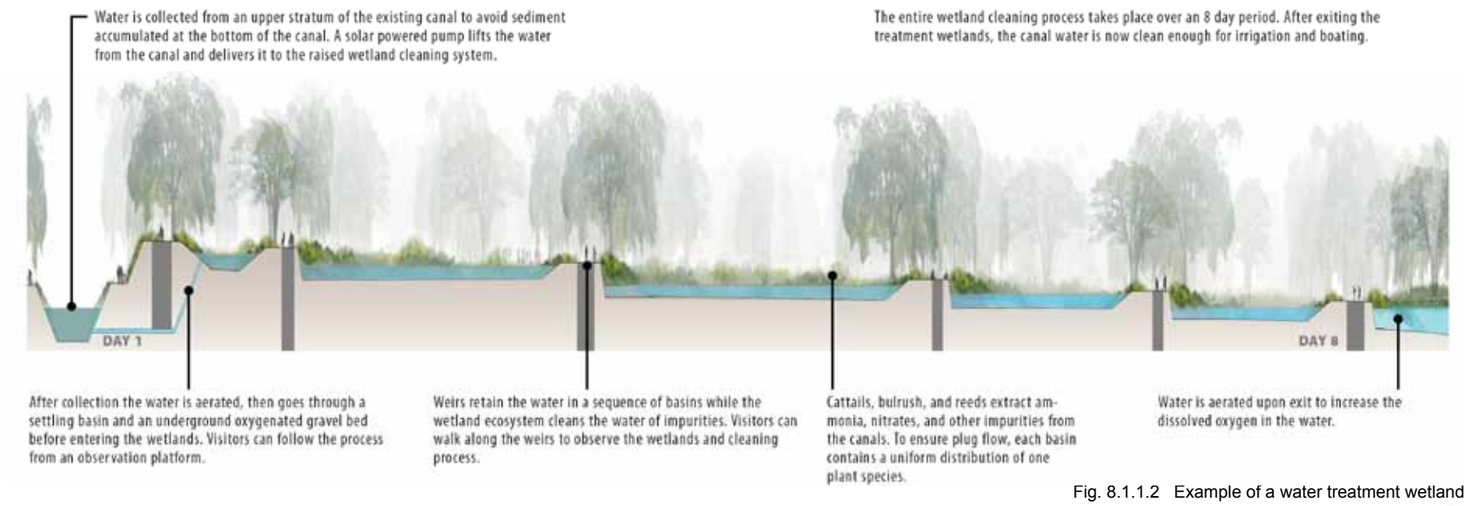
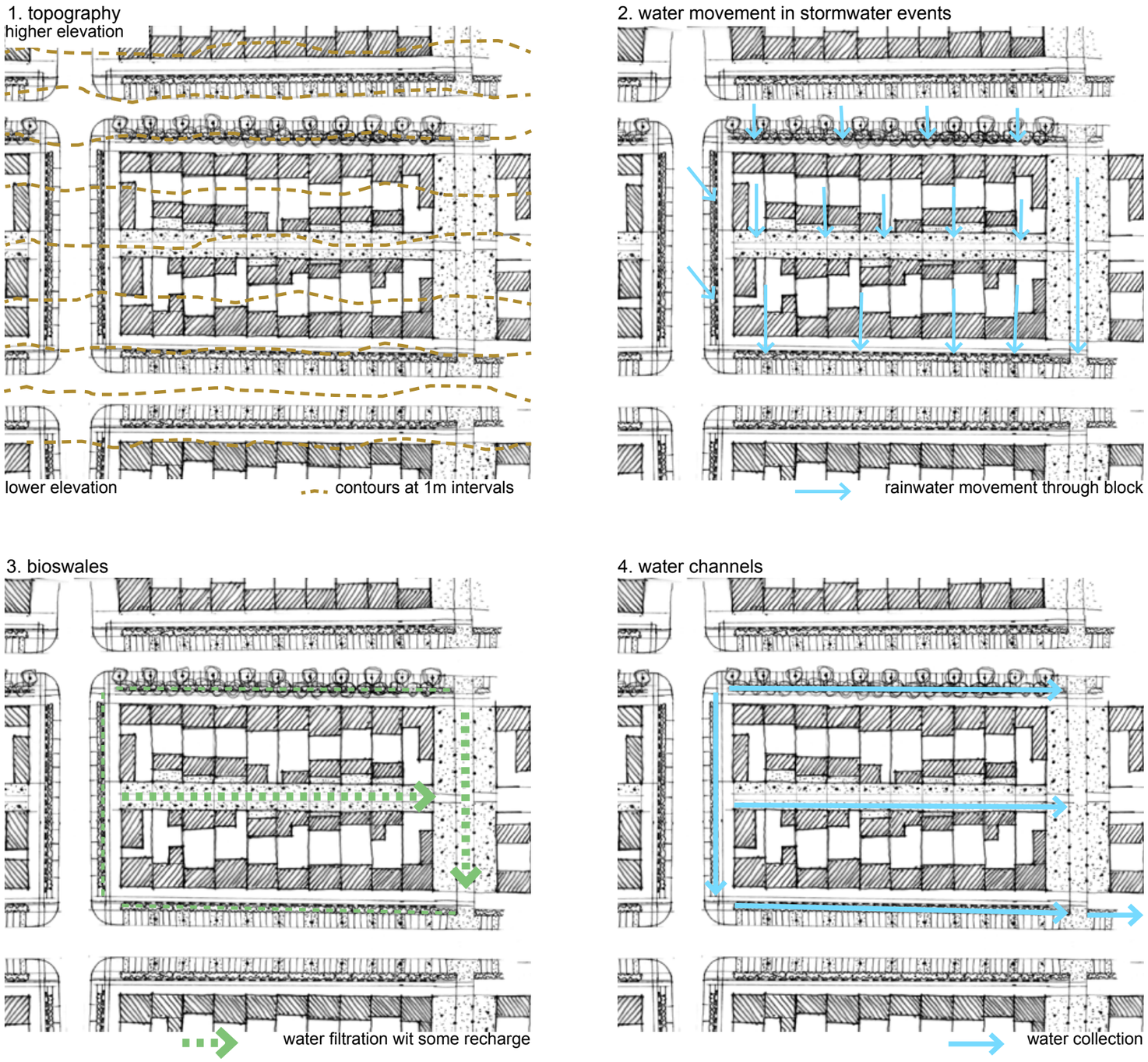


Fig. 8.1.1.2 Example of a water treatment wetland

Stormwater Management Diagram



Gravity fed surface water channels

Water is guided through the development along public streets in gravity fed channels, these channels become part of the urban environment and open up in areas to allow interaction and become urban features. The water channels shape and are arranged along streets, defining the urban block edges. The channels also take cognisance of the capture of water in storm water events and starts to inform the open spaces within development parcels. The situation diagrammed to explain this concept makes use of the optimum block typology.

1. Blocks are laid out and developed in accordance with the gravity fed system.
2. Water is collected during storm events and stored for later use.
3. Water is filtered through vegetation and some recharge occurs.
4. Water is captured by means of exposed channels and runs along streets to further filtration sites or down stream irrigation purposes and eventually back into the river system. Some water is also diverted through the aquaponics system
5. Water enters properties at the highest point. The water can be used for grey water uses or filtered on site for drinking water.

Fig. 8.1.15. Diagrams of gravity fed water systems.

Fig. 8.1.16. Example of a surface water channel.

Water Storage Cells

The system proposed deals with underground water containment. Open cell structures are placed within a sealed area below the surface. The modular cells are structural to allow for vehicular movement to occur at ground level. The subsurface location allows for a large water collection with a more usable ground level and no surface level water tanks or towers. The water within the tank is continuously circulated as part of the water cycle of the site.

Various surface treatment options are available in terms of permeability and allowing surface water to drain directly into the tanks. This is site specific, depending on the surface use and quality of run off. A system of geotextiles and aggregates may be used to act as a filtration layer.

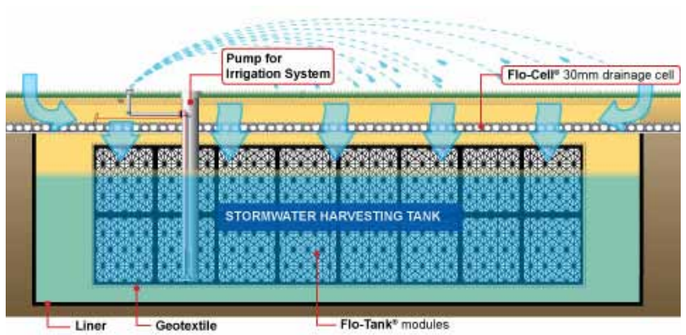


Fig. 8.1.17 Typical installation detail of underground storage cell

Fig. 8.1.18. Underground Water Storage tank during construction phase

Aquaponics

Aquaponics is based on the mutually beneficial relationship between fish farming and hydroponics. The development proposes a fish farming initiative linked to the water system and the agricultural uses proposed on site. The system would effectively be an open one, as the same water may not continuously cycle through. It does, however, take advantage of the nutrients in the water captured from fishing enterprises, as fertiliser for growing crops. The cycling of water also provides benefit to the fish farming as it creates a much lower maintenance system. Presence of the water source will also allow additional niche habitats to encourage biodiversity corridors.

The aquaponics corridor will also provide a variety of public environments for recreation and gathering, as well as small scale economic opportunities for development along its edge, such as coffee shops and cafe's. This would develop into a secondary pedestrian spine, attracting interest from surrounding areas.

Fig. 8.1.19. Example of a sustainable water system in a public environment

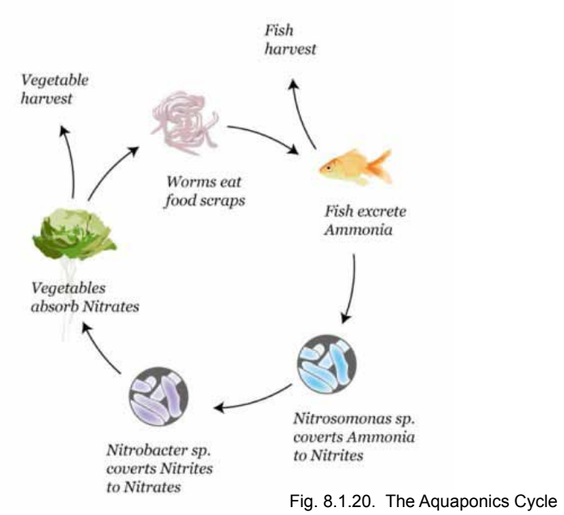


Fig. 8.1.20. The Aquaponics Cycle

Groundwater Recharge Parks

Groundwater recharge has to do with returning water to the immediate system in a similar manner as what rain would usually do in a natural environment that has no impervious surfaces. Water recharge is accommodated at many scales in the proposed development, from site and block to the larger open space network. Recharge and storm water management has always largely been a function of the open space network. In larger areas, it relies on detention and retention ponds and reed beds and wetland filtration.

Fig. 8.1.21. Example of a detention pond and the desired spatial quality of parks.

2. INTEGRATED NETWORK

ECOLOGICAL NETWORK

NON-MOTORISED MOVEMENT

VEHICULAR MOVEMENT HIERARCHY

The integrated network facilitates the movement of people and ecology through the site

Ecological Movement

- Ecological Corridor
- Open Space Links
- Green Boulevard

Fig. 8.2.1. Diagram showing elements of the ecological network

Fig. 8.2.2.. Plan showing the various movement routes across the site

Fig. 8.2.3 Example of a street as an ecological corridor

ECOLOGICAL NETWORK

Urban strategies for enabling biodiversity

The biodiversity strategy expands on the principle of a strong green structure, but from a perspective of ecological movement through the site.

It has already been established that a connected green network has been put in place to accommodate various man made and ecological needs. The performance of this green network is strengthened by the species diversity which exists within it.

This section addresses various strategies for increasing species diversity to allow for more niche habitats. It also focuses on maintaining and strengthening the links in the green structure through urban landscaping interventions.

Streets as ecological corridors.

Streets take on many different functions in this proposal, facilitating the movement of people and vehicles, water and also animals. This takes the ideals beyond the complete streets dialogue and makes the argument to invest in the design of streets as an important part of the open space of a place. Some strategies regarding increased ecological function are discussed here, including diversification of street trees, lawnscaping, bioswales and bug hotels.

Habitat fragmentation and edge effect

Habitat patches should aim to be as whole as possible, as certain species can only survive in larger habitat patches. Larger habitat patches will also allow for larger species to inhabit the site, bringing the system towards a more self regulating equilibrium.

Increasing the edge between different environments enables larger species diversity in the same size of habitat. Edge effect as a principle should be carries through in the planting program and the design of open spaces, especially those edging more natural environments.

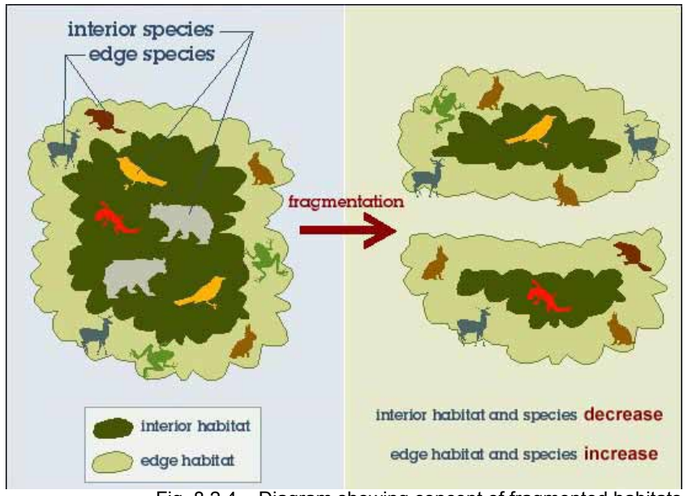


Fig. 8.2.4. Diagram showing concept of fragmented habitats

Fig. 8.2.5. Example of species diversification in street trees

Diversity in street trees

Street trees in the urban context are often mono planted of the same species for entire lengths of streets of even entire suburbs. Diversifying the selection of street trees has many benefits to people and the environment, including visual attractiveness during seasonal changes and bringing in a variety of birds. Streets planted with a range of trees can still provide a system of spatial logic depending on arrangement.

Fig. 8.2.6. Visual attractiveness in species diverse street trees.

Planting diversity in bioswales

Planting in swales is based on the same principle of street trees, in that there is more benefit in using an extensive planting palette of context appropriate species. This allows for self propagation and natural succession in instances, as well as being water resourceful and low maintenance.

Fig. 8.2.7. Example of species diversification in a bioswale

Lawnscaping

Lawnsaping looks at alternatives to grass. There is also a focus on diversified species of low growing plants and ground covers that respond positively to being cut and traversed. These types of areas become spatially desirable for areas that need to remain low such as the surroundings of sports fields and public spaces.

Fig. 8.2.8. Example of species diversification in a bioswale

Bug hotels

Bug hotels provide urban environments for insects. They comprise of compartments stuffed with varieties of organic matter in which insects can nest

The idea of bug hotels could be incorporated into urban elements such as street furniture including light posts, signage and seats

Fig. 8.2.9. Example of a bug hotel.

Green and inhabitable architecture

Although not extensively discussed in this document. There are many theories and advances being made into seeing architecture as housing living organisms other than just humans. These types of facade treatments are desirable in order to move toward more resilient urban development and should be strongly enforces in the building development in the proposal.

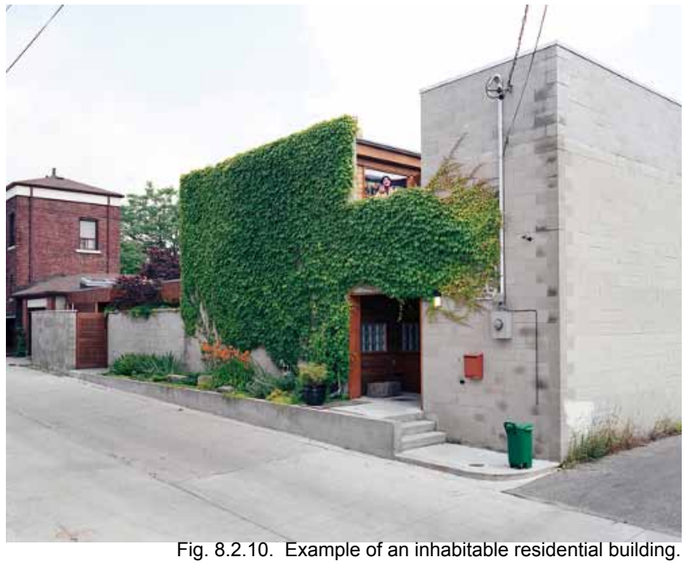


Fig. 8.2.10. Example of an inhabitable residential building.

Fig. 8.2.11. Example of an inhabitable commerciall building.

CONNECTIVITY

Connectivity is important on all levels to ensure a resilient development. As illustrated by the ecological movement principle, stronger connections between nodes ensure a more vibrant environment. As scales change, connections also tend to become barriers, depending on the speed of the crossing systems. Highways become a barrier to the local movement network in the same way that roads become a barrier to pedestrian movement, and pedestrian walkways become a barrier to ecological movement.

Maximum effort must be made to ensure the least amount of blockages to any system of connectivity. By bridging the gaps in connections, the most accessible environment is provided and the greatest amount of choice is available to its users.

Movement Hierarchy

- Regional routes
- Distributor routes
- Local routes
- Integrated transport boulevard

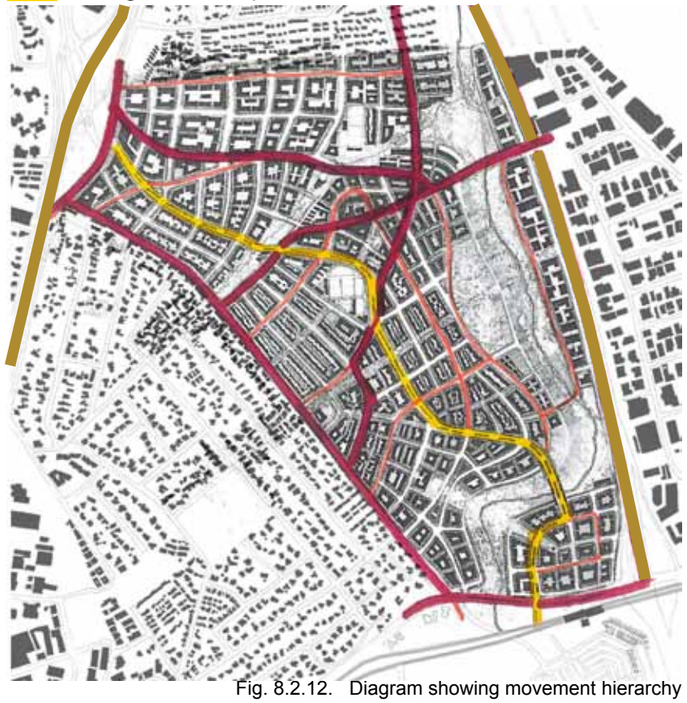


Fig. 8.2.12. Diagram showing movement hierarchy

Connectivity (refer to fig. 8.2.12.)

REGIONAL CONNECTIVITY

Increased development sustainability dependents on physical mobility - it implies accessibility, appropriate connections, availability of public transport and links to locations of desired activities. The scale of the development implies multiple regional connections. The proposed development site needs to maximise its connectivity with the greater city to maximise its own sustainability and development opportunity.

REGIONAL ROUTES:

Regional routes ensure connectivity of the development to the greater region. These routes become barriers at the smaller scale and to other vehicular traffic and forms strong edges for development but allows for the preservation of large ecological expanses.

DISTRIBUTION ROUTES:

Distribution routes allow the greatest movement through the site and connects it with the surrounding neighbourhoods. The distance scale of these routes means that they become dominated by relatively fast moving vehicles and are prone to traffic congestion. Throughout the development, generously designed safe non motorised transport corridors flank these routes on both sides.

LOCAL ROUTES:

Local routes provide connectivity between the different areas within the development. The local movement network is an integrated grid of streets these streets are slower and allow for ample parking on both sides of the road as well as generous and safe pedestrian walkways. The distribution routes integrate with the local street network, It facilitates ease of movement for a variety of road users: public transport, private vehicles, cyclists and pedestrians.

INTEGRATED TRANSPORT BOULEVARD:

The Boulevard provides a core public and non motorised transport system and is flanked on both ends of the site by inter modal transport facilities. It is also supported by the Marlboro Gautrain Station on the northern edge just outside the site.

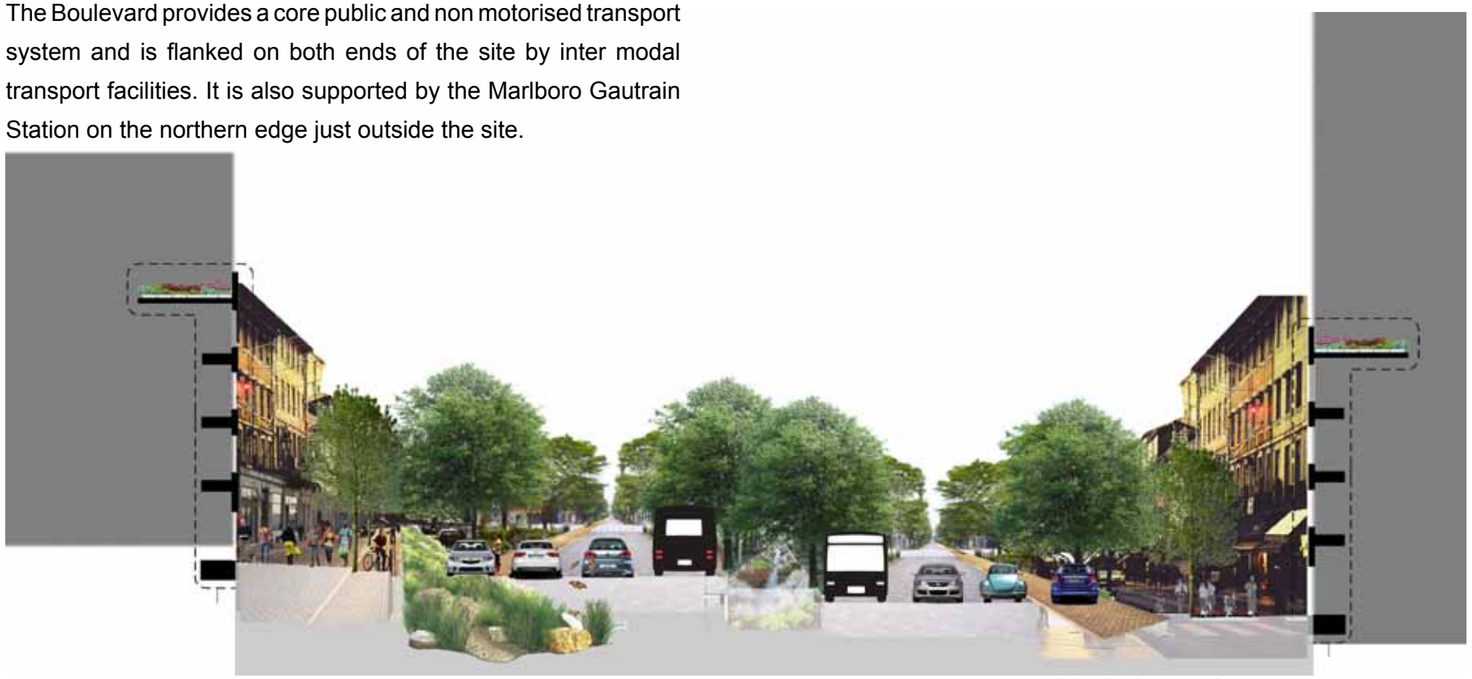


Fig. 8.2.13. Section of proposed Boulevard. Author

NON MOTORISED AND PUBLIC TRANSPORT

Non motorised transport network

Public and non motorised becomes of utter importance in moving towards a more sustainable urban model. Non motorised transport resonates strongly with the proposed development. Where possible, streets are laid out along contours and otherwise along rouses with the least steep slopes to assist in easily traversing the site. Where site conditions have steeper slopes, slow routes have been provided, with ample shade and greenery, leaving wide servitudes to accommodate ramps and staircases. Smaller spaces with seating and street furniture provided along the slow routes pay special attention to providing safe and well lit environments. These routes are by nature always short (60 - 80m) with movement routes on either side. Pedestrian and non motorised transport routes, with an integrated accessible route, are provided along all streets with areas for street furniture, street trees, and spill out areas for building edges.

The public transport runs along the levelled contour routes, while the pedestrian and non motorised movement only are accommodated in many of the steeper slow streets.

Public transport corridor and support systems.

As mentioned previously, there is a public transport corridor moving through the site. This corridor will, most likely accommodate an extension of the Rea Vaya Bus Rapid Transit system of Johannesburg with stops ant the various nodes of the development. The public transport system will be supplemented with feeder routes for the Rea Vaya and the Gautrain Bus System. The bus routes will run along the Distribution Routes and Local Routes through the site.

Public transport stops occur at an interval of between 600m and 800m, which equates to a walking distance of about 7 to 10 minutes between stops. The placement of stops encourages pedestrian to rather walk short distances as opposed to using public transport.

Technologies for high performance streets

There are a variety of green infrastructure strategies which should be applied to the streets in the development. Some of these have already been discussed under biodiversity strategies and enhanced ecological performance earlier in this chapter.
Listed and discussed briefly below are additional strategies for high performance streets.

Reducing heat island effect:
Urban environments often suffer from high temperatures which have a negative effect on native occurring plant and animal species. This is largely due to the high ratio of non absobtive surface material (especially tar) used in urban areas. The material palette for streets should focus on using paving materials lighter in colour for streets and walkways.

Permeable surfaces:
Permeable surfaces make use of permeable paving with sub surface drainage to mitigate storm water run off. Depending on the context and water collection strategy, filtration needs and functionality, permeable paving should strongly be considered in walkways and some cases streets.

Green permeable paving and grass blocks:
Grass blocks should be used for on street parking, especially in quieter residential areas where there would be more opportunity for sunlight on the parking. Even in the case of highly used parking areas, a grass block variety with turf or aggregate should be considered; as phasing out vehicular traffic over time will offer the opportunity to green them up.

Rain harvesting and green roofs:
Green roofs speak to a multitude of benefits including heat island effect including rain water harvesting, biodiversity strategies and local food production the street needs to be able to accommodate rain water to be released in the system, in the development this water would most likely flow through the water channel infrastructure.

MOVEMENT NETWORK

This section discusses the grain of various forms and speeds of movement and the typical street typologies that accommodate dthem in the development. the development coniders various forms of thansport including existing public and vehicular transport, to create a multi modal matrix. The focus is towards more sustainable forms of transport for future scenarios, where the ample on street parking provided could relatively easily be converted to extend the already present ecological network; and streets bould be partially convertedparkingThe grain of streets. and street typologies

Streets

Street design determines the capacity to accommodate all surface level modes of transport, and is a very important design tool for sustainable urban environments. This has most recently sparked the greenest street debate, mentioned earlier, and in the context of this development, now also includes facilitating ecological movement. The street should provide a sense of place as an element of cohesion between all of the other design aspects. The street as the public realm is re imagined in this urban context, where it becomes a high performance element as a movement corridor, intermediate link, social environment and the essential building block of community. Well designed streets assist in encouraging walkability and moving towards a more sustainable urban environment
A street network influenced by the motorised transport network remains and allows for free access. Green urban infrastructure, in this context, consists of the activity that aims to discover and highlight the potential of the public space of the development.

Fig. 8.2.14. Primary routes

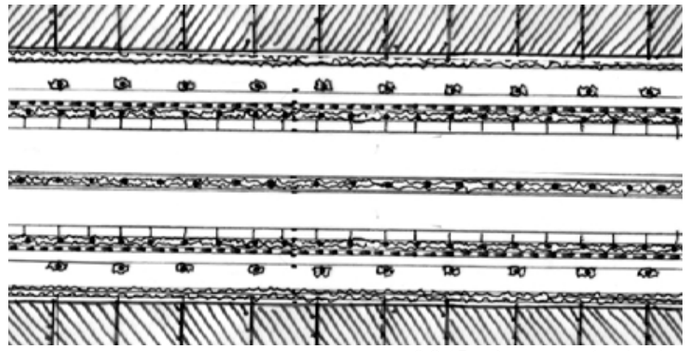


Fig. 8.2.15. Boulevard street detail

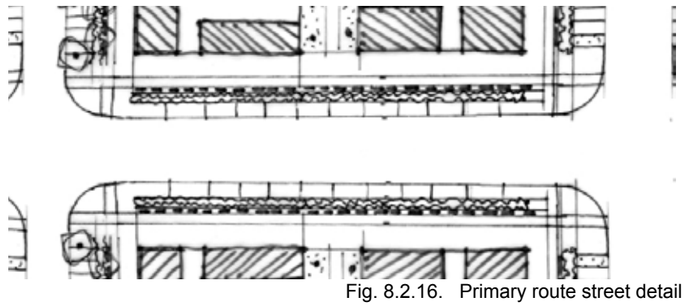


Fig. 8.2.16. Primary route street detail

Fig. 8.2.17. Secondary movement routes shown in orange

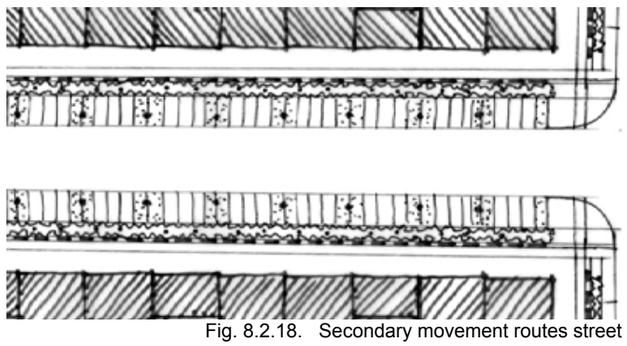


Fig. 8.2.18. Secondary movement routes street detail

Scale for all street detail plans

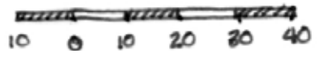


Fig. 8.2.19. internal streets shown in red

Fig. 8.2.20. Internal Street Section

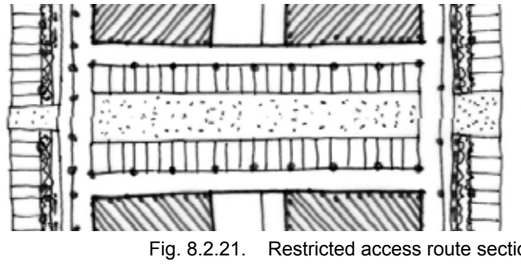


Fig. 8.2.21. Restricted access route section

Fig. 8.2.22. Pedestrian lanes shown in green

Fig. 8.2.23. Pedestrian Lane Section

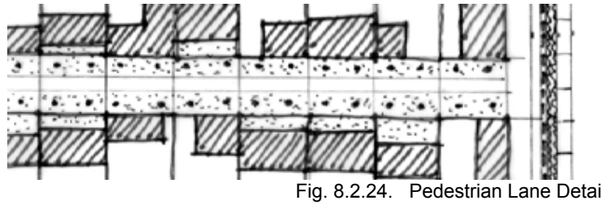


Fig. 8.2.24. Pedestrian Lane Detail Plan

3. SUSTAINABLE DEVELOPMENT PATTERNS

COMPACT DEVELOPMENT

VARIETY AND MIX OF USE

BLOCK TYPOLOGIES

COMPACT DEVELOPMENT

Walkability:

Sustainable development patterns are based on blocks designed around the most accessible means of transportation, which is walking. Pedestrian proximity is highly considered in the design of the development, and all essential amenities are within a walkable distance with greater choice of amenities in reach of public transport.

With the most recent environmental concerns, the advantages of walking in cities seem more apparent than ever. It is the most sustainable environmental mode of thansportation, and contributes to social well being and health. Walkability should be encouraged and the public transport network that supports it reinforced.

Fig. 8.3.1. Example of a mixed use walkable scale street

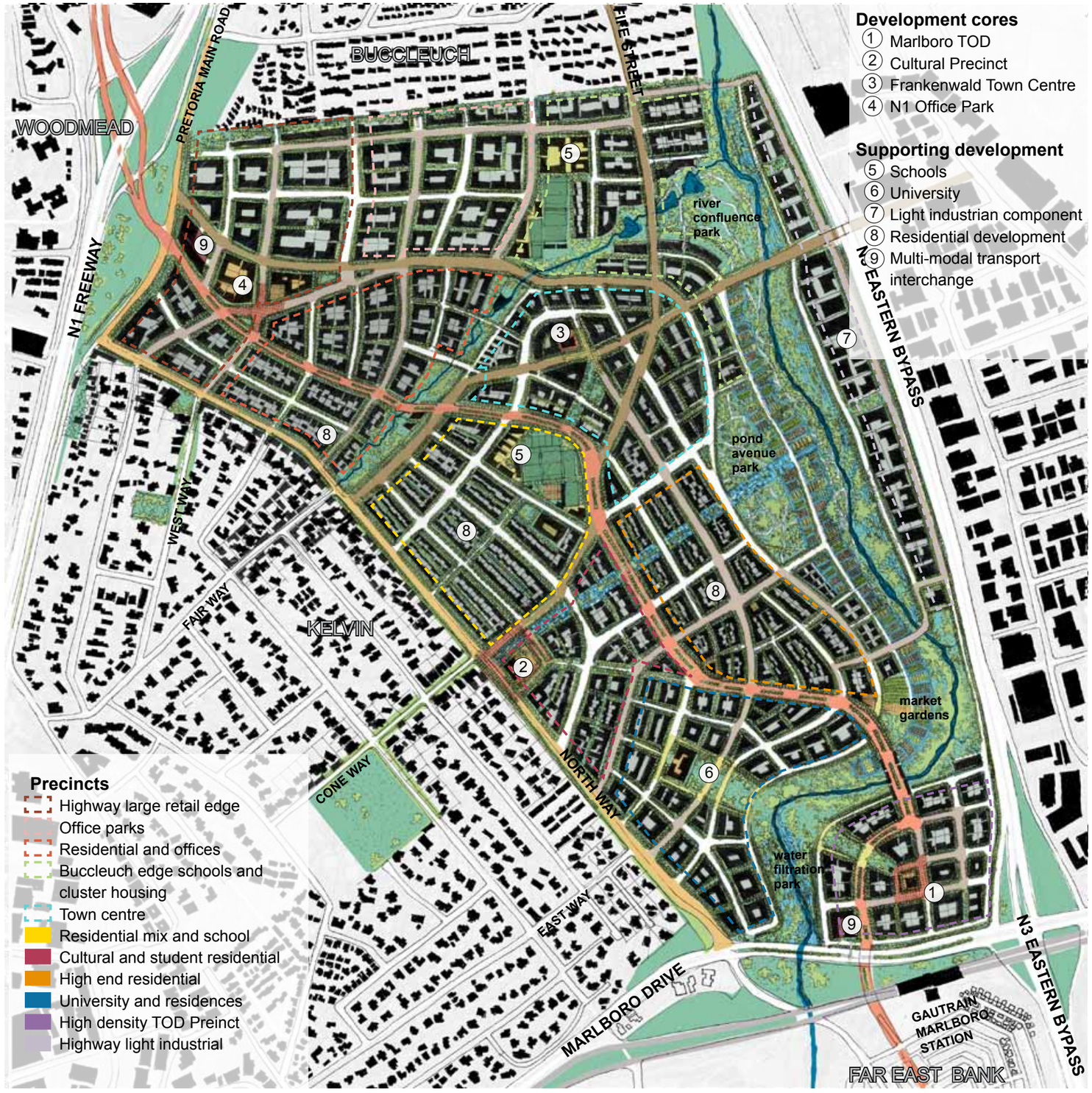


Fig. 8.3.2. Plan showing the elements of sustainable development patterns.

Defined clusters of development

Defined neighbourhoods are bound by green edges. Each of there areas can be verbally described in relation to their binding elements and specific use. Defined development edges ensure complete pieced of urbanism, especially in a phased development context. Clusters of development are self-sustainable segments of urbanity. the idea is to complete development parcels instaed of doing a little bit all over the place. development parcels would ideally be completed street by street.

Land use patterns

Mix of use is encouraged in all instances to move towards developing a richer and more diverse urban fabric. Residential mixes include home offices and small shops. Offices often have a residential component and specified mix used areas include a mix of various uses. Mixed use is encourage to develop urban fabric that is vibrant throughout the day and night., providing safer environments for the users.

Fig. 8.3.3. Diagram showing development clusters bound by green space

Land Use

- Intensive mixed use, upper floors residential, middle floors office and lower floors retail
- Retail mixed use with offices
- Office park mixed use with some residential and supporting retail
- Residential blocks of flats with some office
- Residential cluster development, 3-4 storey
- Schools and community shared sports facilities
- Residential, 1-2 storey with home office
- Residential 3-4 storey with ground floor office or small retail
- University academic, research, residential and admin

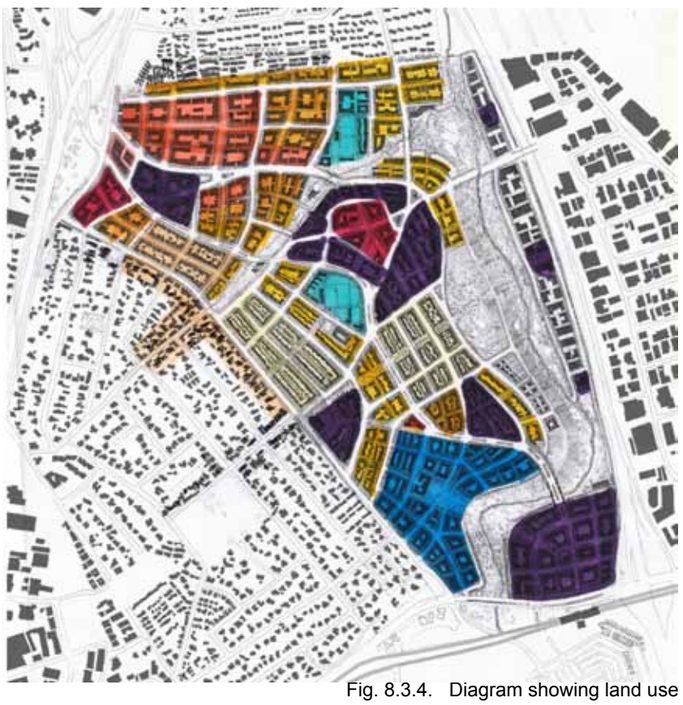


Fig. 8.3.4. Diagram showing land use

Building heights

Building heights vary from 2 - 8 storeys. Towards the western edge of the site building heights are lower to meet with the existing edges opposite the street. densification though edge development is encouraged along the street. Building heights towards the northern edge meet with the cluster housing developments, while at the southern edge high building heights define the transit orientated development principles around the gautrain. Throughout most of the side, a 3-4 storey height, sustainable for non mechanised accessibility, is proposed.

Building Heights

- 1 - 3 storeys
- 2 - 3,5 storeys
- 3 - 4 storeys
- 4 - 6 storeys
- 6 - 8 Storeys

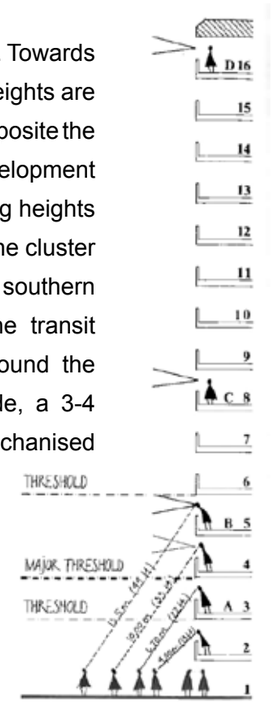


Fig. 8.3.5. Diagram of building sight lines, Jan Gehl

Fig. 8.3.6. Diagram showing building heights

Basic Block Typology

The basic block is based on the desired quality of a medium density, walk-up, accessible typology

The erfs are set to a standard 12.5m by 30m layout, arranged across contours rather than along them. The block envelope is mostly solid, the erf size ensures that there are no blank walls and regular entrances to the street. The provision of streets, green bands and internal streets allow for larger building enveloped along corner erfs

Amalgamation of the basic erf site occurs on larder sites to accommodate blocks of flats, office parks, larger retail and mixed use activities. The erfs along the green public transport boulevard have been specified to adhere mostly to the basic erf size to ensure variety on the pedestrian edges.

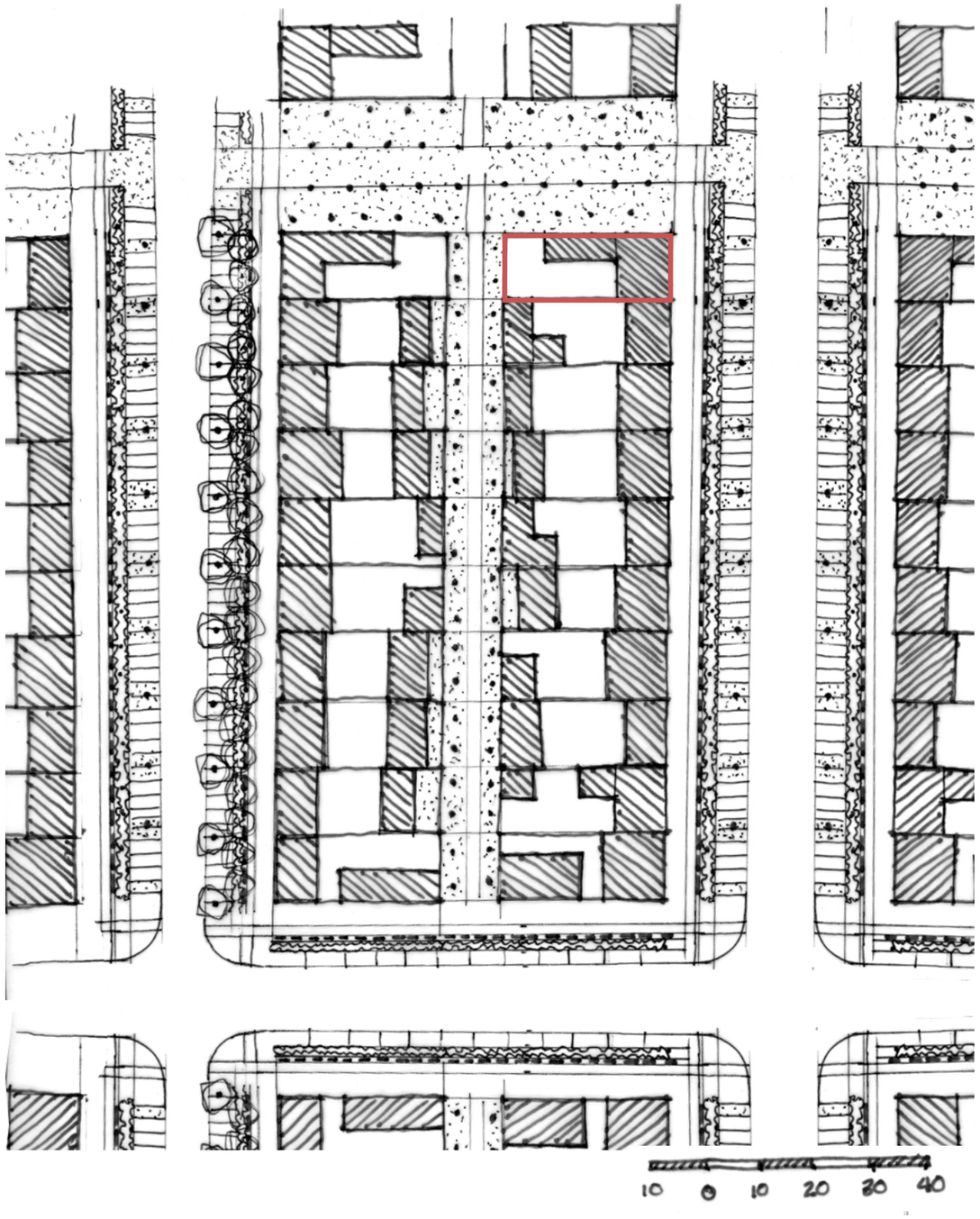
Vehicular access to erfs is restricted in most cases, specifically residential. Amalgamation of erfs for the purposes of additional parking would typically result in a lot of 25m by 30m with the capacity to hold 24 vehicles parked at 90 degrees with a 7m roadway between them. This is the typology of the restricted access road discussed under movement networks.

Parking occurs on street, preferably at 90 degrees, with the exception of distribution roads and the non motorised transport.

Most of the green space is contained in the streetscape with a 1m spill out for greening and accommodating threshold activity.

It is desired to maintain the central street servitude where possible, as it insentivises denser development with the option of a second building towards the back end of the erf. This, in effect creates a courtyard typology for each erf, which buildings could live out onto.

The service lane, depending on the type of mixed use, could be used as a neighbourhood green yard, a service lane for deliveries and access to erfs, or additional parking. Service lanes should ideally be managed by the block as a collective.



restricted vehicular access route

12,5m by 30m erf

block servitude

edge fronted development

90 degree on street parking

primary building

secondary development

internal courtyard

parallel parking on primary movement routes

Fig. 8.3.9. Typical block typology.

Fig. 8.3.10. Plan showing the erf layout of the proposed development

Block Typology Variations

Refer to next spread for images.

Fig 8.3.11

2-3,5 storey residential mix with ground floor office/studio. Located closer towards the integrated transport boulevard, this layout proposes ground floor, street facing office/studio/workshop with an upstairs living unit and a secondary back yard dwelling unit, possibly for rental. An internal courtyard provides the open space on the erf. A pedestrian lane running parallel to the streets provides secondary access to backyard dwelling units and a neighbourhood green space.

Fig 8.3.12

1-3 storey residential mix with home office

Located closer to existing residential area. The left side of the block shows a more densely developed street edge with shops/ offices responding to the boulevard, 2-4 storeys in height and residential functions from first floor up. The right side of the block shows a more permeable street front responding to the existing fabric of Kelvin. Development of 1-3 storey semi-detached units and green yards. Depending on the intensity of use of the boulevard over time, these properties might be used from the boulevard edge through with connections from the boulevard street for functions requiring larger floor areas.

Fig 8.3.13

3-4 storey residential flats with some offices and corner shops

Higher density residential use is proposed in proximity to the boulevard and in the development areas of the university and office park. Proposed ground floor shops and residential upstairs. Some building forms are more viable if developed over 2-3 stands to share services, however, original erf boundaries should be architecturally articulated to retain scale and fenestration proportion. This applies to all buildings constructed over more than one stand. Internal streets support higher parking ratio needs. Over time, as reliance on individual motor transport decreases, these internal streets should be converted to community parks or vegetable gardens.

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2-3,5 storey residential mix with ground floor office/studio

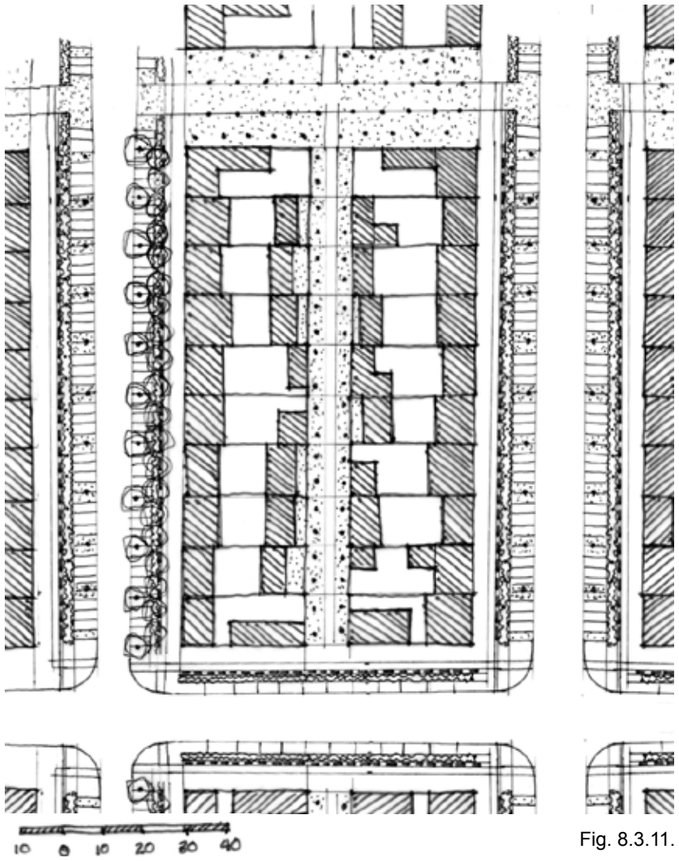

Fig. 8.3.11.

1-3 storey residential mix with home office

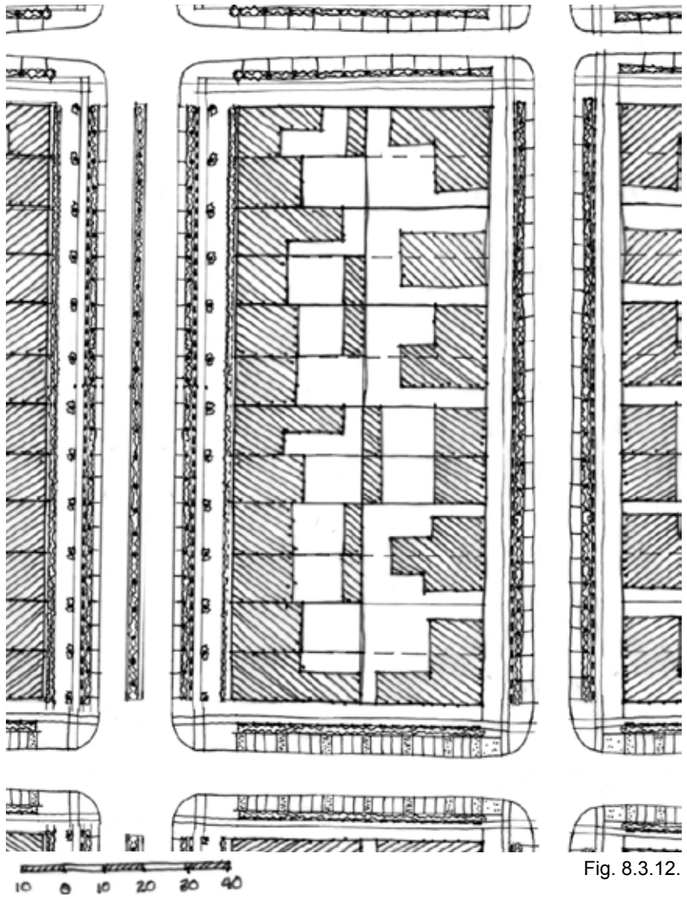

Fig. 8.3.12.

3-4 storey residential flats with some offices and corner shops

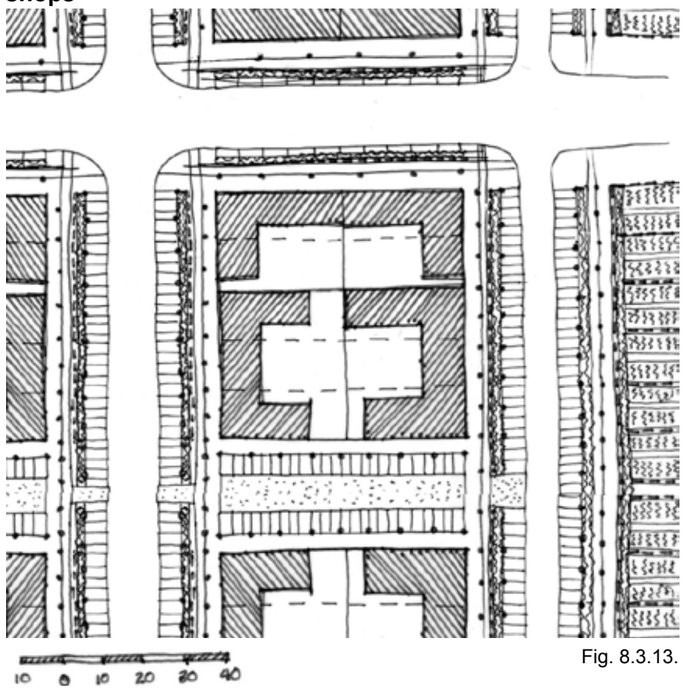

Fig. 8.3.13.

Fig 8.3.14

4-8 storey intensive mixed use

Intensive mixed use developments should ideally occur on individual sites, possibly tith shared services. High intensity mix should be introduced throughout the building, including shopfronts on ground and first floor, offices above and some residential. Larder offices and residential should be located on internal streets that are less public than the boulevard, but still with the presence of residential on upper floors along the boulevard for security and visibility. Internal streets offer quitter community street environments and more parking.

Fig 8.3.15

4-8 storey intensive mixed use with service lane

Mixed use throughout as per 8.3.14 with residential component located on pedestrian lane, essentially offering woon-erf type environments.

Fig 8.3.16

3-4 storey office block

Most large office developments are located along the N1 Freeway edge of the development, following an already existing pattern of office clusters in this vicinity. Office block layouts offer internal streets for additional parking and should also include some mixed

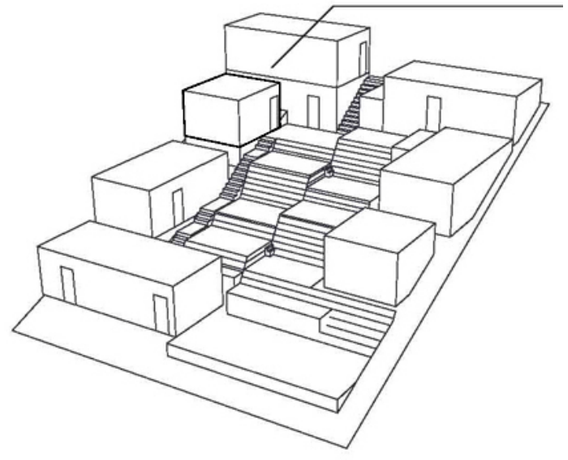

Fig. 8.3.18. Example of central shared courtyard typology on steep slope

4-8 storey intensive mixed use

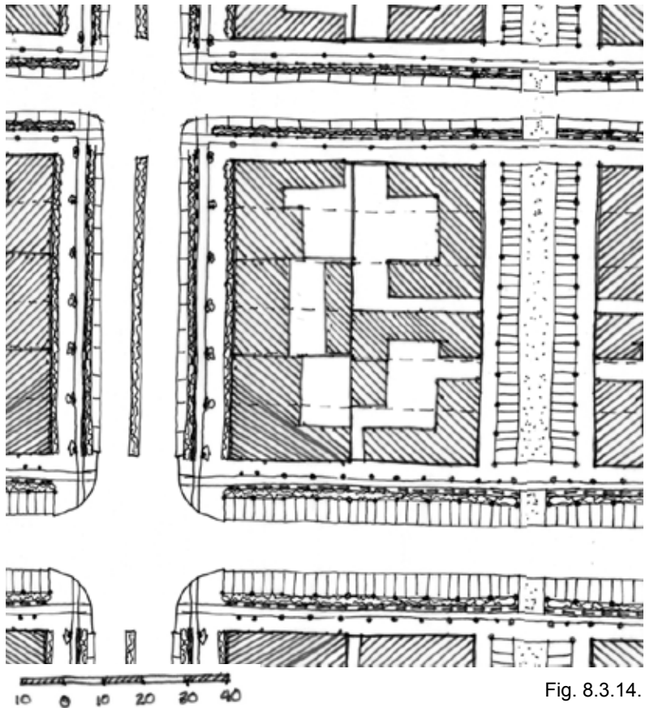

Fig. 8.3.14.

4-8 storey intensive mixed use with service lane

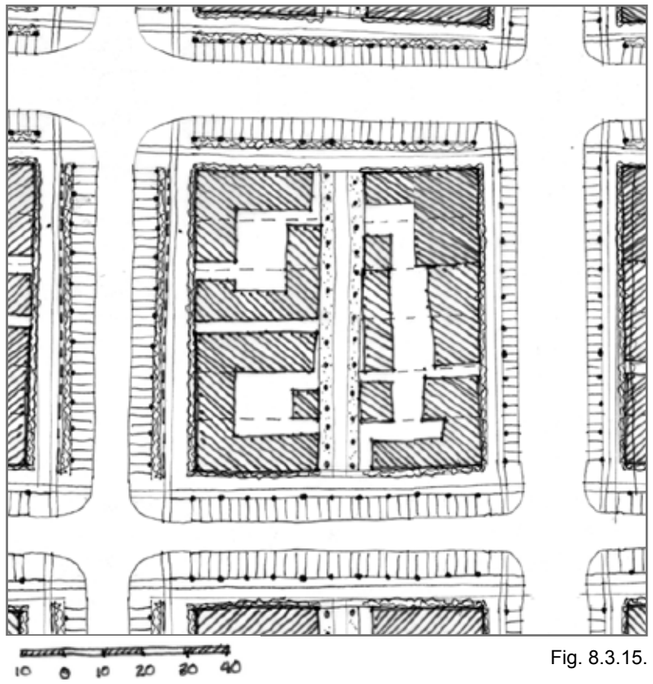

Fig. 8.3.15.

3-4 storey office block

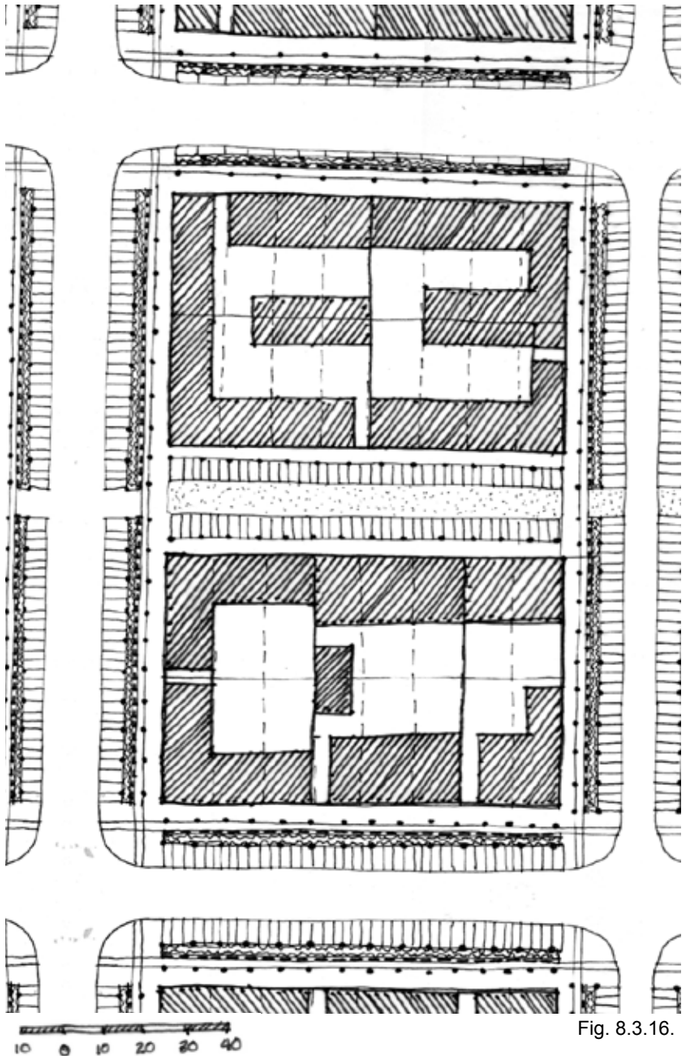

Fig. 8.3.16.

use such as small shops, restaurants and rooftop bars. Some residential should be included in or near these developments to provide a 24 hour presence in the area. Building development should ideally occur over 6-8standard erfs, with shared services. Developments should be managed as one building and units to be sold sectional title or rented.

3-4 storey university block

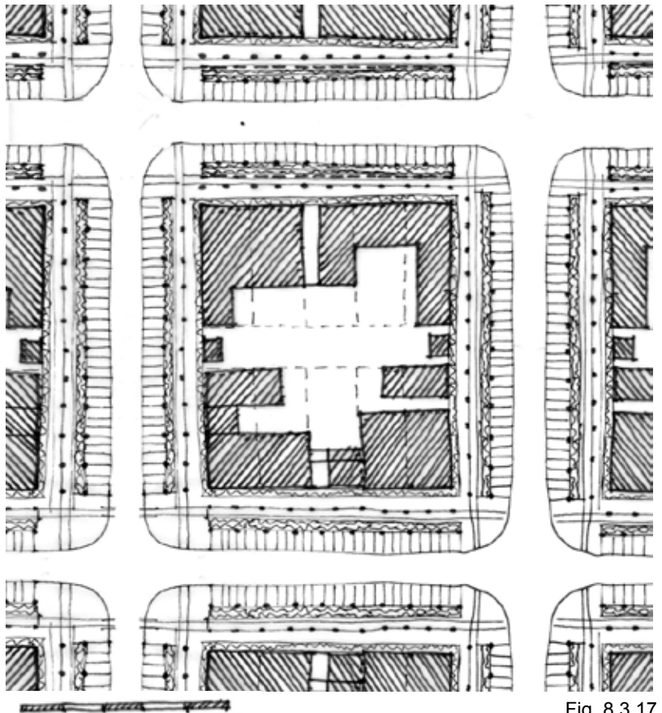

Fig. 8.3.17.

Fig 8.3.17

3-4 storey university block

University blocks are arranged to provide a variety of space and size needs, as well as secured courtyards for academic exchange, with parking on the perimeters of blocks and distinctive building corners to identify the university precinct.

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4. PLACE MAKING

IDENTIFYABLE PRECINCTS

HIERARCHY OF SPACES

LANDMARKS AND FEARUTES

Place making involves a range of considerations to give identity and provide character to spaces. These considerations make use of informants gathered across scales. The human scale and the usability of spaces becomes very important to place making. Various principles that contribute to place making are discussed in this section.

This investigation is mainly concerned with the layering and engraining of elements which would be brought out in detailed design to show their inherent contextual value and subsequent identity

.

Fig. 8.4.1. Example of exemplary place making in the public realm

Fig. 8.4.2.. Plan showing the elements of sustainable development patterns.

Identifiable precincts

The development design proposed many different precincts of identifiable character. Identity of precincts is derived from use, activities, and building typologies.

Identifiable precincts

- Highway large retail edge
- Office parks
- Residential and offices
- Kelvin edge schools and cluster housing
- Town centre
- Residential mix and school
- Cultural and student residential
- High end residential
- University and residences
- High density TOD Preinct
- Highway light industrial

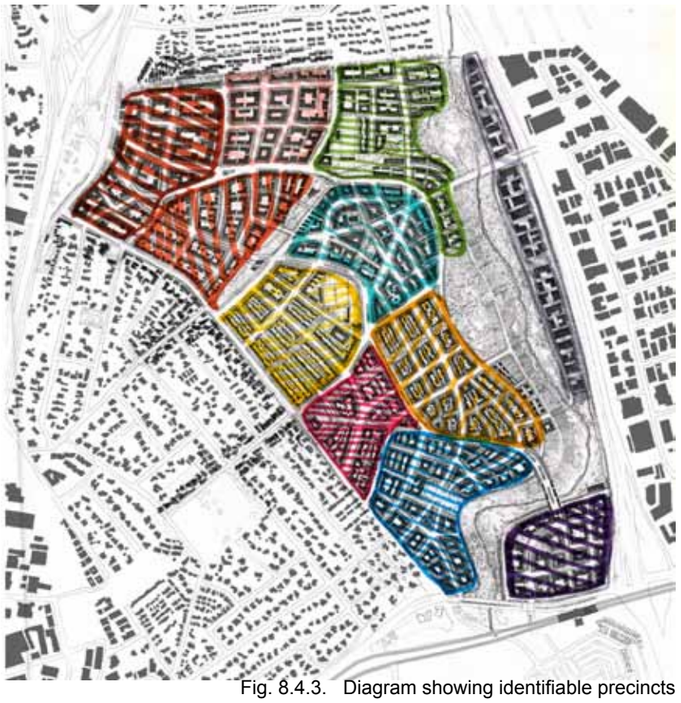

Fig. 8.4.3. Diagram showing identifiable precincts

Hierarchy of spaces

The development considers a variety of public spaces. The most public of spaces is the public squares. These spaces hold the capacity to assemble large groups of people. The buildings around public squares have defined edges and hold a variety of uses to support activities on the site. The second hierarchy of space is the public transport boulevard which is lined with pedestrian scale uses and active edges. The public green space becomes somewhat vaster in scale and is supplemented with an extensively green streetscape and smaller restricted access streets.

Hierarchy of spaces

- 1 Public squares
- 2 Public transport boulevard
- 3 Parks
- 4 Spaces of special character
- 5 Streets

Fig. 8.4.4. Diagram showing hierarchy of spaces

Landmarks and orientation

A system of landmarks and orientation hint at the spatial logic of the design. Landmarks occur in the form of celebrated building edges, elements, tall points and public art.
Site lines provide orientation though a sense of what is happening in the distance.
Long axis become somewhat difficult to achieve with the topography of the site, while strong efforts have been made to keep the definition of the existing ones.

Axis and Landmarks

- Primary visual axis through green network
- primaty axis along streets
- Secondary axis along streets
- Landmark buildings
- Points of visual interest

Fig. 8.4.5. Diagram showing landmarks and orientation

Place-making by building guidelines

Building guidelines are a very important tool for place making. Coherent building forms define the edges of public space and should be coded to better support them. It is strongly advised that strong guidelines should be put in place to further define each of the precincts. Illustrated below are building guidelines which have been adopted into policy.

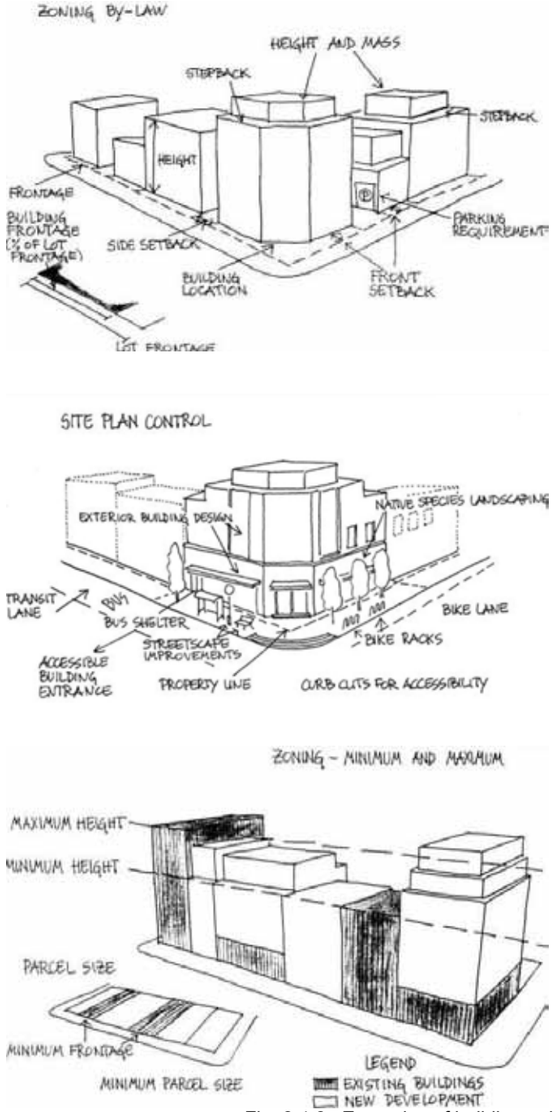

Fig. 8.4.6. Examples of building guidelines

Place-making by high performance streets and green infrastructure elements

Fig. 8.4.7. Examples of an environment which has adopted a variety of green strategies

High performance streets and green infrastructure elements which have been ingrained into the design offers many opportunities to develop an identifiable character in the development in general and specifically in the range of public spaces. Didactics in the design of public space is encouraged to act as an educational tool to learn about how the systems are operating within the space. This also falls in line with the establishment of a green technologies research hub as part of the university development.

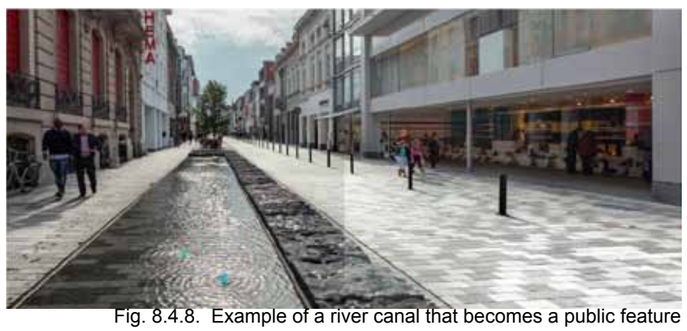

Fig. 8.4.8. Example of a river canal that becomes a public feature

Fig. 8.4.9. Example of urban agriculture in a dense urban environment

Fig. 8.4.10. Example of a biofiltration swale as a public element

The didactic nature of public open space

The mechanisms contributing to the functioning of the integrated network and green infrastructure should be brought out in the detailed place making interventions. Many kinds of examples of this kind of spatial design are illustrated in chapter 9.

Non-African examples of place making

Many of the examples illustrated are non-African in design. The reasoning for this is that, specifically in terms of green infrastructure discourse, not many African examples are well documented or journaled. The essence behind showing these examples is not to gain a specific idea of what the environment should look like, as that is something that should naturally evolve through detail design and the use of local materials rather, the purpose is to illustrate the types of processes that could be designed for in a local context and vernacular.

Place making by landmark buildings

.

Landmark buildings can inform orientation through various devices, including height, facade treatmennt, shape, fucntion and use. a guide of appropriate landmarking features for buildings should be developed in the framework going forward.

Fig. 8.4.11. Example of a landmark building

Place making by public art

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Public art can give resonance to a variety of histories, uses and thoughts about the environment. The examples illustrated herespeak specifically to the loss of biodiversity in the urban context and at as a showcase for surrounding animal species and environments

Fig. 8.4.12. Public art in place making

Fig. 8.4.13. Graffiti as public art to illustrate didactic processes or local species

Place-making by temporary means

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Temporarily made places have a specifically ephemeral quality about them and are often wildly successful spaces to build community. this type of intervntion is ideal for the site considering it will be phased out over a long period of time and emergent economies could thrive in the absence of future planned structured development.

Fig. 8.4.14. Example of intermediate use by means of mobile vegetable garden

Fig. 8.4.15. Example of intermediate site connections

5. PHASING OVER TIME

COMPLETE PORTIONS OF INFRASTRUCTURE AND URBANITY

INTERMEDIATE USE

PRIMING THE SITE

Complete portions of infrastructure and urbanity

The implementation of the phasing is planned to be delivered as complete functioning portions of urban development and infrastructure. Phasing development to adhere to half of the development being constructed at a later point, often ends in additional costs and repairs, especially to urban environments during building construction. The feasibility of developments where all of the infrastructure is developed before the buildings run into the same trouble with maintenance costs and the time leads of development often incurs additional running costs on already completed infrastructure.

With the exception of the green infrastructure primer and the important distribution routes that would allow these portions of urbanity to function, no incoherent bits of infrastructure or building should be developed.

Fig. 8.5.1 Plan showing the first phases of development

Fig. 8.5.2 Example of an urban wheat field

Urban fields are ideal for spaces that can not yet be developed. as an intermediate use it provides a local food source and teaches about the natural processes of growth and harvest.

Fig. 8.5.3 Example of an urban wheat field to become a public square

Fig. 8.5.4 Example of a mobile vegetable garden.

Gardens are a great temporary use for the site as there would be a network of water supply running through the site. pardens will support the local economy and reduce food miles.

Intermediate Natures

For the detailed phasing strategy, please see the next chapter. The guidelines for phasing here focuses on layering the site with green infrastructures that will encourage temporary and intermediate uses and the ecosystem services that draw people to the site.

Fig. 8.5.5 Example of a pedestrian avenue lined with trees

Tree avenues are one of the first proposed interventions on the site, as they take a long time to mature and grow into appropriate street trees. Tree avenues placed along an empty site would also create an interesting visual experience for users.

Fig. 8.5.6 Example of an intermediate route across the landscape

Intermediate landscapes offer great opportunities for people to engage with the environment in a unique way.

Fig. 8.5.7 Example of an informal library in the woods

Informal places for meeting and gathering offer immense opportunities for community building and site development from community initiatives. it also facilitates the growth of a creative capital to get involved in projects and to further the local economy.

Fig. 8.5.8 Example of a vegetable garden adding charactet to a disused site

The Urban Master Plan

CHAPTER 9

Phasing and Impementation

IMPLEMENTATION PHASING

Using Green Infrastructure As A Primer

Minimum Intervention

HUBS, LINKS AND NODES

The Value Of Green Infrastructure

This chapter illustrates how development could be phased in terms of developing green infrastructure and proposes the minimum intervention that could add the most value to the site.

PHASE I

Phase I of priming the site involves upgrading the site edges, creating access across the site to existing neighbourhoods, collecting water from the surrounding areas, filtration of river water entering the site and opening the boundaries.
In order to establish a green infrastructure network, based on water provision to the site, the water first needs to be collected. Water is collected from hard impenetrable surfaces in the surrounding existing neighbourhoods, instead of being removed by conventional storm water channels. Water is stored in underground water reservoirs acting as sponge parks. This intervention also allows for the upgrading of existing neighbourhood parks and supports storm water alleviation. Water collection sites can be found at the intersection of the site and Pretoria Main Road to the north; where the site meets Marlboro drive in the south, in the region of the Gautrain station; and in parks within the Kelvin neighbourhood.
Opening movement networks through the site allows for alleviation of traffic for the surrounding development and starts to introduce the site to its surrounding users. The first movement routes to be opened up should be the east-west link connecting Kelvin and Linbro Park, and the west-north link connecting Kelvin to Buccleuch. These routes should be established along complete streets principles, allowing for pedestrian and vehicular movement and establishing the strong green street network discussed in the development guidelines. Upgrading the site edges should follow the same principles. Upgrading the street edges starts to raise excitement about the area.
Water filtration of the river entering the site is an important first step in increasing the ecosystem services of the site. The filtration of water in the river is done through a series of filtration swales, from capturing large debris to deep filtration through reed beds to increase water quality. By opening the site to the surrounding communities and the greater public, people have the ability to start to engrain the site with greater cultural and recreational informants. Clean water provides a basic resource to support local communities through feeding livestock and reintroducing fish to water bodies where possible.

forestry

recreational river areas

plan showing extent of phase i

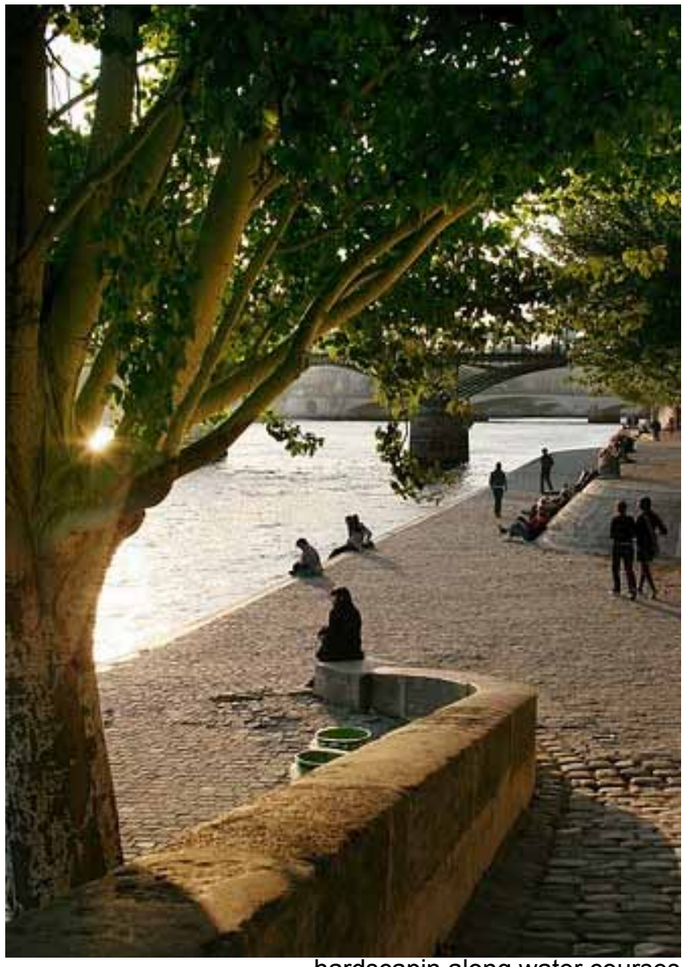
water filtration

deep filtration

PHASE II

Phase II sees the development of the public transport boulevard, establishing an on-site nursery, introducing food provision through the implementation of terraced fisheries, formalising park areas towards the Marlboro TOD node, and in the proximity of the neighbourhood of Kelvin and hardscaping on-site water storage sites.
Introducing the boulevard increases site mobility and allows movement through the site from the Gautrain station towards the existing Woodmead node. Establishing parks invites a wider spectrum of users to become familiar with the area and support the local economies. Hard spaces are made available through developing on site water storage reservoirs. These hard spaces could be used in the intermediate term to introduce markets and gatherings. The establishment of a nursery is necessary to start to locally provide plants and trees to grow the environment and move towards increased biodiversity. Introducing fishery to the environment provides a food resource and, as a by-product, provides fertiliser to feed plants. At this point, some of the water channels need to be developed to transport water to these areas and to the forestry sections.

plan showing extent of phase ii



hardscapin along water courses

public squares for gathering and informal markets

tree nursery to continue to grow the site

PHASE III

Phase III sees the catalytic development of land parcels responding to the pressures from the surrounding areas and raised site activity. Along with the catalytic development, strategic road networks need to be developed to start to connect the land parcels. With time, further landscape upgrading of the ecological corridor along the Jukskei river needs to develop to diversify the green corridor.
Allotment gardens become available to community members to grow vegetables and sell them at market gardens, supporting local economies. Recreational, cultural and retail interest start to draw surrounding communities to the site. The development of the Marlboro TOD anchors the site and starts to become a new destination, drawing people from regional contexts.

plan showing extent of phase iii

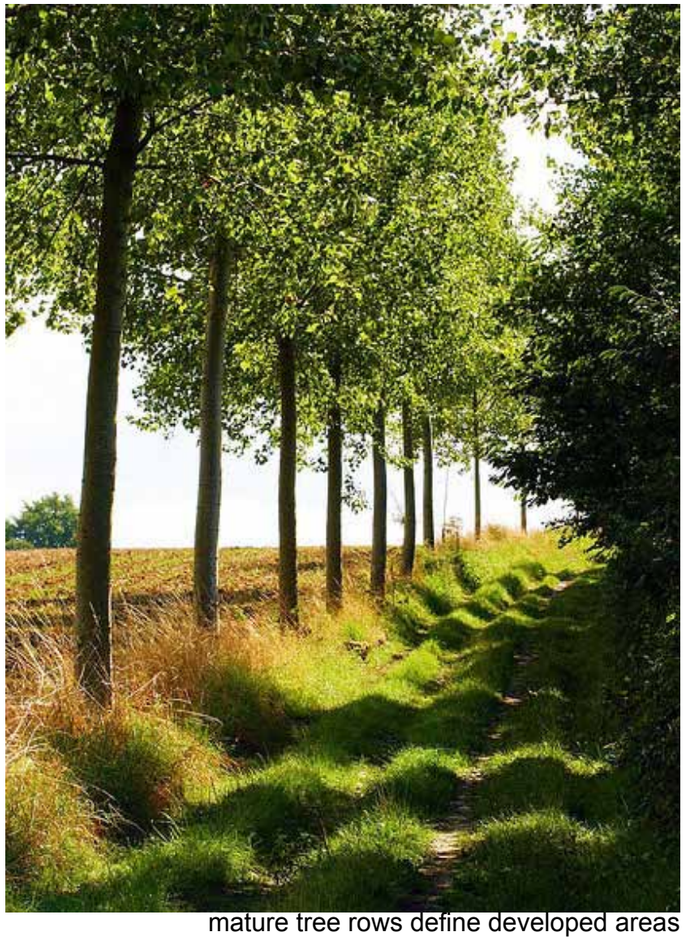
As development grows, the water supply and street network grow out ahead of it. Green streets and future streetscapes are defined by street trees and planted avenues. Development edges are defined by the spatial form of forest edges. Public spaces start to be defined by building development.


filtration becomesincorporated into public spaces

DEVELOPMENT PARCELS

1. Transport oriented mixed use development inresponse to Marlboro Gautrain station
2. Formalising Post Graduate Research Facilites for University with special interest in Integrated Sustainable Development
3. Educational facility linked to sports fields and cultural centre (theatre/events space)
4. School, residential and recreational are to support Buccleuch neighbourhood
5. Retail and office delelopment along N1 Woodmead retail corridor


green infrastructures become didactic in place making


mature tree rows define developed areas

PHASE IV

As development clusters reach completion, the development parcels between Marlboro Road, North Way, Pretoria Main Road and the boulevard fill out and start to intensify building form on the Kelvin edge of North Way. More industrial development starts to occur on the N3 Eastern Bypass and the establishment of the university precinct becomes more populated and supported by the Gautrain.
The green infrastructure network, at this point, is completed and growing into a mature ecosystem and becomes evident in the public spaces. A cascading river wetland park is constructed on the disturbed slopes of the eastern bank of the Jukskei river. The wetland park picks up the water overflow from the N3 Eastern Bypass and restores it to the natural system.

plan showing extent of phase iv

DEVELOPMENT PARCELS

1. Completed TOD Precinct
2. Light industrial edge along N3 Eastern Bypass
3. Further development of commercial and office park along N1
4. University expansion to include administrative and residential functions
5. Development of residential neighbourhoods next to Kelvin


green infrastructure becomes part of the identity of the space


streetscapes mature


completed development parcels thrive

PHASE V

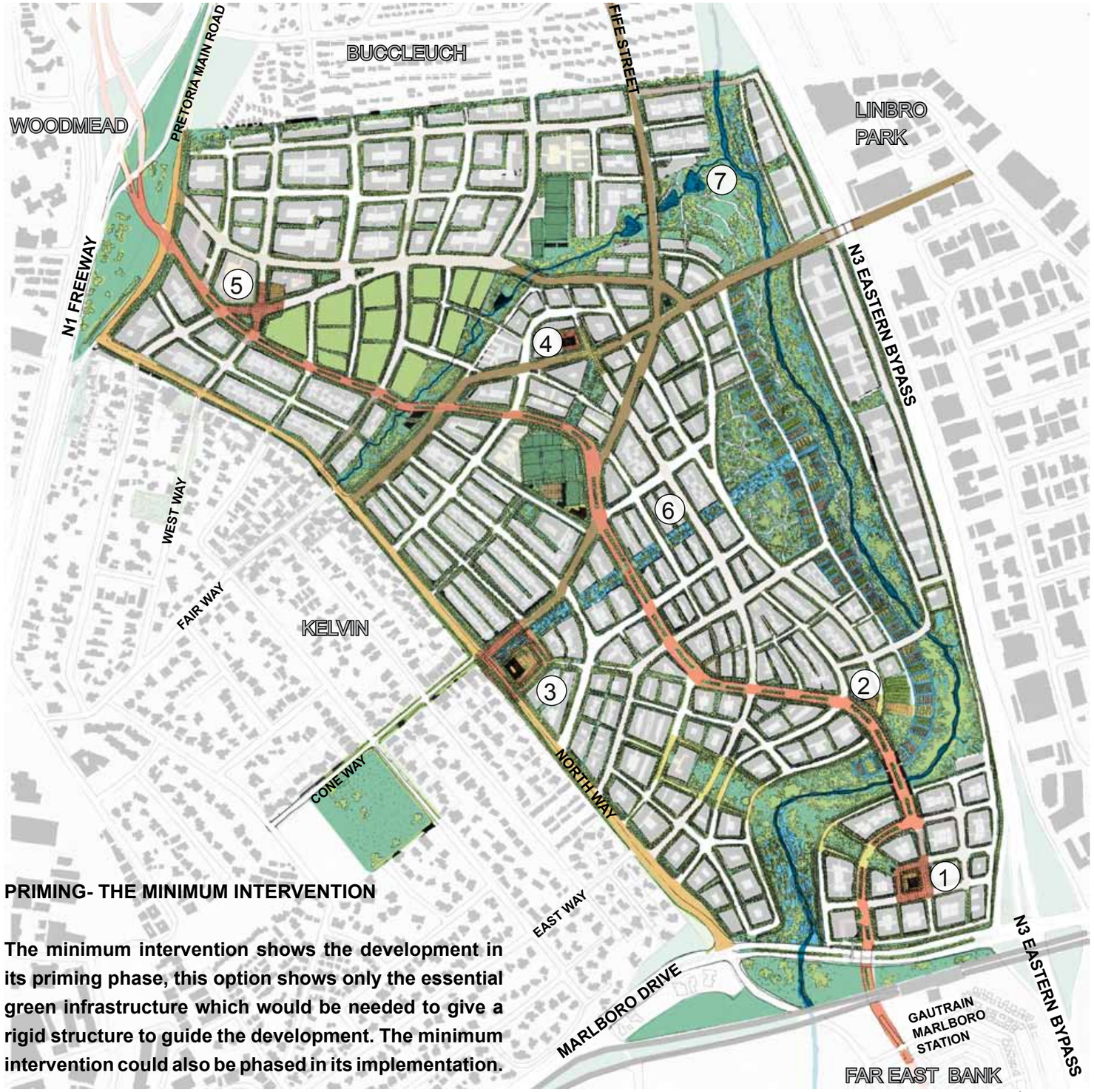
Phase III sees the catalytic development of land parcels responding to the pressures from the surrounding areas and raised site activity. Along with the catalytic development, strategic road networks need to be developed to start to connect the land parcels. With time, further landscape upgrading of the ecological corridor along the Jukskei river needs to develop to diversify the green corridor.
Allotment gardens become available to community members to grow vegetables and sell them at market gardens, supporting local economies. Recreational, cultural and retail interest start to draw surrounding communities to the site. The development of the Marlboro TOD anchors the site and starts to become a new destination, drawing people from regional contexts.

Self-sustained precincts are fully operational and there is a highly evolved network of mobility through the site. Development plots can essentially plug into a fully serviced and mature environment. There exists a range of employment opportunities and a variety of residential choice

DEVELOPMENT PARCELS

1. Commercial office park along Buccleuch edge
2. Light indistrial and research edge along N3 Eastern Bypass
3. Mixed use development with residential component to support University and Cultural Precinct

plan showing extent of phase v



PRIMING- THE MINIMUM INTERVENTION

The minimum intervention shows the development in its priming phase, this option shows only the essential green infrastructure which would be needed to give a rigid structure to guide the development. The minimum intervention could also be phased in its implementation.

amplified geographies

HUBS

parks as green infrastructure

- Water collection sites
- Water filtration along the Jukskei river
- Sports parks
- Recreational parks along river edge
- Nurseries and Forestation

connected networks of spaces

LINKS

streets as green infrastructure

- Public transport boulevard
- Street network
- Internal and pedestrian streets
- River corridors
- Tree avenues

special sites

NODES

squares as green infrastructure

1. TOD Square
2. Market Square
3. Cultural Square
4. Town Centre Square
5. Corporate Square
6. Aquaponics terraces
7. River Confluence

N

0 100m

1

0

HUBS - Parks as green infrastructure

Parks, in this intervention, become a vital part of the urban green infrastructure system. They capture storm water and allow infiltration and aquifer recharge within the local water catchment. The proposed parks filter and clean water collected from the Jukskei river at the southern edge of the site, where it enters the proposed development area; as well as water collected from the capture of storm water in surrounding areas along freeways and residential developments.

Hubs range from large scale interventions with more natural features, such as the river confluence and the parks around the river and its tributary; to more designed urban active recreational parks and sports grounds distributed throughout the site. There are also site-specific parks such as the aquaponics park, the market gardens and the TOD park and visual corridor across the river, linking the university with the regional transit network.

Agricultural gardens form part of Hubs. They are presented in the proposed development through community market gardens, allotment gardens and small scale urban agriculture. Nurseries and forestry are included in hubs as the build intermediate natures by providing increased biodiversity opportunities through establishing pioneer species for successional ecologies, improving soil condition and keeping water on site.

These urban parks provide a source of resilience to the environment by bringing ecosystem services closer to the people that can make use of them. The performance of Hubs has been further explained in three functions, namely filtration, absorption and expenditure.

FILTER

Filtration swales work by means of moving water through a series of gravity operated planted swales which slow down the movement of water while the vegetation traps organic and mineral particles. The swales make use of the existing slope of the site except in the case of the eastern edge of the river where the requirements for prepared sites allow for the design of a combined treatment landscape.

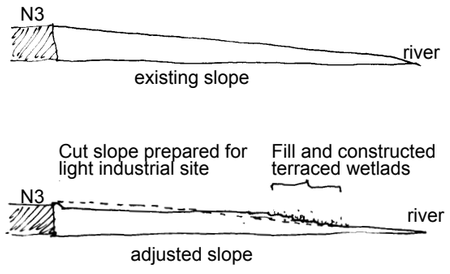


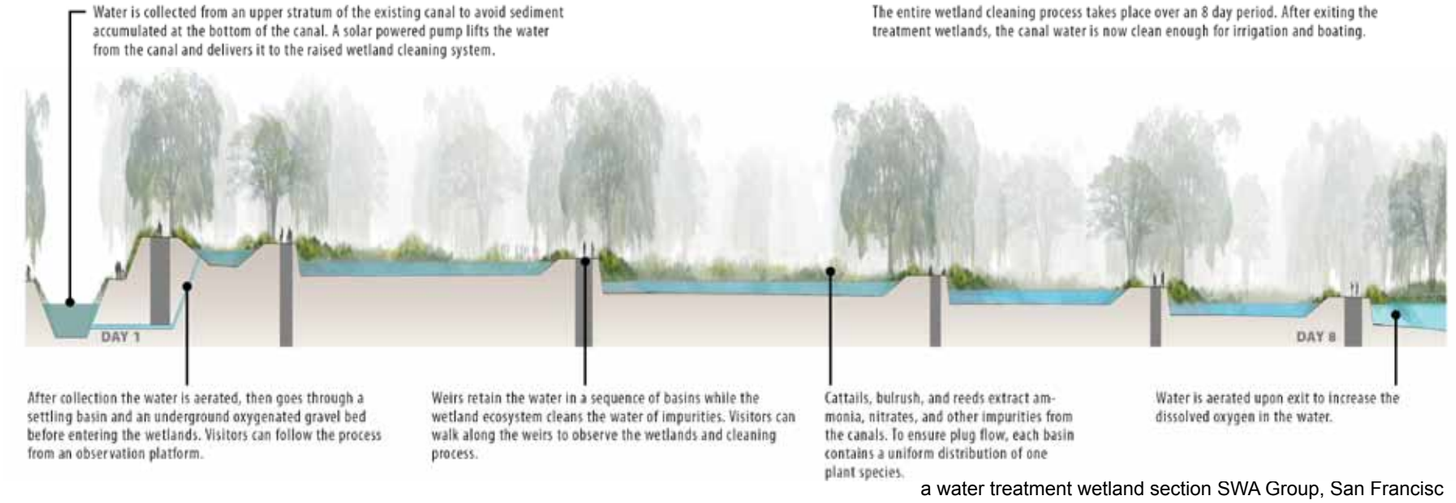
Diagram of terraced wetland

amplified geographies

HUBS

parks as green infrastructure

- Water collection sites
- Water filtration along the Jukskei river
- Sports parks
- Recreational parks along river edge
- Nurseries and Forestation



a water treatment wetland section SWA Group, San Francisc

Filtration

The most notable elements of filtration occur on the site through the capturing and filtering of river water of the Jukskei entering the site from the south, and the terraced filtration wetland on the eastern bank of the Jukskei river, aimed at treating water run off from the adjacent industrial development and freeway. Secondary filtration swales are to be implemented along the N1 Freeway, and a system of filtration and capture and further filtration down hill on the park in the vicinity of Kelvin.

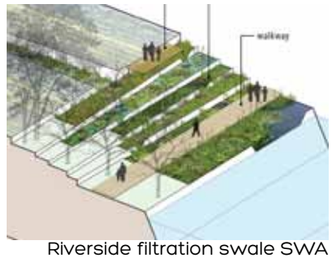
The examples of filtration below show proposed ways of dealing with the two instances of the terraced filtration swale and the and the deep filtration system of the Jukskei rivers entrance to the site, and how these interventions might start to shape the environment.

The terraced water treatment wetland makes use of terraced planted wetlands to remove particles and micro elements from the water by means of phyto-remediation. The environment it provides is a rather tranquil one with a range of views of the surrounding areas with walkways and resting spots to take in nature.

The example of deep filtration makes use of a series of weirs to capture and larger debris and a series of ponds which settle sediment and make use of displacement to move water from one to the next. The water moves through a gradient of cleaning mechanisms, from large scale debris to particles and smaller micro-elements.

The resultant environment is one of a meandering passive landscape interdispersed with activity.


constructed wetland
Photo by Uncle Kick-Kick on Flickr



Riverside filtration swale SWA


Liupanshui Minghu Wetland Park, Turenscape

ABSORB

Groundwater recharge has to do with returning water to the immediate system in a similar manner as what rain would usually do in a natural environment that has no impervious surfaces. Water recharge is accommodated at many scales in the proposed development, from site and block to the larger open space network. Recharge and storm water management has always largely been a function of the open space network. In larger areas, it relies on detention and retention ponds and reed beds and wetland filtration.


example of a detention pond


bioswale edging development. Sustainable Urban Drainage Systems can benefit wildlife whilst reducing flood risk: Sustainable Urban Drainage Systems HubPages


Stewart Middle School, Sidwell Friends School, constructed wetland © Albert Vecerka/Esto

EXPEND

The filtered water can be used in many different ways to grow the development. It could be enhanced with natural fertilisers to grow crops and sustain the on site nursery; to irrigate tree avenues and forests.

The presence of water in the development also brings an interesting design challenge and adds to the diversity of place making opportunities and temporary interventions.

terraced agriculture
Modern terraced vegetable garden. Echo Logical

forestry as a building resource

using water in place making
Photo by Bananocrate on Flickr

LINKS - Streets as green infrastructure

The green infrastructure and the proposed intervention calls for green streets and corridors. Water management is dealt with on-street by means of bio-swales for capture and filtration and gravity fed irrigation channels to supply water back into the system. Streets make use of a variety of strategies to absorb water for aquifer recharge and also feed water towards storage sites.

Beyond managing surface water, streets are also able to deal with water expenditure from building sites. Streets are also green corridors for ecological movement between hubs and links, as well as facilitating the movement of people. River corridors and tree avenues also function as ecological carriers.

These strategies provide opportunities for humanising streets and reclaiming them as part of the public realm, creating environments that sustain lively communities and networks. Green alleys and pedestrian lanes add an additional layer of green network to the

connected networks of spaces

LINKS

streets as green infrastructure

- Public transport boulevard
- Street network
- Internal and pedestrian streets
- River corridors
- Tree avenues

proposed development, as well as creating more permeable surfaces and smaller spaces for people to gather outside and build community.
Different vegetative sequences are adapted to different scales of corridors to identify the magnitudes of links and add to the identifiable character of the site.

HIGH PERFORMANCE STREETS

The high performance street is one of the mechanisms that has received more attention over the last few years. There exists some quite in-depth research into high performance streets and their individual components as shown in the descriptive street section adjacent.

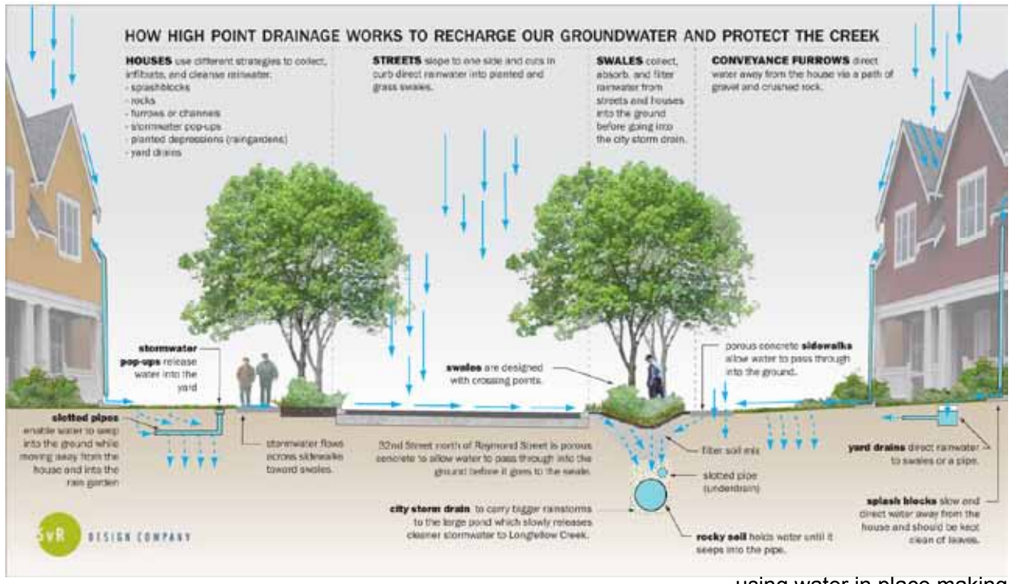
Bio swales have resulted in many interesting design interventions in recent times. This image shows a bio swale and an agricultural drain in the form pf a gabion channel to capture water run-off from the street.

Permeable green alleys and lanes have the possibility for many interesting design interventions as per the example adjacent.

This image illustrates the impact of green corridors on the urban environment, in this case, along Pretoria Main Road at the north-western edge of the proposed development.

TERRACED AQUACULTURE PONDS

The cascading aquaculture ponds is one of the main features of the proposed development. It runs down to the river in an easterly direction from the intersection of North Way and Cone Way, one of the highest points on site. It provides nutrient rich water for the plants, a hydrological corridor, and a source of food. It is also one of the primary interventions to establish site specific character in the environment establishing an identity for the development.



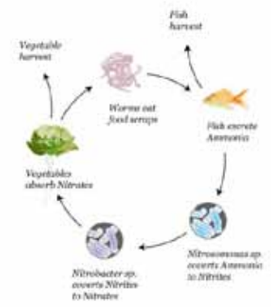
using water in place making


Bioswale/ Hunter's Point South Waterfront Park : Inhabitat


Green alley: Department of Architectire, Sala Phuket


Significance of Green corridors for streetscapes: Author

CASCADE PONDS



the aquaponics cycle


fish ponds arranged down the hill.
Zeytouneh Square | Beirut Lebanon | Gustafson e


permaculture duckponics: freestylefarm.ca


using water in place making.
Hangzhou New CBD Waterfront Park

WATER CHANNELS

Irrigation channels supply water to the development. This becomes the vehicle for the supply of grey water to the development. During incremental phasing the supplied water is used to grow the environment to ensure a mature environment once development occurs. the water cycles through the cascading aquaponics and duckponics to enrich it with nurtients to support plant growth. Water channels offer the opportunity to bring out the nature of the site onto the streetscape.

Example of a temporary channel to capture water in storm events: Waterplein Benthemplein, by De Urbanisten, in Rotterdam, Netherlands

Example of a water channel through an urban environment. Westminster Presbyterian Church: landezine

TREE AVENUES

Mature landscapes go a long way in adding value to an environment. Tree avenues would, at the start of the intervention, add a very ephemeral quality to the site, following grids that do not yet exist. As they grow and mature they could turn into destinations unto their own.

tree avenue with agriculture
Photo by julsatmidnight on Flickr.

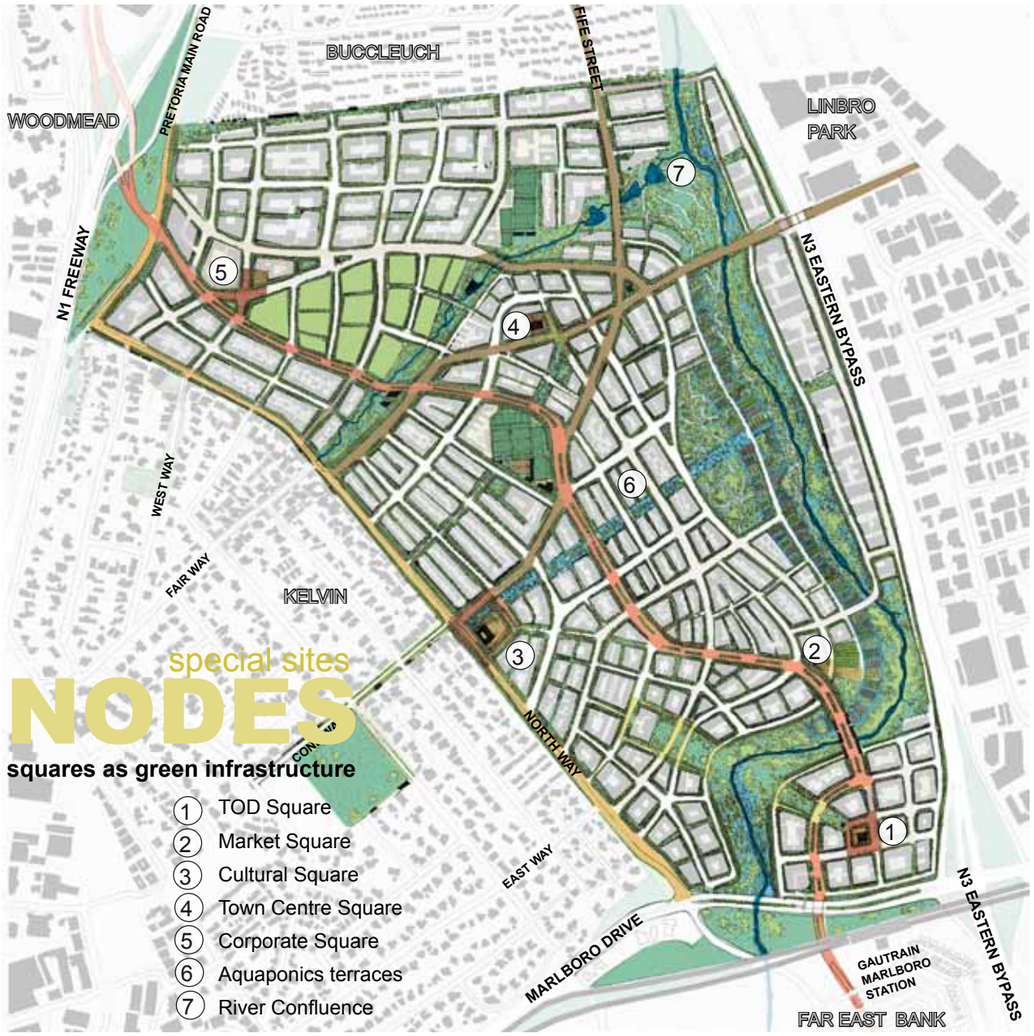
tree avenue leading path
Grounds for Sculpture in Hamilton, NJ

Paris, France. Tree avenues as gathering spaces in the Luxembourg Gardens. Image source Flickr

NODES - Public squares as green infrastructure

NODES are the special public spaces in a development; they are the smaller scale hard and soft landscapes that facilitate higher density development. A less explored facet of potential stormwater management, public squares occupy large surface areas with much potential to store water and make use of didactics to educate about the environment. They have the inherent capacity to reduce impermeable surfaces and capture the storm water runoff in enhanced and enlarged landscapes.
Captured stormwater is proposed to be retained on site through an underground water storage system. This water is then be used for irrigation purposes and transported by means of the gravity fed channels. The play areas can be transformed into rainwater capture areas. Other strategies such as urban fields and food production are also proposed. These are the spaces that show the inherent identity of the site and underlying infrastructure.
High performance streets and green infrastructure elements which have been ingrained into the design offers many opportunities to develop an identifiable character in the development in general and specifically in the range of public spaces. Didactics in the design of public space is encouraged to act as an educational tool to learn about how the systems are operating within the space. This also falls in line with the establishment of a green technologies research hub as part of the university development.

All the large identified public nodes are built on the underlying ecological function of them as underground water storage sites.



SQUARES

1. TOD Square

The TOD square is one of the first squares to be developed and stores water captured in the ecological area surrounding the Gautrain, as well as from the N3 Eastern Bypass. It stores excess water in the event that there is overflow generated by the deep river filtration project. It supplies water to the TOD node, and the gardens that reach across to the university precinct.

As one of the most urgent pressures for development, this space should be occupied intermediately by pop up cafes and events. Space should be designated with the capacity to handle large crowds in conjunction with the adjacent park. It should be designed to accommodate events that include open air shows and fairs.

2. Market Square

The market square is established around the surrounding market gardens, and is also the source of their water supply. Functions of the market garden can be established early on in the development, and can start to draw people to the site and involve the local community. In its development phases, the square itself might become home to intermediate mobile gardens. This square should have the qualities of a market space, with many trees to provide shade and structures to erect stalls or tents. It should also make a design link to the fact that it is situated on the crest and becomes a visually interesting element to passers-by on the N3 Eastern Bypass

3. Cultural Square

The public function of the cultural square is to integrate the community of the existing neighbourhood with the new development. Ecologically it stores water collected in the neighbourhood of kelvin and releases it for use in the aquaponics terraces.

This square is situated next to the highest level of the Aquaponics terraces and should allude to some of the underlying ecological functionality in the design. Special attention should be paid to view corridors as it is one of the highest points of the development

4. Town Center Square

The Town Center square is only up for development much later in the proposal and will be surrounded by forestry for a substantial intermediate period. The idea for this space is that it becomes a hard space in nature, surrounded by the verticality of the forest. It could possibly host intermediate functions such as beer gardens and more intimate scaled events.

5. Corporate Square

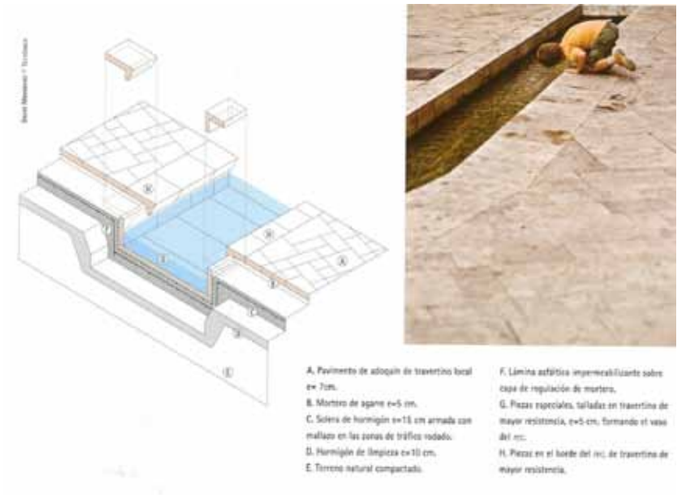
The corporate square holds water gathered from the N1 Freeway and surrounding green areas. It overlooks the tributary and the nursery, which it supplies with water in the intermediate term. The square is located adjacent to the boulevard, which offers an opportunity to stop and look out over the environment.

6. Aquaponics Terraces – discussed under LINKS

7. River Confluence – discussed under HUBS

Examples of an environment which has adopted a variety of green strategies

Public Spaces in Banyoles by Mias Arquitectes



A. Pavimento de adoquín de travertino local e= 7cm.
B. Mortero de agarre e=5 cm.
C. Solera de hormigón e=15 cm armada con mallazo en las zonas de tráfico rodado.
D. Hormigón de limpieza e=10 cm.
E. Terreno natural compactado.
F. Lámina asfáltica impermeabilizante sobre capa de regulación de mortero.
G. Piezas especiales, talladas en travertino de mayor resistencia, e=5 cm, formando el vaso del rec.
H. Piezas en el borde del rec. de travertino de mayor resistencia.

Freeway Park in Seattle combines walls and a concrete water feature. Photo by Charles Birnbaum

The back garden at Het Grachten-huis (The Canal House Museum) in Amsterdam, The Netherlands

Pitt Street Mall
Tony Caro Architecture-

Rain Event waret capture channel
villesetpaysages.fr

Sustainable Public Spaces: greenrealestatesd.com

Pop up coffee shop, Australia. Image source unknown

Waters edge development. Hammarby sjöstad, Stockholm: Flickr

CHAPTER 10

Conclusion

THE QUESTIONS
THE ANSWERS - MASTERPLANNING, PLACE MAKING AND INTEGRATED URBANISM
DESIGN AS A METhOD OF INVESTIGATION

RESEARCH QUESTION

1. What are the principles of a resilient urban environment?

2. How do we derive relevant contextual informants that can assist in structuring resilient development?

3. What is green infrastructure?

4. How can green infrastructure inform the development of urban landscapes towards resilient environments appropriate for foreseeable future living conditions?

5. How can green infrastructure act as a guideline to public space making?

6. What is the value in using green infrastructure as a primer for development?

Future Proofing - Embedding resilience into design

This study set out to test whether green infrastructure can be used as a primer for resilient urban development, in a response to the ecological, social and economic pressures urban environments are currently facing.
Through the theoretical framework and the site design, various strategies were discussed as to how this could be achieved. The overarching idea is that by means of delivering a greater set of ecosystem services to the site through green infrastructure strategies, the environment does become coded for greater resilience. Emerging economies can add to the character and variety of supply in intermittent development phases and benefit from irrigated and prepared plots to aid in local food production. Strategies of encouraging biodiversity along with stormwater strategies and high performance environments will aid in ecological resilience, alongside providing access to and monitoring the use of ecosystem services. Social aspects are addressed through developing guidelines for equitable access and choice within the urban framework.

Landscape as a medium for urban design

A number of strategies that give shape to the urban environment are briefly discussed in the document. The complex interdisciplinary nature of many of these strategies would require a fully integrated team of professionals to put all of these ideas together and make them work in the scale of, say for example, a 40m boulevard as is discussed in the design. Using landscape as a medium has inherent qualities that there is very low maintenance costs involved in the development and if left alone to grow it will add value. The green infrastructure acts as traces in the landscape and many forms of it require very low maintenance.

Future proofing by means of green infrastructure

It is highly possible that an environment resulting from being primed with green infrastructure, would result in a more resilient environment, embedding ecosystem services to provide basic resources to communities. Working within the natural constraints of a site through appropriate terrain analysis ensures a more stable environment and the additional interpretation of resilient principles at smaller scales would develop resilience at many levels.
Green infrastructure for meaningful place making
Embedding green infrastructure elements into the urban environment has the ability to bring to light, through didactic practices, meaningful context sensitive opportunities for space making. The range of mechanisms of green infrastructure showcased in this investigation allude to this quality of place making

Green infrastructure primer as a strategy for Frankenwald

Green infrastructure as a primer for the Frankenwald site holds merit in the possibility to enhance the natural structure but also structure the urban grid for a future environment embedded not only with green infrastructure systems, but also sound resilient urban principles. Although the grid remains flexible in its nature, it codes the site for a specific type of urbanity aligned with projected future growth patterns and already relevant urban pressures. Priming with green infrastructure as a as a strategy for development in this investigation, falls short within currently existing funding mechanisms and a lack of understanding of the inherent value of natural assets and green infrastructure. The entire network of green infrastructure could possibly take much longer to implement and minimum interventions might be reduced to a smaller scale over time. Funding could be gathered through research grants to set up small scale areas on green infrastructure, but should be more widely motivated

as a possible new field of study and research associated with engineering and the built environment, as well as other integrated faculties.

Green infrastructure as a strategy going forward

Green infrastructure as a structuring element for urban development is effective, in that it provides a more sustainable and accessible block typology with many engrained high performance systems. Network theory and the classification of “hubs, links and nodes” for the urban environment holds value as a structuring principle. However, the site specific nature of green infrastructure mechanisms and the required knowledge of ecological functioning, to understand which mechanisms could be imposed, still remains quite a specific field of study.

Greenfield development

Using green infrastructure as a primer for development proves useful, as many of the proposed interventions become engrained in the logic of the plan, and would have a less desired impact if it was to be retrofitted. It would also prove hugely expensive in a retrofitted scenario.

Feedback loops and intermediate natures

Green infrastructure as a primer for resilient development is achievable within certain constraints. As with the nature of resilience, the development over time needs to be continuously monitored to ensure that the design responds to the changing nature of surrounding pressures, both urban and environmental. The use of intermediate strategies creates a higher resilience in the intermediate programme that within the final vision. The role of the vision master plan is to act as a guidance for projected growth over time, and as such is fluid and changing in nature.

Role of the urban designer

It is valuable for the urban designer, as the spatial co-ordinator of the public realm; to understand these principles, as well as to have a basic understanding of all of the informants which would be investigated by a full professional team.
Urban designers, with an engrained knowledge in the the spatial, functional and technological understanding of many of the pieces of the whole, hold a unique position to be able to coordinate the realisation and implementation of such large scale developments, in order to ensure a spatial coherence desired of exemplary place making practices.

Value of the case study for Frankenwals for the University of the Witwatersrand

The multidisciplinary nature of this investigation is touched upon many times throughout this document. It would become an ideal site to study the wider reaching informants for, and effects of green infrastructure on the urban environment. This investigation into green infrastructure could include a full range of disciplined to identify various informants and also to study the mechanisms, scales, interventions and effectiveness of green infrastructure as applied to the urban environment.

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