

CITY OF CAPE TOWN

THE IDENTIFICATION AND PRIORITISATION OF A BIODIVERSITY NETWORK FOR THE CITY OF CAPE TOWN

Final Report



Submitted by

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EXECUTIVE SUMMARY

Introduction

The City of Cape Town's biodiversity¹ is globally unique and its conservation is of international importance. The local variability and uniqueness of vegetation types and species diversity together with processes of urbanisation have resulted in 65% of the remaining natural vegetation in the City being classified as *critically endangered* or *endangered*. No other City in the world harbours as many threatened plant species per unit area.

In 2003, the City of Cape Town committed to implementing a Biodiversity Strategy. This Strategy requires, amongst other, that a Biodiversity Network be established to enable the conservation of Critical Biodiversity Areas. These areas represent the minimum amount of terrestrial and freshwater habitat that is required to meet the City's biodiversity conservation targets. An iterative systematic conservation planning process, which started in 2001, has established biodiversity conservation targets and the identification and prioritisation of the Biodiversity Network.

Over the past six years, the City of Cape Town has engaged international and local partners in implementing the Biodiversity Strategy and Network. These partnership initiatives include *inter alia* the Cape Action Plan for People and the Environment (CAPE), CapeNature, Cape Flats Nature, and more recently, the Local Action for Biodiversity (LAB) Project.

In May 2006, MLA-Sustainability Matters and GISCOE (Pty) Ltd. were appointed to assist the City in a revised desk-top conservation planning analysis to identify and prioritise an updated Biodiversity Network on the basis of:

- A revised vegetation map for the City, compiled in partnership with the South African National Biodiversity Institute (SANBI) and developed by Rebelo and Low, which has aligned the City (Low 2000) and National Vegetation Map (Mucina & Rutherford 2004);
- A revised spatial layer representing the remaining Natural Habitat Remnants (areas of remaining natural habitat) in the City, which was prepared using 2005 aerial imagery in partnership with CapeNature and SANBI.

Purpose and structure of this report

The purpose of this report is to specifically present the results of the revised identification and prioritisation analyses. Detailed descriptions of the concepts of nodes, corridors and the conservation planning methodology processes followed since 2001, are provided as appendices to this report.

The process and participants

The process of the revised desktop biodiversity analyses has focused on the internal stakeholders: City of Cape Town: Environmental Resource Management Department and CapeNature: Cape Metro Business Unit in discussion of revised conservation targets and the results of the identification and prioritisation analyses. However, the principles and criteria underpinning both the revised selection and prioritisation of the network were established with stakeholders in 2003. Key conservation partners, SANBI and CapeNature, have assisted in revising the GIS layer of Natural Habitat Remnants as well as the integration of the national and City vegetation types.

¹ Biodiversity, or biological diversity, refers to "the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and also includes diversity within species, between species, and of ecosystems" National Environmental Management: Biodiversity Act (Act 10 of 2004).

Methodology

The methodology applied in the identification of the City's Biodiversity Network conforms to accepted systematic conservation planning methodology and used C-Plan as well as other GIS (Geographical Information System) software packages designed and adapted for conservation planning.

Identification of the Biodiversity Network

In summary, area-based targets, for representation of vegetation type and species, were set based on the revised City Vegetation Map (habitat type and distribution) and species database (Protea Atlas and SaS species locality data), the revised remnant layer (remaining natural habitat areas or Natural Habitat Remnants - NHRs) and an analysis of areas considered to be conserved within the City (existing protected areas). A GIS-based analysis was undertaken (using agreed key criteria of irreplaceability²; size of NHR; percentage contribution to meeting target; and, vegetation type diversity) to select remnants that would best meet conservation targets for each vegetation type. The extent to which this coarse filter selection, based on vegetation targets, catered for the conservation of the species targets, was then assessed. Additional NHRs were then selected in order to ensure that species targets also were met.

While a previous analysis for the identification and prioritisation of the Biodiversity Network was included, the databases of wetlands and rivers and their ecological assessment were considered not to be comprehensive enough for the purpose. Until such time as an improved basis for decision-making planning exists, all rivers and wetlands are considered as part of the selected Biodiversity Network due to their significant role in both structuring the network, enabling connectivity and providing essential ecological-, engineering-, social- and economic services to the City.

Identification of biodiversity "nodes" and "corridors"

With the understanding that the Biodiversity Network forms the backbone of the City's open space system, the concepts of biodiversity "nodes" and "corridors" were adopted in 2003. "Nodes", the anchors of the Biodiversity Network, were identified using an agreed set of criteria applied to each Biodiversity Network site. "Corridors", were identified using "friction analysis", which is a way of assessing the extent to which current land uses within the City would best support biodiversity pattern and ecological processes thus selecting the optimal pathways or corridors between nodes.

Prioritisation of the Biodiversity Network

The rerun of the prioritisation of the selected Biodiversity Network was undertaken using a decision tree and criteria agreed with stakeholders in 2003. Key decision rules influencing the prioritisation included formal status, irreplaceability and size. This analysis resulted in the assigning of prioritised Biodiversity Network categories A, B and C for each Natural Habitat Remnant selected for the Network. These categories are intended to inform land-use decision-making as well as prioritisation for implementation of the Biodiversity Network.

The *limitations of the study* include the currency of some of the data layers used in the analysis. Specifically, more recent updates of the rivers- and wetlands layer, species data and the remnants layer (based on comprehensive *status quo* assessments for the NHRs) would have improved the accuracy of the analysis, which is based on terrestrial vegetation types. However, with the rate at which internationally significant natural habitats are being converted each day, there are fewer and fewer spatial planning choices remaining to enable the persistence of the remarkable variety of vegetation types and species still present in the City.

The results of the analysis further underscore the need for bold and swift action in securing the Biodiversity Network while continuing to improve data currency.

² Irreplaceability quantifies the contribution of a Natural Habitat Remnant to achieve biodiversity targets. Irreplaceability values range from 0 (site not required to achieve biodiversity targets) to 1 (irreplaceable site, target cannot be achieved without it).

Results of the analyses

Ecosystem status of vegetation types within the City

The new Vegetation Map for the City of Cape Town compiled by Rebelo and Low (2007) includes 43 distinct vegetation types (see Figure 1). Of these 43 types, the distribution of 18 types is entirely limited to within the City's administrative boundary and cannot be conserved elsewhere. Twenty one of the 43 are considered *critically endangered* as there is not enough remaining habitat to meet the City's adopted conservation targets. Of these 21 types, two vegetation types are no longer represented in the City, having been entirely converted into other land uses, and a further six vegetation types have less than 10% area remaining in the City (three of which have less than 3% area remaining).

Of the 22 vegetation types considered not to be *critically endangered*, seven are *endangered*, nine are *vulnerable* and six are considered *least threatened*. More than two-thirds of the vegetation types identified in the City are therefore considered *critically endangered* or *endangered*.

In terms of the National Vegetation Map, of the 18 vegetation types occurring within the City, seven of these vegetation types are *critically endangered*, six are *endangered*, two are *vulnerable* and three are *least threatened*. Six of these vegetation types have distributions entirely limited to within the City's administrative boundary and cannot be conserved elsewhere.

Identification of the Biodiversity Network

Natural Habitat Remnants: On the basis of the 2005 aerial imagery an edited layer has identified Natural Habitat Remnants (NHRs) that are still theoretically available for conserving biodiversity. Together these NHRs make up an area of 45,362.53 ha (Figure 2).

Existing Protected Areas: Protected Areas within the City, for example the Table Mountain National Park, the Blaauwberg Conservation Area, other reserves, conservancies etc, make up a total area of 52,654.57 ha (Figure 2).

Meeting targets for vegetation types and species:

In addition to the habitats conserved within existing protected areas, a further 37,079.71 ha of the identified Natural Remnant Habitats are required to meet the established conservation targets for vegetation types (33,017.37 ha – Figure 3) and species (4,062.34 ha – Figure 4). The Biodiversity Network for the City would therefore require a total of 89,734.28 ha. More than 80% of the area of identified Natural Habitat Remnants is therefore required to meet targets for vegetation types and species.

Identification of Nodes and Corridors

Figure 5 presents the "nodes" and "corridors" identified for the Biodiversity Network. Ten Nodes have been identified Wolfgat/ Macassar Dunes, North West/ Diep River, Blaauwberg, Joostenberg, Tygerberg, Driftsands/ Khayelitsha, Helderberg/ Kogelberg, Zeekoevlei/ Pelican Park, and the Cape Peninsula (including the TMNP).

Prioritisation of the Biodiversity Network

The prioritisation analysis has assigned 96.6% (86,713.10 ha) of the Network as category A, 3% (2,827.81 ha) as category B and 0.2% (193.39 ha) as category C (Figure 6). This emphasises the fact that there are limited choices where conservation targets can still be met within the City. Note that while categories B & C have lower priority, the total amount of land selected in the network (for these two categories) is still required to meet the targets. In category C sites and some category B sites, there may still be limited choices as to where and how the target is met, depending on the irreplaceability of the individual NHRs.

Conclusion

There is a high level of diversity and uniqueness of the biodiversity currently represented in the remaining natural habitats found in the City of Cape Town. This is indicated by the diversity and uniqueness of the vegetation types. This together with the extent of historical habitat transformation

within a rapidly growing urban context means that a high proportion (80%) of the remaining intact Natural Habitat Remnants are required to meet the City's conservation targets. These selected and prioritised Natural Remnants represent the City's last opportunity to conserve an estimated minimum representative area of natural habitat that can enable the conservation of the City's unique biodiversity and its persistence for future generations.

In the context of the competing demands for land in the City, bold action by the City's leadership is required to implement the Biodiversity Network. It is imperative that the City takes convincing and effective strides towards honouring its commitment to the international community under the Biodiversity Convention. Further, the steady growth in tourism and eco-tourism over the past decade has increasingly focused on Cape Town and its environment as a prime tourist destination. This should provide further impetus and incentive to the commitment that the City of Cape Town has already made in conserving its internationally renowned biodiversity.

Recommendations

In order that the Biodiversity Network is secured, a clear programme of action is required. The following are critical initiatives that are recommended for implementation in parallel:

Enabling legal and policy instruments

1. Compilation and submission of a Biodiversity Plan in terms of sections 40 – 50 of the NEM: Biodiversity Act, Act 10 of 2004 in line with the draft Guidelines for Publishing Bioregional Plans and in partnership with SANBI. It is imperative that some form of legal status now becomes attached to the internationally significant biodiversity represented in the Biodiversity Network. Indeed, it may be necessary to investigate further legal options through NEMA that enable a tempering of existing development rights in the context of *critically endangered* and *endangered* habitats.
2. On the basis of the draft submission of the Biodiversity Plan, institute a City protocol through a By-Law in line with the identification of geographic areas requiring EIAs in terms of section 24 of NEMA that would inform specific EIA requirements in relation to the City's fine-scale Biodiversity Plan.

Strategic land use and development frameworks

3. The findings of this study require adequate integration into the Citywide Spatial Development Framework, as well as the eight local District Development Plans that are in the process of being developed. This should also ensure the integration of the Cape Metropolitan Open Space System and the Biodiversity Network at the local level.
4. While biodiversity off-sets will not really be applicable to most of the network sites due to their ecosystem status, alignment is required between the City's draft land use guidelines and draft Biodiversity Off-sets policy and that which has been developed by the Western Cape Provincial Government (2007) in order to provide absolute clarity to decision-makers and land-owners.

Decision-support for land use decision-making:

5. The continued development of a decision-support system for land use decision-making, including the Red-flagging system proposed for the City's internal Land use Information System. This system will enable the implementation of the protocol to be established in Recommendation 2 (above).

Information Management Systems

6. Systematic updating of all data layers (including the rivers and wetlands layer) will be required every three to five years and should focus on integrating the status quo assessment results as well as the SANBI CREW (Custodians of Rare and Endangered Wildflowers) project's database.

7. Ground truthing and *status quo* assessment of all category A sites (including rivers and wetlands), prioritising within this all critically endangered and endangered types will enable the ongoing refinement of the Network.

Planning, implementation and monitoring and evaluation

8. The City requires a plan that enables the implementation of the spatial vision – the Biodiversity Network – on the ground in the medium to long-term. This plan needs to be developed and implemented together with the key CAPE partners. The established prioritisation criteria, together with zoning and ownership information, could be used to inform the plan. Further, the implementation “Toolkit” developed in 2002 provides a range of options for the implementation of the Biodiversity Network.
9. Local communities must be engaged and mobilised in securing and managing identified critical biodiversity areas. Enabling local action for biodiversity will be the single-most important initiative that has the potential to gain the local-level political support for the conservation of the Biodiversity Network. The City’s Local Action for Biodiversity project needs to be focused on driving out this strategy.
10. A Stewardship strategy focusing on the conservation of privately-owned land in the City will need to be developed for the next five years and implemented in partnership with CapeNature.

The most important ingredient of success will be the City’s adoption of a spatial vision that includes the conservation and celebration of its unique and internationally important biodiversity, one that sees future generations enjoying the results of our collective and bold action.

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- Appendix B: City of Cape Town. 2004. Biodiversity Network Prioritisation Project, Final Draft Report prepared by MLA-Sustainability Matters, in association with GISCOE, Biodiversity & Conservation Biology Department UWC, Settlement Planning Services & Freshwater Consulting Group
- Appendix C: Towards achieving biodiversity targets for a global urban biodiversity hotspot: the City of Cape Town's Biodiversity Network, prepared for the City of Cape Town by Gregg Oelofse, 2005.
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Acronyms and abbreviations:

CAPE	Cape Action for People and the Environment
CCT	City of Cape Town
CFR	Cape Floral Region
CREW	Custodians of Rare and Endangered Wildflowers
EPWP	Expanded Public Works Programme
GIS	Geographical Information System
LAB	Local Action for Biodiversity
MOSS	Metropolitan Open Space System
NBSAP	National Biodiversity Strategy and Action Plan
NHR	Natural Habitat Remnants
NSBA	National Spatial Biodiversity Assessment
PSDF	Provincial Spatial Development Framework
SANBI	South African National Biodiversity Institute
TMNP	Table Mountain National Park

1. INTRODUCTION

1.1 Background

In 2003, the City of Cape Town committed to implementing a Biodiversity Strategy. This Strategy requires, amongst other, that a Biodiversity Network be established to enable the conservation of Critical Biodiversity Areas. These areas represent the minimum amount of terrestrial and freshwater habitat that is required to meet the City's biodiversity conservation targets.

An iterative systematic conservation planning process, which started in 2001, has established biodiversity conservation targets and identified and prioritised the Biodiversity Network. Draft land use guidelines were also developed in 2005 to inform the implementation of the prioritised Biodiversity Network.

The Biodiversity Network is the natural spatial framework informing the compilation of the City's Spatial Development Framework and District Spatial Development Plans and forming the backbone to Metropolitan Open Space System (MOSS). Implementation of the Biodiversity Network will ensure the protection of the City's globally unique and threatened biodiversity, the integration of natural areas into the urban environment, the maintenance of natural environmental services, the provision of quality open space for recreation and a healthy living urban environment for the communities of Cape Town. The implementation of the Biodiversity Network is thus essential to protecting and enhancing what is arguably Cape Town's most precious asset – its environment.

Over the past six years, the City of Cape Town has engaged international and local partners in implementing the Biodiversity Strategy and Network. These partnership initiatives include *inter alia* the Cape Action Plan for People and the Environment (CAPE), Cape Flats Nature, and more recently, the Local Action for Biodiversity (LAB) Project.

In May 2006, MLA-Sustainability Matters and GISCOE (Pty) Ltd. Were appointed to assist the City in a revised desk-top conservation planning analysis to identify and prioritise an updated Biodiversity Network. The revised analysis was required specifically to enable alignment with national biodiversity conservation targets identified in the National Spatial Biodiversity Assessment (Driver, *et al*, 2004) and the CapeNature lowlands conservation and stewardship initiatives; and to take account of areas that have been converted from natural habitat to other uses.

The updated, prioritised Biodiversity Network together with revised land use guidelines will form the basis for the submission of a Biodiversity Plan for the City of Cape Town in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004).

1.2 Terms of reference

The terms of reference are as follows:

"Undertake a desktop GIS-based C-Plan analysis, interpretation, presentation and write up for the identification and prioritisation of the Biodiversity Network. This work will include a rerun of previous analyses undertaken for the identification and prioritisation of the Biodiversity Network for the City of Cape Town, according to the agreed methodologies and decision-rules.

The analyses will use:

- the updated vegetation map for the City of Cape Town the updated etc. Low (2000) vegetation map as a surrogate layer for terrestrial habitats represented in the City; and,
- the revised remnant layer prepared by SANBI, the City of Cape Town and CapeNature.

Undertake a comparative analysis of the results with the National Spatial Biodiversity Assessment will be undertaken in order to assess the effectiveness of the identified and prioritised Biodiversity Network in meeting national targets for biodiversity conservation."

The following tasks were undertaken:

- i) Meeting with the client to discuss approach;
- ii) Data review and preparation (review updated remnant layer and consolidated new veg map & including Cape Peninsula);
- iii) Target setting (including a workshop with client and key partners);
- iv) Selection of a network of sites that meets the identified biodiversity conservation targets for the terrestrial habitat types represented in the City and review with client;
- v) Comparative analysis of selected network with Protea Atlas data set, Low's "Site and Species" (SaS) plant species database;
- vi) Prioritisation of the network on the basis of the "decision rules" set out in the draft prioritisation report (March 2005) and review with client;
- vii) Preparation of analysis outputs for presentation of the final analyses;
- viii) A meeting /workshop with relevant staff of the City of Cape Town's Environmental Resources Management Department to present the final draft outputs;
- ix) Incorporating comment on the final draft outputs; and,
- x) Finalising the products on the basis of this feedback (reports, maps and GIS databases)."

1.3 Overall approach and methodology of the study

The Terms of Reference have required a desk-top analysis, applying accepted Systematic Conservation Planning methodologies and Geographical Information System - based tools. A detailed methods description is presented in section 3 and appendix A.

The process of the revised desk-top biodiversity analyses has focused on the internal stakeholders: City of Cape Town: Environmental Resource Management Department and CapeNature: Cape Metro Business Unit in discussion of revised conservation targets and the results of the identification and prioritisation analyses. However, the principles and criteria underpinning both the revised selection and prioritisation of the network were established with stakeholders in 2003. Key conservation partners, South African National Biodiversity Institute (SANBI) and CapeNature, have assisted in revising the GIS layer of Natural Habitat Remnants as well as the integration of the national and City vegetation types.

1.4 Limitations of the study

The *limitations of the study* include the currency of some of the data layers used in the analysis. Specifically, more recent updates of the rivers- and wetlands layer, species data and the remnants layer (based on comprehensive *status quo* assessments for the Natural Habitat Remnants) would have improved the accuracy of the analysis. However, with the rate at which internationally significant natural habitats are being converted each day, there are fewer and fewer spatial planning choices remaining to enable the persistence of the remarkable variety of vegetation types and species still present in the City.

The results of the revised analysis further underscore the need for bold and swift action in securing the Biodiversity Network while continuing to improve data currency.

1.5 Purpose and structure of this document

The purpose of this report is to specifically present the results of the revised identification and prioritisation analyses. Detailed descriptions of the concepts of nodes, corridors and the conservation planning methodology processes followed since 2001, are provided as appendices to this report.

2. DEFINING THE BIODIVERSITY NETWORK

2.1 Introduction

The following section provides a background to the concepts and approaches applied during the course of this study.

2.2 Defining biodiversity

Biodiversity, or biological diversity, refers to “the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and also includes diversity within species, between species, and of ecosystems”.³

2.2.1 Biodiversity pattern⁴

Biodiversity pattern can simply be described as the “structure and composition of ecosystems”. Pattern encompasses biodiversity *structure* and *composition*, referring to genetic variability, and the number and distribution in space and time of populations and species, communities, ecosystems and landscapes.

2.2.2 Biodiversity Process⁴

Biodiversity processes are the “ecological processes and functions that sustain biodiversity”. Process, also known as *function*, refers to the interactions and roles of living organisms, populations, species and communities, which allows the biodiversity pattern to persist. There are *spatially fixed* processes (e.g. linked to physical features such as soil or geological interfaces) and *spatially flexible* processes (e.g. where there are several options to link mountains and the coast)⁵.

Conserving processes requires a significantly larger proportion of the landscape than is needed to represent biodiversity pattern⁶. So, the sound management of land use in the vicinity of areas set aside for conserving pattern (e.g. protected areas) is essential (DEADP 2007).

2.2.3 Biodiversity Offsets

According to the Provincial Guideline Document for Biodiversity Offsets (DEADP 2007), the most often used definition for the concept of biodiversity offsets is:

“conservation actions intended to compensate for the residual, unavoidable harm to biodiversity caused by development projects, so as to aspire to ‘no net loss of biodiversity’. Before developers contemplate offsets, they should have first sought to avoid and minimise harm to biodiversity”⁷.

The guideline document itself defines offsets as:

“Measures to compensate for residual negative impacts, once all other mitigation measures to avoid, minimize and repair/restore impacts have been considered (i.e. offsets are seen as a ‘last resort’ form of mitigation.”

DEADP (2007) qualifies a twofold rationale for biodiversity offsets in the Western Cape. These are the globally unique biodiversity and the importance of the ecosystems in socioeconomic development and service delivery (e.g. reliable supply of clean water, ecotourism and coastal protection).

The Provincial Guideline document (DEADP 2007) further states:

“that the objective of biodiversity offsets (through development authorization and associated EIA process) is to ensure that residual impacts on biodiversity and ecosystem services that are of

³ Definition from the National Environmental Management: Biodiversity Act (Act 10 of 2004).

⁴ Definitions from Brownlie (2005) and the Provincial Guideline on Biodiversity Offsets (DEADP 2007).

⁵ Rouget et al (2003) – in DEADP (2007).

⁶ Pressey et al (2003) – in DEADP (2007).

⁷ ten Kate et al 2004 – in DEADP (2007).

moderate to high significance (i.e. do not represent a 'fatal flaw' from a biodiversity perspective) are compensated by developers in such a way that ecological integrity is maintained and development is sustainable".

The Provincial Guideline document (DEADP 2007) defines and describes offsets; offers principles that might underpin biodiversity offsets; and, provides brief reviews of legislation, policies, plans and guidelines that inform and direct biodiversity offsets. The Guideline uses the City of Cape Town's Biodiversity Network as an example of where biodiversity offsets may be applied within municipal areas.

2.2.4 Biodiversity targets

National guidelines being drawn up by SANBI for conservation target setting suggest that local-scale conservation plans should as a minimum set targets on the basis of the proportional area of each national type occurring within the local planning domain and where finer scale vegetation maps are available for local conservation planning, as a minimum the targets set for the finer scale types should be set on the basis of the proportional area of each type within the local planning domain.

2.3 The context and significance of the Biodiversity of the City of Cape Town

The City of Cape Town's biodiversity is globally unique. Both the Cape Peninsula and the Cape Flats are Centres of Endemism (Wood *et al* 1994). The Cape Peninsula alone harbours almost 2,300 plant species including 158 endemic species (Helme & Trinder-Smith 2006) and the Cape Flats has been recognised by numerous authors over the past three decades (e.g. Jarman 1986, McDowell & Low 1990, McDowell *et al* 1991, Wood *et al* 1994, McKenzie & Rebelo 1997, Maze and Rebelo 1999) as requiring special protection for a variety of reasons. The Cape Flats supports 1,466 plant species in 1,874 km², of which 76 are endemic and 208 are Red Data Book species (www.sanbi.org/biodiversity/reddata.htm). The Cape Flats also has the highest number of threatened plant species per unit area of remaining vegetation in the world (Wood *et al* 1994). In total, two thirds of the vegetation types within the City of Cape Town are *endangered* or *critically endangered*.

The Cape Peninsula, the Cape Flats and the Darling/Dassenberg areas have been identified as three distinct centres of diversity and endemism (Daines & Low 1993, Rebelo 1992, Wood *et al* 1994) and the numbers of Red Data Book species of butterflies, amphibians and reptiles are the highest in the southwest of South Africa, centred on the Cape Peninsula and adjacent lowlands (Rebelo 1992, Wood *et al* 1994).

Many species and populations of plants, mammals, birds, invertebrates, amphibians, reptiles and other animals of the City of Cape Town have been shown in various studies to be special, deserving of conservation and in many cases internationally significant (Hall & Veldhuis, 1985; Huntley, 1989; Rebelo, 1992; Richardson *et al.*, 1998). The vegetation types and plant habitats support a diversity of fauna. Forty-one mammal- and 250 bird species remain in Cape Town, although in recent years six species of mammal and at least three species of bird have become locally extinct within the City's boundaries (Oelofse 2007). Of the 18 amphibian- and 48 reptile species found in the City, four amphibians and four reptiles are listed in the Red Data Book, and two reptiles are locally extinct (Oelofse 2007). At least 112 endemic invertebrate species are found on the Cape Peninsula Mountain Chain alone (Picker & Samways 1996).

Table Mountain National Park (TMNP) is one of eight protected areas making up the Cape Floral Region Protected Areas World Heritage Site (CFRPA-WHS). A second protected area within the CFRPA-WHS is the Boland Mountain Complex, of which the Kogelberg is a component. The Cape Flats is the terrestrial corridor linking these two components of the south-western CFRPA-WHS.

2.4 The role of the Biodiversity Network

The Biodiversity Network is seen as the "backbone" of the Metropolitan Open Space System. Its role therefore is multidimensional and its functions include the provision of ecosystem services or "the

direct or indirect benefits to society in general and communities in particular provided by ecosystems.⁸

The National Environmental Management: Protected Areas Act (Act no 57 of 2003) refers to ecosystem services as 'environmental goods and services', and defines them to include:

"benefits obtained from ecosystems such as food, fuel and fibre and genetic resources; benefits from the regulation of ecosystem processes such as climate regulation, disease and flood control and detoxification; and cultural non-material benefits obtained from ecosystems such as benefits of a spiritual, recreational, aesthetic, inspirational, educational, community and symbolic nature".

2.5 The Biodiversity Network – the backbone of an Integrated Open Space System

2.5.1 The CMOSS Concept

The Cape Town Metropolitan Open Space System (CMOSS) Synthesis Project developed a vision and criteria for the identification of open space in the City of Cape Town. After the successful conclusion of a pilot project in the Metro South East, the remainder of the metropolitan area was mapped. As part of this study a Framework for Management Guidelines for CMOSS was developed. The CMOSS Mapping Project used open space typologies or categories that were originally developed for the CMOSS Value Study, a further initiative of the City of Cape Town that undertook research based on resource economics methodologies to establish the value of open space in two pilot areas.⁹

The City is currently in the process of planning for integration of the implementation of the Biodiversity Network within CMOSS. Following a pilot project in the Southern Component of the Biodiversity Network (Le Grange *et al* 2005), Dewar *et al* (2005) defined the Metropolitan Open Space Concept for the City of Cape Town as comprising 7 generic open space types. These are:

- Ecologically determined space - the biodiversity network and declared protected areas;
- Agricultural anchors - described as those areas with intrinsic value (agricultural potential) as well as existing agricultural areas;
- 'Blue Parks': the Vleis and watercourses – with appropriate buffer zones or edges;
- Scenic routes – part of the tourist and recreational experience of Cape Town;
- Beaches and public edges – ensuring public access;
- Multi-purpose urban parks – serving a variety of functions including core conservation, sports facilities, cemeteries and hiking trails; and,
- Socially-determined open space – including recreational facilities, cemeteries, solid waste disposal sites and urban public space.

It is therefore envisaged that the Biodiversity Network will form the "backbone" of the CMOSS, conserving the pattern and process of the City's biodiversity.

2.5.2 Functions of open space in an urban context

It is envisaged that conservation of biodiversity and the maintenance of ecosystem goods and services will be integrated into the planning of open space in a manner that makes them key structuring elements of the urban form, and a resource to City's residents.

Open space performs a variety of functions and embraces a host of direct or indirect benefits within the urban context. These include ecosystem functions. The Millennium Ecosystem

⁸ The Millennium Ecosystem Assessment (2003) quoted in DEADP (2007) classifies the services that ecosystems can provide into four broad categories: provisioning services, regulating services, cultural services, and, supporting services

⁹ The full report is available from the City of Cape Town's Spatial Planning Department.

Assessment (2003 - quoted in DEADP (2007)) classifies the services that ecosystems can provide into four broad categories: provisioning services, regulating services, cultural services, and supporting services.

DEADP (2007) further summarises the function and worth of ecosystem services into "use" and "non-use" values.

Use values include:

- Direct, consumptive uses or outputs such as harvesting (e.g. of medicines and wood), etc.;
- Direct, non-consumptive uses such as tourism and recreation; and,
- Indirect use values such as flood regulation, nutrient retention, etc.

Non-use values include:

An "option value" that is the value placed on keeping future options open for direct or indirect use of biodiversity and ecosystems in future, bearing in mind that some uses may not yet be known (e.g. medicinal or food properties of plants); and,

An "existence value" referring to the intrinsic, aesthetic or cultural values of natural landscapes, ecosystems and biodiversity, irrespective of their use.

2.6 Biodiversity nodes and corridors

It is proposed that the Biodiversity Network for the City of Cape Town should lean towards the "*Greenways*" concept, which is very explicit and structural rather than the North European planning frameworks, which are more inferred and conceptual in nature. The *Greenways* concept embraces planning for a sustainable physical environment that is less altered but also ensures maintenance and even increasing economic activities within urban areas (in contrast to the North European situation which largely sees economic development as being maintained at a status quo). As a consequence spatial components need to be identified that correspond to the *Greenways* planning framework which uses *nodes* and *corridors*. Within this context, a *node* is an area with a "concentration" of biodiversity features or an area of "attraction" of features that enable the maintenance of biodiversity pattern and process, while a *corridor* maintains flows or fluxes between these areas of concentration/attraction.

In applying the *Greenways* concept to the City of Cape Town's Biodiversity Network, we will refine its specific use for the maintenance of the biodiversity within the City, rather than as an overall spatial planning objective. Consequently, the concept of a node and a corridor are qualified as "biodiversity node" and "biodiversity corridor".

2.6.1 Biodiversity "nodes"

Nodes are discrete and circumscribed spatial objects usually identified by cadastral parcels of land or which have a clearly defined "edge" and can be made up of one or a number of Natural Habitat Remnants or wetlands in close proximity presenting a concentration of conservation-related opportunities. By adding the qualifier of "biodiversity" to a node concept we wish to imply that biodiversity nodes are essentially areas to attract and maintain biodiversity. They can be seen as anchors within the Biodiversity Network supplying essential services of biodiversity conservation and a range of conservation related services such as recreation, tourism, environmental education, conservation and youth skills development. Furthermore, these nodes should be well-managed areas that serve as flagships of the City's conservation initiatives. As such these nodes should be profiled and marketed as providing the range of services mentioned above and broadly accessible to the people of Cape Town.

From a conservation planning perspective, these "biodiversity nodes" should have relatively high area to edge ratio, or be of a sufficient size (i.e. ecologically viable) so that they can maintain ecological processes, or be a remnant of a highly threatened and valuable (in terms of ecosystem functioning) habitat of any size (e.g. wetlands and areas of groundwater recharge). They are the key areas that "anchor" the maintenance and flows of biodiversity at a landscape level. These nodes

are analogous to refugia¹⁰. The physical processes associated with urban development generally promote fragmentation of habitat and increase environmental stress - the nodes function to mitigate these effects.

The “biodiversity node” concept strongly parallels concepts developed from the theory of Island Biogeography. For example small islands have fewer species (lower biodiversity) and with increasing area more species may coexist and thereby increase species richness/biodiversity. Similarly, small islands that are close to a mainland may have more species (higher biodiversity) than a same-sized island that is situated further from the mainland. This outcome reflects that an island closer to a source of new species is more easily colonised than an island further away. A cluster of islands in close proximity tends to support more species (higher biodiversity) than islands that are more distantly dispersed. Consequently, clear functional analogies exist between the concepts of Island Biogeography and the spatial planning processes required to define a suitable biodiversity node. This definition of a biodiversity node directly addresses the maintenance of biodiversity at both the site-specific level (alpha-diversity) and in terms of spatial turnover of biodiversity (beta diversity).

Thus, biodiversity nodes can be a discrete, large, contiguous NHR, a collection of discrete adjacent NHRs (that can be smaller), or a collection of discrete NHRs in close proximity to each other (that can be of smaller size). Furthermore, the NHRs that constitute a biodiversity node may have different levels of prioritisation within the network (see section 4 below). An additional qualification to the definition would be a smaller discrete NHR that has exceptional value with respect to biodiversity or maintenance of ecosystem services (e.g. wetland or site important for the recharge of underground aquifers).

In the context of the shortage of capacity and resources for biodiversity management in the City, the development of “biodiversity nodes” that provide a full range of biodiversity conservation and social and economic resources, also makes sense from a pragmatic and institutional management perspective. This means that nodes made up of larger sites or clusters of smaller sites can be managed coherently as one management unit. Further, these “biodiversity nodes” can be seen as focal areas for local stakeholders who can benefit from and be involved in conservation areas close to their homes.

In summary then, the identification of biodiversity nodes are driven by three perspectives:

- Biodiversity conservation function;
- Social and economic functions and opportunities; and
- Management practicalities.

2.6.2 Biodiversity “corridors”

A biodiversity corridor in structural terms is non-discrete (i.e. does not have a specific edge) and has an essential function that reflects linearity and connection so as to ensure that flows/fluxes are maintained within larger spatial processes. Within an urban development context corridors are seen as allowing physical movement such as transportation, or conceptual movement such as flows of economic investment between development nodes. Corridors are most usefully defined using models such as transport networks and are often mathematically generated through processes of optimisation. Consequently a *biodiversity corridor* should provide for movement of species and organisms along and between ecosystems, which is an essential process for the maintenance of biodiversity at the landscape level. Whereas the biodiversity node is essentially a planning unit, the biodiversity corridor is more of a spatial concept informing a management approach. An example is a corridor of private gardens connecting two urban protected areas. While the gardens themselves may have no formal conservation status, their development and management as natural refuges (e.g. appropriate plantings, removal of physical barriers such as boundary walls, exclusion of pesticides) could significantly support the connectivity between the two protected areas.

¹⁰ Areas where species can remain protected from the effects of environmental stress

Consequently the appropriate planning and management of biodiversity corridors will complement the ecological sustainability of biodiversity nodes.

Natural linear ecosystems provide physical corridors which promote and maintain levels of biodiversity and include rivers, coastlines and skylines. Rivers, by their linear nature, are corridors. This would apply even to canalised systems. However, the effectiveness of rivers as corridors varies according to the location of the river, its river type, condition, etc. In the case of the City of Cape Town, mobile sand dunes also represent potential biodiversity corridors. Generally, natural corridors are not as transformed by economic activities as other urban areas and therefore provide ideal conduits for the movement of species and organisms. Consequently, biodiversity corridors should be seen as the natural routes that species/organisms would have used in the past when migrating towards "refugia" during periods of adverse environmental change, or which are used simply as routes of movement (e.g. upstream migration of adult insects to lay eggs in the upper reaches of streams, dispersal of plant propagules or feeding). For many invertebrate species, these corridors may be essential for the completion of a particular life history stage.

In terms of the corridors that have been identified using friction analysis (described in section 3.4 below), the "biodiversity corridors" in the City may be described as:

- Enabling the east-west and north-south linkages of NHRs and nodes;
- Incorporating "stepping stones" – i.e. NHR's or open space in the path of the corridor and may not be continuous routes like river corridors;
- Including corridors of differing scales with a number of narrower corridors contributing to wider conceptual corridors;
- Incorporating a range of land uses compatible with maintaining biodiversity processes, e.g. private gardens; and,
- Promoting a conservation ethic on private land.

In order that biodiversity corridors can perform their intended function, land use management must support the persistence of the biodiversity function performed by these areas. For example, riparian zones of important river corridors should be maintained in as natural state as possible, mowing of verges on an important transport route serving as a corridor should be limited and the use of indigenous plants should be encouraged in private gardens and within road reserves etc.

3. METHODOLOGY

3.1 Introduction

The methodology applied in the identification of the City's Biodiversity Network conforms to accepted systematic conservation planning methodology, using C-Plan as well as other GIS (Geographical Information System) software packages designed and adapted for conservation planning. The following section outlines the essential details of the methods applied in the identification and prioritisation of the City's Biodiversity Network and a complete description of the methodological approach and process is included in Appendix A.

3.2 Identification of the Biodiversity Network

Area-based targets, for representation of vegetation type and species, were set based on the revised City Vegetation Map (habitat type and distribution) (Rebelo and Low 2007) and species databases from Protea Atlas (www.protea.worldonline.co.za) and SaS species locality database (Low, 2002), the revised remnant layer¹¹ (remaining natural habitat areas or Natural Habitat Remnants - NHRs) and an analysis of existing protected areas (areas considered to be conserved within the City). The planning unit layer consisted of 661 remnants, ranging in size from just over 1 ha to 7,055 ha, and covering an area of 98,017.1 ha (39.4% of the City). Of the 661 remnants, 114 were considered to be conserved covering an area of 52,654.57 ha (21.1% of the City).

3.2.1 Setting conservation targets for Vegetation types

Targets were graduated based on the premise that vegetation types would have differential requirements for protection. In other words, targets were not set as uniform for all types. Area targets were calculated as the percentage of the estimated historical area of each vegetation type required within a City conservation network. This has become accepted as a standard approach for target setting in systematic conservation planning.

Using other conservation planning studies as a starting point, and through a process of stakeholder consultation, the following criteria were used to determine target values for vegetation types:

- a. **Historical rarity within the City of each vegetation type (expressed as a percentage of the City area covered by the historical distribution of each type).** This was based on the premise that types with small natural areas need larger targets due to greater risk to unprotected portions from extensive potential disturbances (Pressey *et al.*, 2003).
- b. **Percentage of the national vegetation types, historically occurring in the City.** This criterion emphasises the importance of the City for conserving those types, which are endemic to the area. Considering the high levels of transformation of the City's natural environments, it is important to ensure that as much of the remaining area of those types limited to the City are protected. The amount of upward adjustment of target values is dependent on the degree of endemism associated with each vegetation type.
- c. **The degree of transformation of vegetation types within the City.** This criterion serves to ensure larger target values (particularly in terms of the percentage of extant vegetation) for those vegetation types, which have historically been extensively transformed by development. While a direct correlation between historic loss and future loss is not clear for all vegetation types, the extent of historic loss does give an indication of the threat status of each type.

Firstly, to determine starting/base target values, three rarity classes were identified using the historical extent of each vegetation community (criterion (a) listed above). Classes were identified using a Natural Breaks Classification system (Jenks optimisation). Those vegetation types belonging

¹¹ From January to May 2006 the CCT, in partnership with SANBI and CapeNature, updated the remnant layer using 2005 aerial photography. During this process the City's remnant layer was also integrated with the remnant layer being used by Cape Nature and derived from the Lowlands study.

to the rarest class were assigned an arbitrary 20% target; intermediate class communities were assigned 15%, while the most common were assigned a 10% target.

These target values were then adjusted upwards on the basis of the percentage of the national type occurring in the City (criteria b above) to derive the base target values. Vegetation types with less than 35% of the national distribution falling in the City were adjusted upwards by 0%, types between 35% and 99% were adjusted upwards by 5%, with those occurring entirely within the City (100%) were adjusted upwards by 10%. This resulted in base target values ranging between 10% and 30%.

The base target values were then used to produce the final targets percentages. This was undertaken by altering the base target by the degree of vegetation transformation. Vegetation community transformation (t) was calculated using the current- (ce) and historical (he) extent of each community type:

$$t = 2 - ce/he$$

This transformation value (t) was used to calculate the final target for each vegetation type:

$$\text{Final Target} = \text{Base Target} * t$$

This yielded final target values ranging from 15% to 60% (Table 1).

These target values were then converted to area values by multiplying the percentage values by the historic area. These area values represent the targets used in the selection of the conservation network.

For 21 of the 43 vegetation types the conservation targets cannot be attained due to insufficient current area within the City remnants. Eleven of these 21 vegetation types historically covered <1% of the City. Two of these smaller vegetation types (Swartland Shale Renosterveld on older non-aeolian colluvium and Cape Flats Dune Strandveld on recent non-aeolian colluvium) have been completely lost within the City.

Using similar criteria and categories to those used in the NSBA, each vegetation type was assigned an ecosystem status (Table 1).

The target areas were amalgamated at the national vegetation type level to compare with those targets set by the National Spatial Biodiversity Assessment (Table 2). National guidelines being drawn up by SANBI for conservation target setting suggest that local-scale conservation plans should as a minimum set targets on the basis of the proportional area of each national type occurring within the local planning domain. Furthermore, in instances where finer scale vegetation maps are available for local conservation planning, as a minimum the targets set for the finer scale types should be set on the basis of the proportional area of each type within the local planning domain. It is important to note that these guidelines talk about minimum target values. Local targets can be set separately using criteria focussed on local ecological characteristics and aimed at ensuring biodiversity maintenance within the local planning domain.

It is important to understand that any target value under 100% of the historic area of a vegetation type will result in the loss of biodiversity. Lack of accurate and up-to-date data on the distribution of all elements of biodiversity (for example poorly known and cryptic groups like fungi, invertebrates, etc.) necessitates the use of vegetation types as surrogates for biodiversity. Tests of surrogates have shown that surrogacy is at best only approximate (Kirkpatrick and Brown 1994, Howard *et al* 1998). This suggests that even though some of the target values may be considered as high, they will still fall substantially short of what is required to ensure conservation of all remaining elements of the City's biodiversity. Even conserving 100% of the extant native vegetation will more than likely be insufficient for preservation of the City's full remaining complement of biodiversity. Extinction debt, resulting from habitat loss and fragmentation, could result in loss of species even if the *status quo* is maintained (Tilman *et al* 1994). This should serve to emphasise the importance of conserving the remaining extant vegetation, to at least minimise the loss of biodiversity within the City.

It is important to note that the wetland and river layers are incomplete at the time of this report, and the Biodiversity Network is currently based solely on terrestrial vegetation types.

Table 1: Historic and current (remnant) distribution of the terrestrial vegetation types in Cape Town presented together with the conservation targets and the variables used to determine these. The ecosystem status of each type is also shown, with critically endangered types (i.e. those where the target area exceeds the current available area) shown in red.

National Vegetation Type	Sub Type	Historic Area in Hectares	Historic % of Study Area	Base Target %	Remnant Area (Hectares)	% Lost	Transformation Index	National % in CCT factor	Adjusted Base Target %	Adjusted Final Target %	Adjusted Actual Target (Hectares)	Adjusted Difference (Current-Target) (Hectares)	Ecosystem Status
Atlantis Sand Fynbos	Strandveld/Fynbos transition (on calcareous/acidic/neutral sands)	8930.44	3.66	20	7,734.43	13.39	1.13	5	25	28.35	2531.61	5202.82	LT
Atlantis Sand Fynbos	on marine-derived acid sands	10798.98	4.42	15	6,958.64	35.56	1.36	5	20	27.11	2927.86	4030.78	VU
Atlantis Sand Fynbos	on recent non-aeolian colluvium	384.53	0.16	20	186.45	51.51	1.52	5	25	37.88	145.65	40.80	EN
Atlantis Sand Fynbos	on older non-aeolian colluvium	7655.78	3.13	20	1,699.90	77.80	1.78	5	25	44.45	3402.91	-1703.01	CE
Boland Granite Fynbos	on Granite	3528	1.44	20	2701	23	1	0	20	25	871	1830	VU
Boland Granite Fynbos	on recent non-aeolian colluvium	5,853.37	2.40	20	3,402.49	41.87	1.42	0	20	28.37	1,660.85	1,741.64	EN
Boland Granite Fynbos	older non-aeolian colluvium	180.13	0.07	20	47.41	73.68	1.74	0	20	34.74	62.57	-15.17	CE
Cape Flats Dune Strandveld	on Sandstone	192.90	0.08	20	149.60	22.45	1.22	10	30	36.73	70.86	78.74	VU
Cape Flats Dune Strandveld	on sands over or on limestone	4,200.26	1.72	20	2,757.01	34.36	1.34	10	30	40.31	1,693.05	1,063.96	VU
Cape Flats Dune Strandveld	on Shale	296.31	0.12	20	187.00	36.89	1.37	10	30	41.07	121.69	65.31	VU
Cape Flats Dune Strandveld	on sands	35,376.44	14.49	10	15,994.27	54.79	1.55	10	20	30.96	10,951.72	5,042.54	EN
Cape Flats Dune Strandveld	on recent non-aeolian colluvium	80.44	0.03	20	0.00	100.00	2.00	10	30	60.00	48.26	-48.26	CE
Cape Flats Sand Fynbos	on recent non-aeolian colluvium	492.15	0.20	20	169.35	65.59	1.66	10	30	49.68	244.48	-75.13	CE
Cape Flats Sand Fynbos	on older non-aeolian colluvium	4,116.03	1.69	20	1,184.91	71.21	1.71	10	30	51.36	2,114.15	-929.24	CE
Cape Flats Sand Fynbos	on marine-derived acid sands	49,777.86	20.38	10	8,030.07	83.87	1.84	10	20	36.77	18,305.13	-10,275.06	CE
Cape Flats Sand Fynbos	Strandveld/Fynbos transition (on calcareous/acidic/neutral sands)	268.04	0.11	20	7.93	97.04	1.97	10	30	59.11	158.44	-150.51	CE
Cape Lowland Freshwater Wetlands	on recent non-aeolian colluvium	451.97	0.19	20	260.74	42.31	1.42	0	20	28.46	128.64	132.10	EN
Cape Lowland Freshwater Wetlands	Wetlands	944.47	0.39	20	124.38	86.83	1.87	0	20	37.37	352.91	-228.53	CE
Cape Winelands Shale Fynbos	on Shale	1,961.84	0.80	20	1,022.96	47.86	1.48	5	25	36.96	725.18	297.77	EN
Cape Winelands Shale Fynbos	on recent non-aeolian colluvium	7.52	0.00	20	0.03	99.60	2.00	5	25	49.90	3.75	-3.72	CE

National Vegetation Type	Sub Type	Historic Area in Hectares	Historic % of Study Area	Base Target %	Remnant Area (Hectares)	% Lost	Transformation Index	National % in CCT factor	Adjusted Base Target %	Adjusted Final Target %	Adjusted Actual Target (Hectares)	Adjusted Difference (Current-Target) (Hectares)	Ecosystem Status
Elgin Shale Fynbos	on Shale	242.44	0.10	20	241.73	0.29	1.00	0	20	20.06	48.63	193.10	LT
Hangklip Sand Fynbos	on sands	1041	0.43	20	798	23	1	5	25	31	321	478	VU
Hangklip Sand Fynbos	on marine-derived acid sands	2,357.55	0.97	20	1,185.43	49.72	1.50	5	25	37.43	882.42	303.02	EN
Kogelberg Sandstone Fynbos	on Sandstone	10,671.20	4.37	15	10,608.32	0.59	1.01	0	15	15.09	1,610.11	8,998.21	LT
Lourensford Alluvium Fynbos	on recent non-aeolian colluvium	4,819.25	1.97	20	646.68	86.58	1.87	10	30	55.97	2,697.54	-2,050.86	CE
North Peninsula Granite Fynbos	on recent non-aeolian colluvium	857	0.35	20	627	27	1	10	30	38	326	301	VU
North Peninsula Granite Fynbos	on Granite	1,140.40	0.47	20	734.17	35.62	1.36	10	30	40.69	463.99	270.18	VU
Peninsula Sandstone Fynbos	on Sandstone	20,615.85	8.44	15	19,363.26	6.08	1.06	10	25	26.52	5,467.11	13,896.15	LT
Peninsula Sandstone Fynbos	on Mudstone	884.94	0.36	20	784.72	11.32	1.11	10	30	33.40	295.55	489.17	LT
Peninsula Shale Fynbos	on Shale	456.98	0.19	20	314.11	31.26	1.31	5	25	32.82	149.96	164.15	VU
Peninsula Shale Fynbos	on recent non-aeolian colluvium	805.39	0.33	20	369.19	54.16	1.54	5	25	38.54	310.40	58.79	EN
Peninsula Shale Renosterveld	on Shale	1,882.89	0.77	20	290.07	84.59	1.85	10	30	55.38	1,042.71	-752.64	CE
Peninsula Shale Renosterveld	on recent non-aeolian colluvium	491.86	0.20	20	5.41	98.90	1.99	10	30	59.67	293.49	-288.08	CE
South Peninsula Granite Fynbos	on recent non-aeolian colluvium	3,683.78	1.51	20	1,274.36	65.41	1.65	10	30	49.62	1,827.96	-553.60	CE
South Peninsula Granite Fynbos	on Granite	3,497.44	1.43	20	1,133.03	67.60	1.68	10	30	50.28	1,758.55	-625.53	CE
Southern Afrotemperate Forest		301.29	0.12	20	298.80	0.83	1.01	0	20	20.17	60.76	238.04	LT
Swartland Alluvium Fynbos	on Malmesbury Sandstone	1,742.41	0.71	20	88.32	94.93	1.95	0	20	38.99	679.30	-590.98	CE
Swartland Granite Renosterveld	on Granite	5,680.67	2.33	20	1,522.82	73.19	1.73	0	20	34.64	1,967.70	-444.89	CE
Swartland Granite Renosterveld	on recent non-aeolian colluvium	154.36	0.06	20	39.73	74.26	1.74	0	20	34.85	53.80	-14.07	CE
Swartland Shale Renosterveld	on Shale	41,484.95	16.99	10	3,823.32	90.78	1.91	0	10	19.08	7,914.66	-4,091.34	CE
Swartland Shale Renosterveld	on recent non-aeolian colluvium	4,875.99	2.00	20	246.56	94.94	1.95	0	20	38.99	1,901.08	-1,654.52	CE
Swartland Shale Renosterveld	on older non-aeolian colluvium	20.59	0.01	20	0.00	100.00	2.00	0	20	40.00	8.24	-8.24	CE
Swartland Silcrete Renosterveld	on recent non-aeolian colluvium	1,009.09	0.41	20	220.44	78.15	1.78	0	20	35.63	359.55	-139.10	CE

Table 2: Summary of historic and current (remnant) distribution of the terrestrial vegetation types in Cape Town, amalgamated at the level of the national vegetation types (SANBI vegetation map, Mucina and Rutherford, 2004). Amalgamated target values and shortfalls are also presented, and shown in comparison to targets (total and proportional) set by the National Spatial Biodiversity Assessment (NSBA).

National Vegetation Type	Historic SA Area (Hectares)	Historic Cape Town Area (Hectares)	% in Cape Town	NSBA Ecosystem Status	NSBA Target %	Proportional Cape Town Target %	Average CCT Target %	Sum of Actual CCT Target Area (Hectares)	Summarised CCT Target %	Difference between CCT and NSBA Targets	CCT Remnant Area (Hectares)	Difference between Remnant Area and Target Area
Atlantis Sand Fynbos	69800.63	27769.72	39.78	EN	30	11.94	34.45	9008.04	32.44	2.44	16,579.43	7,571.39
Boland Granite Fynbos	49,902.81	9,561.36	19.16	EN	30	5.75	29.27	2,594.38	27.13	-2.87	6,150.85	3,556.47
Cape Flats Dune Strandveld	40,146.35	40,146.35	100.00	EN	24	24.00	41.81	12,885.59	32.10	8.10	19,087.87	6,202.29
Cape Flats Sand Fynbos	54,654.07	54,654.07	100.00	CE	30	30.00	49.23	20,822.20	38.10	8.10	9,392.27	-11,429.93
Cape Lowland Freshwater Wetlands	7,487.60	1,396.44	18.65	VU	24	4.48	32.91	481.55	34.48	10.48	385.12	-96.43
Cape Winelands Shale Fynbos	8,613.39	3,231.74	37.52	EN	30	11.26	39.56	1,189.30	36.80	6.80	1,706.29	516.99
Elgin Shale Fynbos	27,947.73	242.44	0.87	CE	30	0.26	20.06	48.63	20.06	-9.94	241.73	193.10
Hangklip Sand Fynbos	8,121.47	3,398.30	41.84	VU	30	12.55	34.13	1,203.19	35.41	5.41	1,983.84	780.66
Kogelberg Sandstone Fynbos	91,527.99	10,671.20	11.66	LT	30	3.50	15.09	1,610.11	15.09	-14.91	10,608.32	8,998.21
Lourensford Alluvium Fynbos	4,819.25	4,819.25	100.00	CE	30	30.00	55.97	2,697.54	55.97	25.97	646.68	-2,050.86
Peninsula Granite Fynbos	9,178.59	9,178.59	100.00	EN	30	30.00	178.64	4,376.63	47.68	17.68	3,768.42	-608.20
Peninsula Sandstone Fynbos	21,500.79	21,500.79	100.00	LT	30	30.00	29.96	5,762.66	26.80	-3.20	20,147.98	14,385.32
Peninsula Shale Renosterveld	2,374.74	2,374.74	100.00	CE	26	26.00	57.52	1,336.20	56.27	30.27	295.49	-1,040.72
Southern Afrotropical Forest	81,520.97	301.29	0.37	LT	34	0.13	20.17	60.76	20.17	-13.83	298.80	238.04
Swartland Alluvium Fynbos	46,984.43	1,742.41	3.71	EN	30	1.11	38.99	679.30	38.99	8.99	88.32	-590.98
Swartland Granite Renosterveld	94,744.78	5,835.02	6.16	CE	26	1.60	34.75	2,021.50	34.64	8.64	1,562.55	-458.95
Swartland Shale Renosterveld	494,576.60	46,381.53	9.38	CE	26	2.44	32.69	9,823.98	21.18	-4.82	4,069.88	-5,754.09
Swartland Silcrete Renosterveld	9,984.86	1,009.09	10.11	CE	26	2.63	35.63	359.55	35.63	9.63	220.44	-139.10

Notes reconciling Tables 1 and 2:

1. The historical areas of the following vegetation types were mapped at a finer scale by Rebelo and Low (2007) and supercede the coarser national mapped units (Mucina and Rutherford 2004): Cape Flats Dune Strandveld; Cape Flats Sand Fynbos; Lourensford Alluvium Fynbos; Peninsula Granite Fynbos; Peninsula Sandstone Fynbos; and, Peninsula Shale Renosterveld.
2. Peninsula Shale Fynbos is a local subtype of the national Cape Winelands Shale Fynbos.
3. The national Peninsula Granite Fynbos comprises both North and South types recognised by Rebelo and Low (2007) for the CCT.

3.2.2 Setting Conservation Targets for Plant species

A simple target for each species was set on the basis of the number of known locations. Species with 5 or less locations had a target of 100% of these locations. Species with 6 or more locations were assigned a target of 80% of known locations. These targets were based on a similar premise to that used for the inclusion of rarity as a criterion for determining vegetation type target values. In other words, rarer species will be assigned relatively higher target values (as a percentage of known locations) than more common species.

3.3 Site selection

The ArcView 3.2 extension C-Plan was used to select an optimal and efficient set of remnants to meet the conservation targets. C-Plan is a conservation-planning tool that provides the tools for the application of a logical and sequential planning process.

The process of analysis using C-Plan followed the following steps:

1. Calculate achievable targets based on the remaining extent of each vegetation type.

C-Plan assesses the available area of each vegetation type and uses this to determine the actual areas that can be conserved. Thus, for those vegetation types where the current available area is less than the graduated target, the achievable target will be equal to the former, i.e. all remnants are selected irrespective of size. For those types with available area greater than the target, C-Plan uses the target values.

2. Review the extent to which achievable targets are met by existing conservation areas.

The area of each vegetation type falling in existing conserved areas is then determined. The difference between this area and the target area is the remaining area required to achieve the target.

3. Determine the irreplaceability of non-conserved areas based on contribution to attaining the remaining target areas.

The irreplaceability of the non-conserved remnant areas is then calculated, based on their contribution to achieving the remaining target areas.

4. Use an algorithm based on the biological planning criteria to select additional areas required to achieve targets.

An algorithm (known as a minimum set algorithm) was developed and applied to the selection of remnant areas required to meet the remaining target values. The algorithm made use of the following selection rules:

- i. remnant irreplaceability;
- ii. size;
- iii. percentage contribution; and,
- iv. vegetation type diversity.

Rules ii-iv are only used if ties occur.

5. Using C-Plan's ability to track target attainment for individual elements of biodiversity, the contribution of the areas selected for vegetation types to attaining targets for plant species was assessed and additional areas selected where required.

C-Plan enables users to view the percentage of set target values attained for each element of biodiversity being used.

Firstly, the contribution of the currently conserved sites and sites selected for attainment of vegetation targets toward meeting the species targets was assessed. For those species with outstanding targets, a minimum set algorithm was used to select additional sites. The algorithm used the following selection rules:

- i. remnant irreplaceability;
- ii. size;
- iii. percentage contribution; and,
- iv. species richness.

Rules ii-iv are only used if ties occur.

3.4. Corridor modelling

Overall, the maintenance of connectivity among conservation areas is seen as one of the most important ways of ensuring the persistence of ecological processes, and thus the long-term persistence of biodiversity. While smaller scale processes were catered for in the attainment of the vegetation and species pattern targets, broad scale connectivity was assessed through a spatial modeling process known as friction analysis.

Friction analysis was undertaken to define spatially explicit corridors encompassing the biodiversity network. A friction surface (which divides the study area into grid cells) was developed in which low values are used for areas where a high compatibility for biodiversity exists and high values are used for land uses that create effective barriers to connectivity (Table 3). The friction surface is then used to derive a cost (to connectivity) surface, where the cost assigned to each cell is dependent on the minimum accumulated friction value when moving from an individual cell to a range of targets. Movement can occur in all 8 cardinal directions. The cost surface is then used to define pathways from a starting point to target areas. By examining all pathways along known gradients such as altitude or examining pathways to connect critical ecosystems (mountains to mountains or coasts to coasts) a network of flows is generated which will describe areas most compatible for maintaining connectivity. The networks of paths are then converted to lines, which are finally buffered to provide a corridor-planning framework.

The development of these spatial modelling approaches ensures that ecological gradients and possible effects of global changes are managed within corridors. Identified corridors linked the following significant areas, Zandvlei, Macassar, Gordons Bay, Cape Point, Noordhoek Wetlands, West Coast, Mamre, and Paardeberg). Effectively these corridors optimise routes containing natural vegetation and all major vegetation types. The advantages of this procedure is that it looks at the viability of patches in relation to where neighbouring viable patches are located and is therefore fully spatially explicit.

Table 3: Friction values ascribed to various features and landscapes for the development of the corridors for conservation management. The base value of 1 is all areas that are either protected or been selected for protection. As friction values increase the area becomes increasingly unattractive for biodiversity. The corridors ensure the viability of existing biodiversity is optimised through a network of areas most compatible for supporting it.

Base Friction = 1

Existing Nature Reserves, Core Floral Sites, Selected remnants (all), Wetlands, Estuaries, Vleis

Friction = 3

Rivers with natural banks, non-selected remnants

Friction = 5

Dams, waste water treatment works' water bodies

Friction = 10

Major powerlines, reservoirs, detention ponds, retention

Friction = 15

Irrigation ponds, canals, composite canal, open channels, weirs

Friction = 30

Major Roads and Freeways, Urban Open Spaces

Friction = 60

Low intensity agriculture*, wheat fields*, built up areas

Fiction = 120

High intensity Agriculture, Vegetable growing, Commercial areas

Friction = 240

Industrial areas, Settlements

*Originally run with frictions of 120 but no difference was observed in the network

3.5. Site prioritisation

Prioritisation analyses were undertaken using ArcGIS 9.1 (ESRI, Redlands, California). While a single set of decision rules aimed to integrate the terrestrial and aquatic elements of the network, in practice the analysis needed to be undertaken separately using the separate datasets for the terrestrial component of the Biodiversity Network, rivers and wetlands.

3.5.1 Summary of GIS methods used in assigning prioritisation of selected planning units, wetlands and rivers

The NHRs, wetlands and rivers were provided in three separate GIS layers:

1. The planning unit layer describing the terrestrial remnants, which were selected as Key Nature Conservation Areas during the conservation planning analysis. This layer also included the current network of protected areas and the Core Flora Sites.
2. The wetland layer described a set of 14 wetlands which were assigned importance and sensitivity by the study entitled *"River and vlei assessment and monitoring in the CMA: Revisiting and refining the river importance and sensitivity maps"*. This river and vlei assessment study actually included 17 wetlands, however the location and extent of three of these were not available in the data supplied by the City of Cape Town.
3. The river layer described the river centre-lines and separate reaches for the primary riverine systems in the study area. The river and vlei monitoring and assessment study also used this data to assess the ecological importance and sensitivity of these key systems.

The decision tree for prioritisation of the selected planning units, wetlands and rivers into A, B and C categories (Table 4) was then applied to each individual through a spatial model developed using the Model Builder Extension for ArcGIS 9.1. Three separate sub-models were developed for each of the three layers.

1. Each NHR was attributed for the information needed by the decision tree:
 - a) Protected area or core flora site status (yes or no).
 - b) Occurrence of at least 5% of the extant distribution of the 19 critical vegetation types contained by the NHRs. NOTE: the critical vegetation types are those for which the extant area is less than that required by the conservation targets (yes or no).
 - c) NHR area
 - d) Irreplaceability value as assigned by the Key Conservation Areas study (this included irreplaceability values for the vegetation and species analyses).

The GIS model stepped through a series of selections based on the criteria for each rule within the decision tree and assigned each planning unit with a category based on its compliance with each rule. The decision tree and model were designed in such a way that each planning unit was assigned the highest category in cases where more than one category could apply. The model also kept an audit of which rules applied to each planning unit.

2. Each wetland feature was assigned a value for wetland importance class as defined in the river and vlei assessment and monitoring study. The wetland model used this value during the process of stepping through a series of selections based on the criteria for each rule in the decision tree that applied to wetlands. Using this process, the highest relevant prioritisation category was assigned to each wetland feature.
3. Each river feature was assigned a value for ecological priority ranking as defined in the river and vlei assessment and monitoring study. The river model used this value during the process of stepping through a series of selections based on the criteria for each rule in the decision tree that applied to rivers. Using this process, the highest relevant prioritisation category was assigned to each river feature.

Table 4: Decision rules applied to prioritise terrestrial planning units, wetlands and riverine features.

Rule 1: Is the planning unit a protected area or a Core Botanical Site? – Yes, then A
Rule 2: Does the planning unit contain more than 5% of the extant distribution of 1 of the 19 critical vegetation types? – Yes, then A
Rule 3: Is the planning unit ≥ 10 ha in area and have an irreplaceability value of ≥ 0.9 ? – Yes then A
Rule 4: Is it a wetland of high to very high importance class or a river reach of extreme or high ecological priority? – Yes then A (Note that for the purposes of this iteration of the analysis, all wetlands and rivers are regarded as Priority A features – this may be reviewed in subsequent iterations).
Rule 5: Does the planning unit have an irreplaceability value of between ≥ 0.75 and < 0.9 , and is ≥ 10 ha in area? – Yes then A
Rule 6: Does the planning unit have an irreplaceability value of between ≥ 0.75 and < 0.9 ? – < 10 ha in area? – Yes then B
Rule 7: Does the planning unit have an irreplaceability value of < 0.75 and is > 5 ha in area? Is it a wetland of moderate importance class or a river reach of moderate ecological priority? – Yes then B, No then C
Rule 8: Remainder of planning units not assigned a category in Rules 1 – 7 are categorised as C

3.6. Identification of biodiversity nodes

Node identification was undertaken using ArcGIS 9.1 (ESRI, Redlands, California).

A series of spatial analyses (particularly nearest neighbour analysis) were undertaken to obtain the required data needed to identify nodes. The nodes were then identified by stepping through a decision tree planning units into nodes. A decision tree was then implemented. This involved implementing a series of rules in a decision tree structure (Table 5) within the GIS environment through a series of spatial queries in order to identify the biodiversity nodes and their constituent planning units/wetlands/rivers.

Iterations of the nodes were presented to officials of the Environmental Management Department (City of Cape Town) for comment and refinement.

Table 5: Decision rules applied to identify biodiversity nodes consisting of terrestrial planning units, wetlands and riverine features.

Rule 1: Is it a large protected area/planning unit/wetland greater than 100 hectares? YES? – becomes a node/part of a node NO? – go to rule two <i>Justification:</i> <i>100 ha represents a ten-fold increase in size compared to the threshold of 10 ha used in the ranking of the planning units. A collective area of planning units smaller than this would not have a significant impact with respect to the overall reserve network. One larger area is easier to manage compared with many small areas.</i> Rule 2: Are there several protected areas/planning units/wetlands adjacent and <u>physically</u> connected that have a summed area of greater than 100 hectares? YES? – together these areas form a node NO? – go to Rule 4 Rule 3: There are nodes (identified in 1 or 2 above) that are closer than 1 km to each other. YES? – these nodes are combined into a single node/nodal cluster NO? – these remain as individual nodes Rule 4: There are protected areas/planning units/wetlands that are closer than 1 km to a node identified in 1, 2 or 3 above? YES? – become part of a node/nodal cluster NO? – end of decision tree
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4. RESULTS OF THE IDENTIFICATION AND PRIORITISATION ANALYSES

4.1 Introduction

The Biodiversity Network prioritisation analysis was undertaken iteratively, with draft results being presented to the client and at the stakeholder workshops. Feedback at these work sessions assisted in refining the decision tree and analysis. All analyses were undertaken using ArcGIS 9.1 (ESRI, Redlands, California). While a single set of decision rules, aimed to integrate the terrestrial and aquatic elements of the network, were used, in practice the analyses needed to be undertaken separately using the separate datasets for the terrestrial component of the Biodiversity Network, rivers and wetlands. Furthermore, a number of analyses were run as checks on the resulting prioritisation and categorisation.

The iterative process up to, and including, the 2004 analyses is described in the draft report attached as Appendix B. The following section summarises the most recent results and outputs from the 2007 analyses, based on the revised vegetation map for the City (Rebelo and Low 2007).

4.2 Ecosystem status of vegetation types within the City

The new Vegetation Map for the City of Cape Town compiled by Rebelo and Low (2007) includes 43 distinct vegetation types (Table 1, Figure 1). Of these 43 types:

- The distribution of 18 types is entirely limited to within the City's administrative boundary and cannot be conserved elsewhere;
- Twenty one of the 43 vegetation types are considered *critically endangered* as there is not enough remaining habitat to meet the City's adopted conservation targets (Table 1);
- Of these 21 types, two vegetation types (Swartland Shale Renosterveld on older non-aeolian colluvium and Cape Flats Dune Strandveld on recent non-aeolian colluvium) are no longer represented in the City, having been entirely converted into other land uses, and a further six vegetation types have less than 10% area remaining in the City (three of these six have less than 3% area remaining (Table 1));
- Of the 22 vegetation types considered not to be *critically endangered*, seven are *endangered*, nine are *vulnerable* and six are considered *least threatened*;
- More than two-thirds of the vegetation types identified in the City are therefore considered *critically endangered* or *endangered* (Table 1);
- In terms of the National Vegetation Map, of the 18 vegetation types occurring within the City, seven of these vegetation types are *critically endangered*, six are *endangered*, two are *vulnerable* and three are *least threatened* (Table 2); and,
- Six of these vegetation types have distributions entirely limited to within the City's administrative boundary and cannot be conserved elsewhere.

4.3 Identification of the Biodiversity Network

Natural Habitat Remnants: On the basis of the 2005 aerial imagery, an edited layer has identified Natural Habitat Remnants (NHRs) that are still theoretically available for conserving biodiversity, but that are not yet protected. Together these NHRs make up an area of 45,362.53 ha (Figure 2).

Existing Protected Areas: Protected Areas within the City, for example the Table Mountain National Park, the Blaauwberg Conservation Area, other reserves, conservancies, etc, make up a total area of 52,654.57 ha (Figures 2).

Meeting targets for vegetation types and species:

In addition to the habitats conserved within existing protected areas, a further 37,079.71 ha of the identified Natural Habitat Remnants are required to meet the established conservation targets for vegetation types (33,017.37 ha – Figure 3) and species (4,062.34 ha – Figure 4). The Biodiversity Network for the City would therefore require a total of 89,734.28 ha (Figure 4). More than 80% of the area of identified Natural Habitat Remnants is therefore required to meet targets for vegetation types and species.

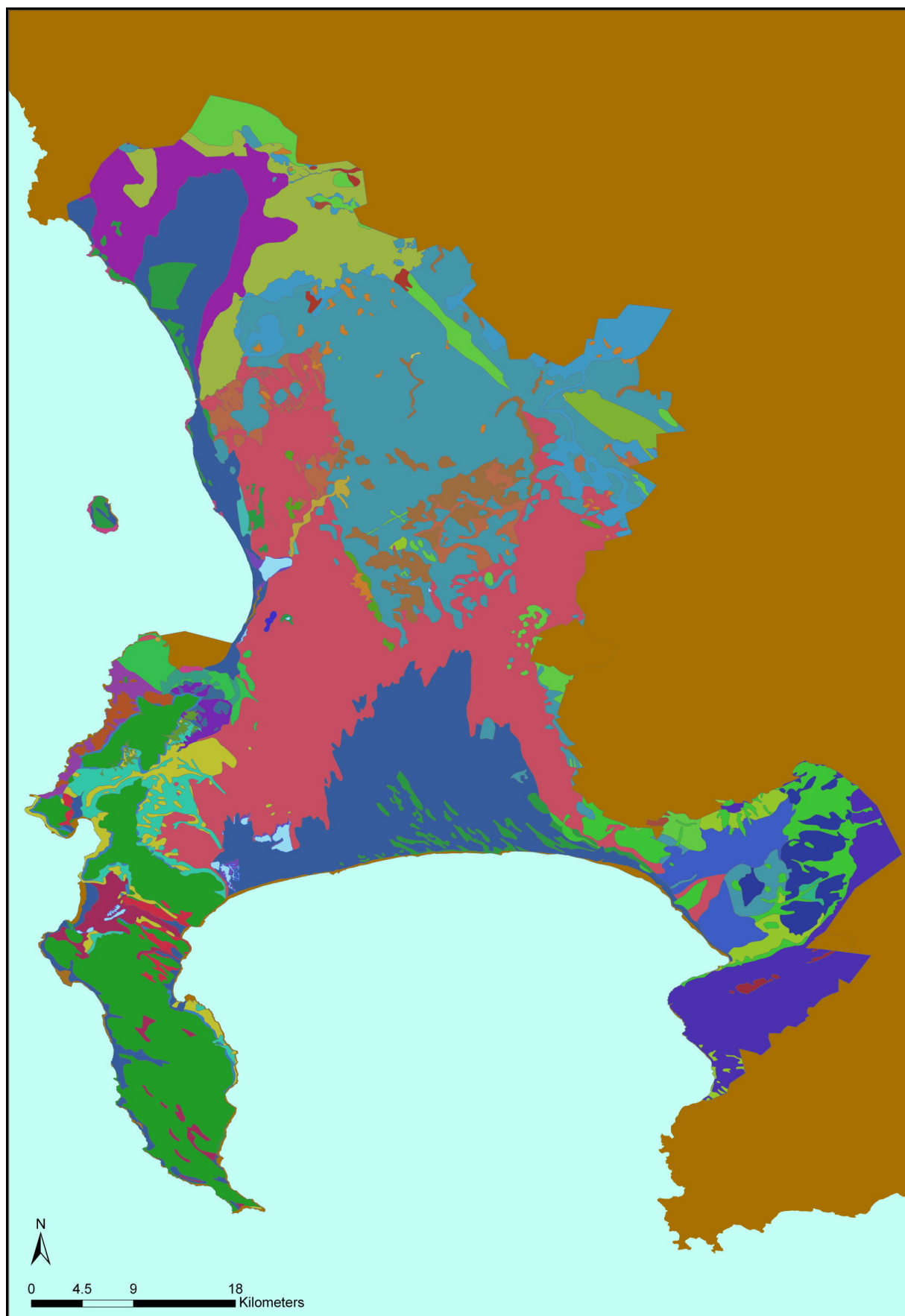


Figure 1: Terrestrial vegetation types of the City of Cape Town (adapted from Rebelo & Low, 2007)

Legend

	Wetlands & Estuaries
	Atlantis Sand Fynbos Strandveld/Fynbos transition (on calcareous/acidic/neutral sands)
	Atlantis Sand Fynbos on marine-derived acid sands
	Atlantis Sand Fynbos on older non-aeolian colluvium
	Atlantis Sand Fynbos on recent non-aeolian colluvium
	Boland Granite Fynbos older non-aeolian colluvium
	Boland Granite Fynbos on Granite
	Boland Granite Fynbos on recent non-aeolian colluvium
	Cape Flats Dune Strandveld on Sandstone
	Cape Flats Dune Strandveld on Shale
	Cape Flats Dune Strandveld on recent non-aeolian colluvium
	Cape Flats Dune Strandveld on sands
	Cape Flats Dune Strandveld on sands over or on limestone
	Cape Flats Sand Fynbos Strandveld/Fynbos transition (on calcareous/acidic/neutral sands)
	Cape Flats Sand Fynbos on marine-derived acid sands
	Cape Flats Sand Fynbos on older non-aeolian colluvium
	Cape Flats Sand Fynbos on recent non-aeolian colluvium
	Cape Lowland Freshwater Wetlands
	Cape Lowland Freshwater Wetlands on recent non-aeolian colluvium
	Cape Winelands Shale Fynbos on Shale
	Cape Winelands Shale Fynbos on recent non-aeolian colluvium
	Elgin Shale Fynbos on Shale
	Hangklip Sand Fynbos on marine-derived acid sands
	Hangklip Sand Fynbos on sands
	Kogelberg Sandstone Fynbos on Sandstone
	Lourensford Alluvium Fynbos on recent non-aeolian colluvium
	North Peninsula Granite Fynbos on Granite
	North Peninsula Granite Fynbos on recent non-aeolian colluvium
	Peninsula Sandstone Fynbos on Mudstone
	Peninsula Sandstone Fynbos on Sandstone
	Peninsula Shale Fynbos on Shale
	Peninsula Shale Fynbos on recent non-aeolian colluvium
	Peninsula Shale Renosterveld on Shale
	Peninsula Shale Renosterveld on recent non-aeolian colluvium
	South Peninsula Granite Fynbos on Granite
	South Peninsula Granite Fynbos on recent non-aeolian colluvium
	Southern Afrotemperate Forest
	Swartland Alluvium Fynbos on Malmesbury Sandstone
	Swartland Granite Renosterveld on Granite
	Swartland Granite Renosterveld on recent non-aeolian colluvium
	Swartland Shale Renosterveld on Shale
	Swartland Shale Renosterveld on older non-aeolian colluvium
	Swartland Shale Renosterveld on recent non-aeolian colluvium
	Swartland Silcrete Renosterveld on recent non-aeolian colluvium

Figure 1: (cont) Terrestrial vegetation types of the City of Cape Town (adapted from Rebelo & Low, 2007)

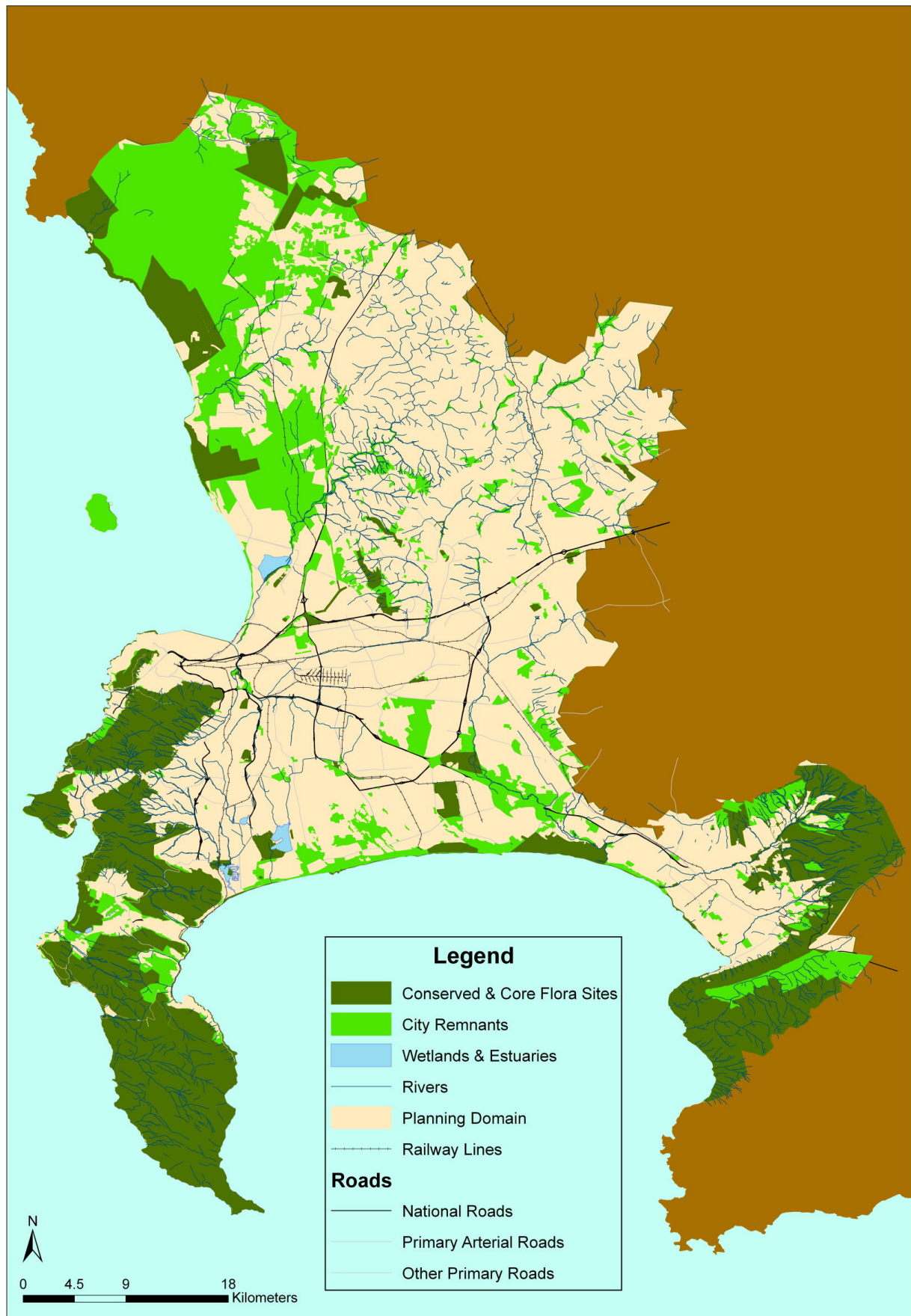


Figure 2: Existing protected areas and natural habitat remnants in the City

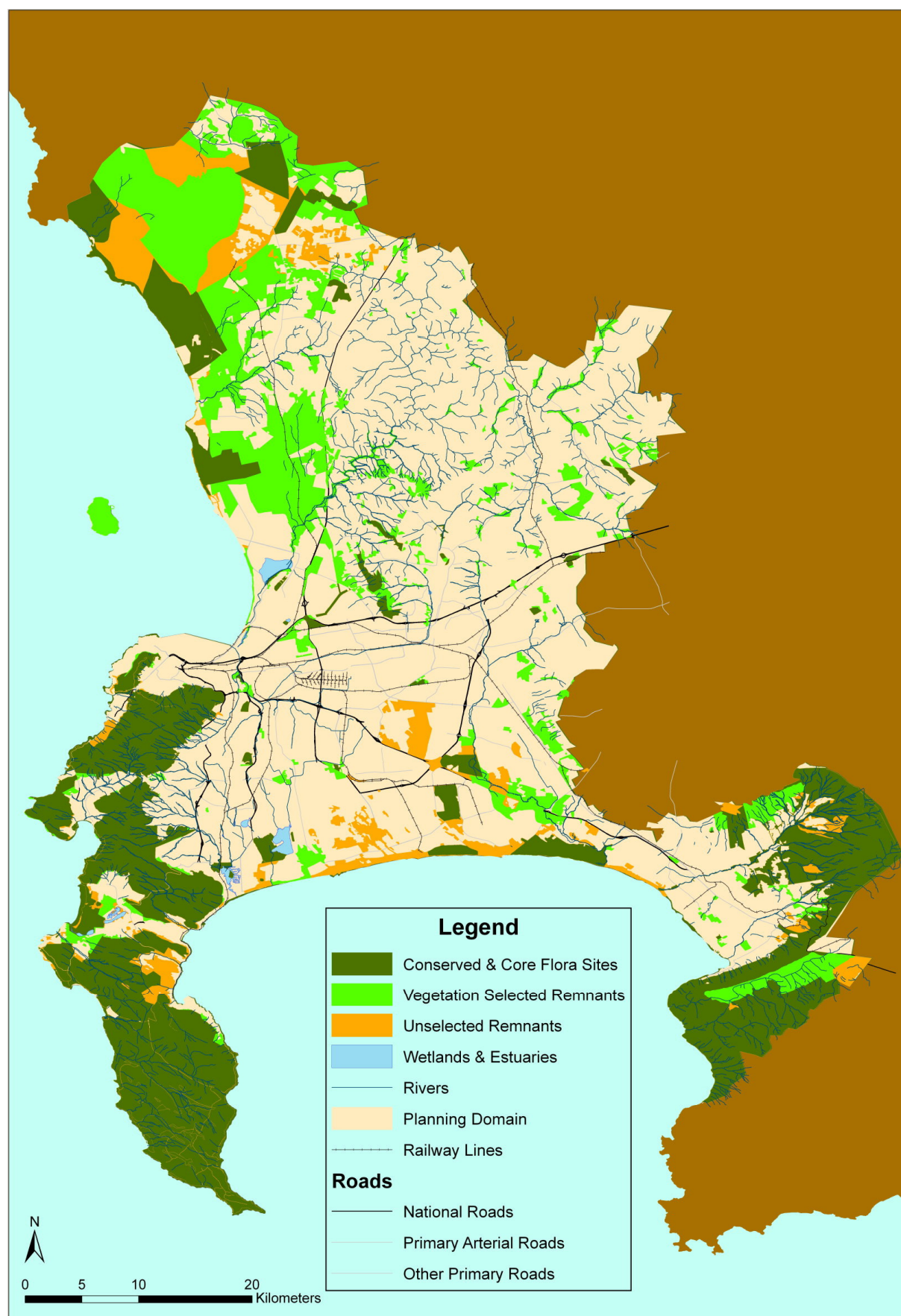


Figure 3: Selection of remnants for terrestrial vegetation type targets

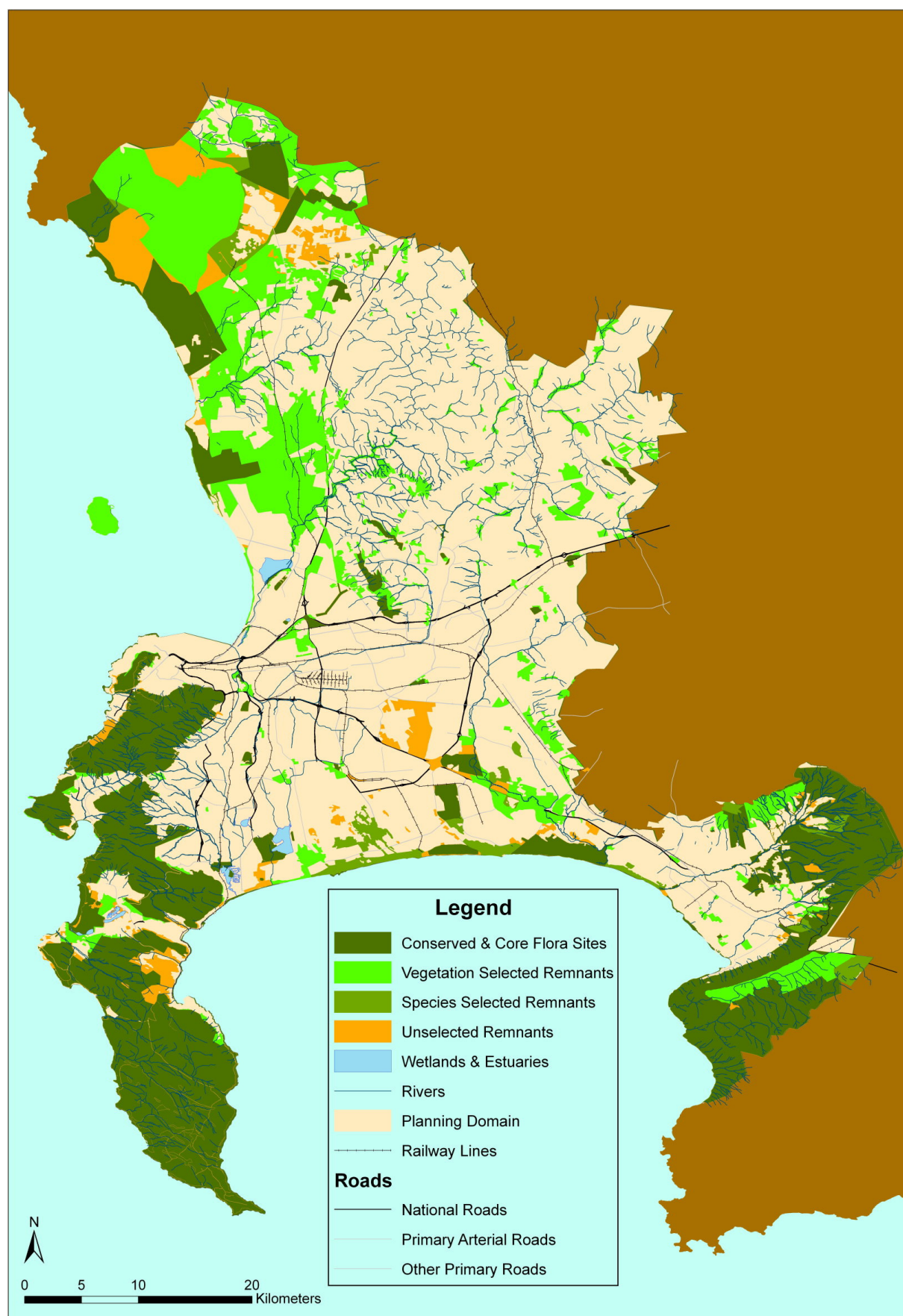


Figure 4: Selection of remnants for species targets

4.4 Identification of Nodes and Corridors

Figure 5 presents the “nodes” and “corridors” identified for the Biodiversity Network. Nine Nodes have been identified, namely Wolfgat/ Macassar Dunes, North West/ Diep River, Blaauwberg, Joostenberg, Tygerberg, Driftsands/ Khayelitsha, Helderberg/ Kogelberg, Zeekoeivlei/ Pelican Park, and the Cape Peninsula (including the TMNP) (Table 6).

Table 6: Areas in hectares of the nine nodes identified for the City of Cape Town Biodiversity Network

<i>Node number</i>	<i>Node Name</i>	<i>Area (ha)</i>
1	Wolfgat/Macassar Dunes	1,823.10
2	North West/Diep River	22,471.47
3	Blaauwberg	7,149.15
4	Joostenberg	568.76
5	Tygerberg	1,582.06
6	Driftsands/Khayelitsha	1,654.54
7	Helderberg/Kogelberg	18,600.41
8	Zeekoeivlei/Pelican Park	691.56
9	Cape Peninsula (incl. TMNP)	27,529.29
Total area of nodes *		82,070.34

* Note that the total area the biodiversity network of 89,734.28 ha (Section 4.3 above) is made up of the nodes with corridors, thus the nodes alone comprise over 91% of the network.

4.5 Prioritisation of the Biodiversity Network

The prioritisation analysis has assigned 96.6% (86,713.10 ha) of the Network as category A, 3% (2,827.81 ha) as category B and 0.2% (193.39 ha) as category C (Figure 6). This emphasises the fact that there are limited choices where conservation targets can still be met within the City. Given the multifunctional role of these habitats, all rivers, wetlands and estuaries are designated as category A sites.

Note that while categories B & C have lower priority the total amount of land, selected in the network for these categories (3012.20 ha), is still required to meet the targets. In category C sites and some category B sites, there may still be limited choices as to where and how the target is met, depending on the irreplaceability of the individual NHRs.

4.6 GIS outputs

The GIS database, which includes all the source data for target setting, identification, prioritisation and node and corridor selection, as well as the results of these analyses, described in sections 3 and 4, are provided as GIS data files. This database together, with the metadata (ArcGIS 9.1 (ESRI, Redlands, California)), is included as an electronic appendix (Appendix 4).

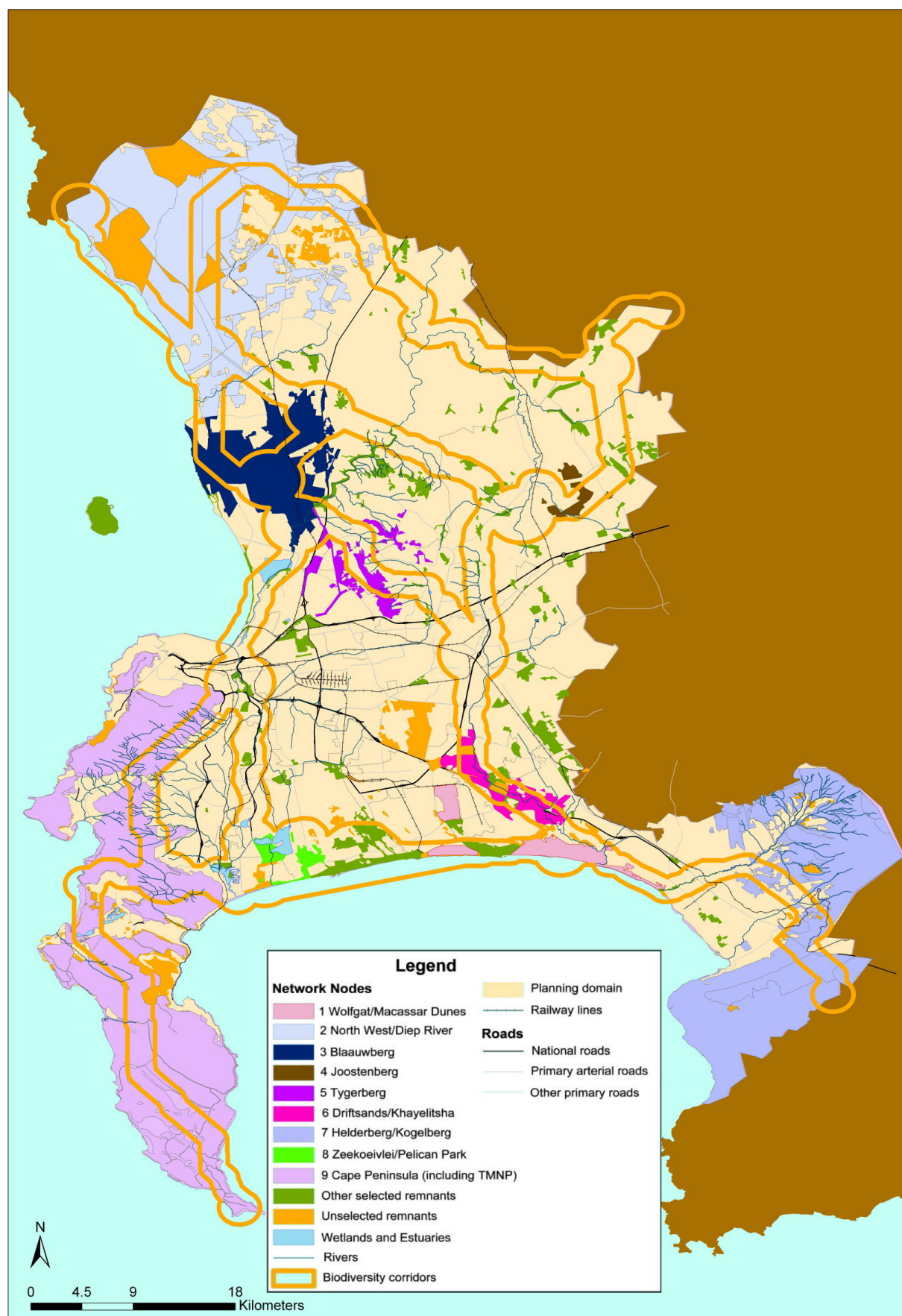


Figure 5: Selected biodiversity nodes and corridors

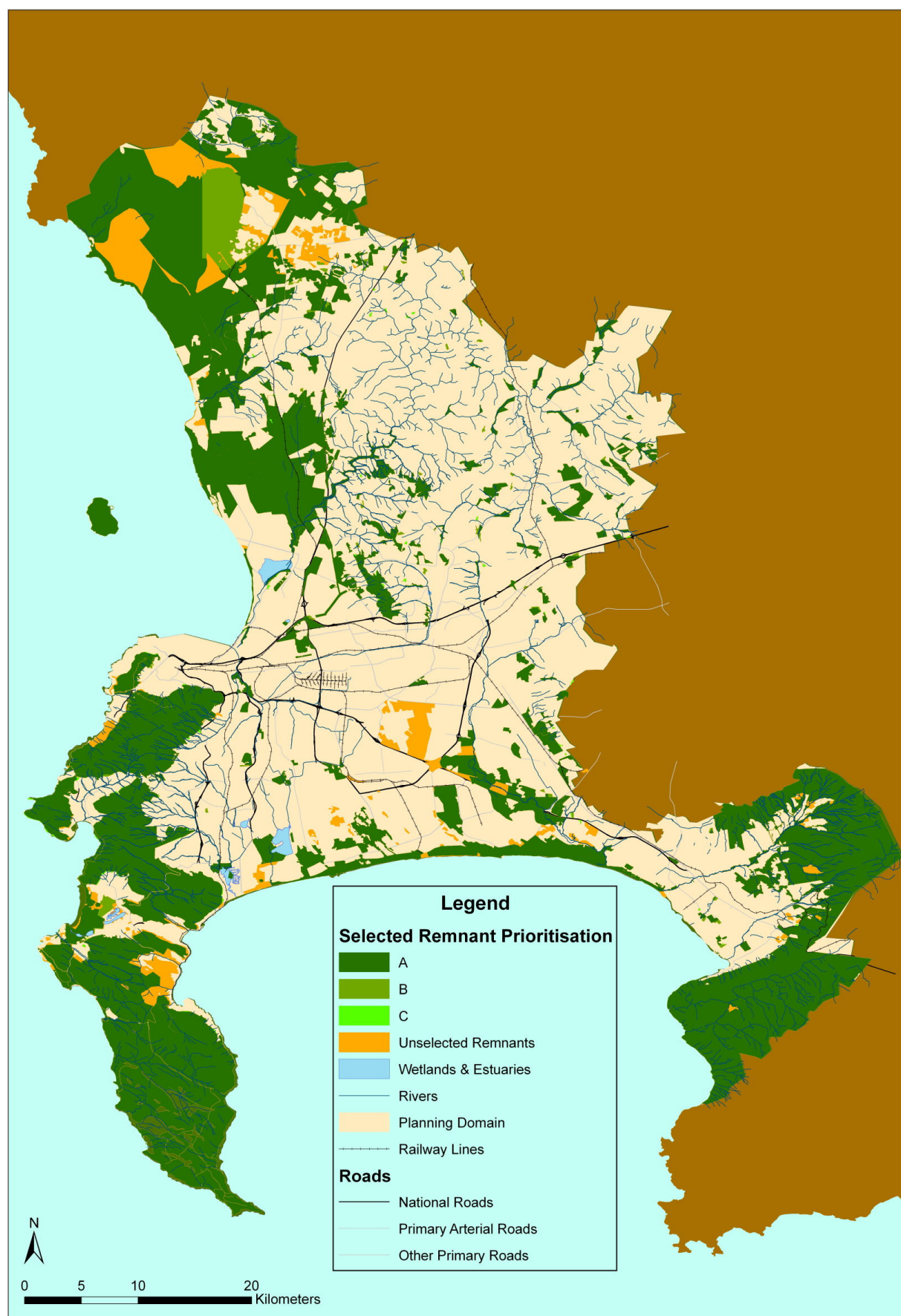


Figure 6: Prioritisation of remnants selected for the biodiversity network

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

There is a high level of diversity and uniqueness of the biodiversity currently represented in the remaining natural habitats found in the City of Cape Town. This is indicated by the diversity and uniqueness of the vegetation types. This together with the extent of historical habitat transformation within a rapidly growing urban context means that a high proportion (80%) of the remaining intact Natural Habitat Remnants are required to meet the City's conservation targets. These selected and prioritised Natural Remnants represent the City's last opportunity to conserve an estimated minimum representative area of natural habitat that can enable the conservation of the City's unique biodiversity and its persistence for future generations.

In the context of the competing demands for land in the City, bold action by the City's leadership is required to implement the Biodiversity Network. It is imperative that the City takes convincing and effective strides towards honouring its commitment to the international community under the Biodiversity Convention. Further, the steady growth in tourism and eco-tourism over the past decade has increasingly focused on Cape Town and its environment as a prime tourist destination. This should provide further impetus and incentive to the commitment that the City of Cape Town has already made in conserving its internationally renowned biodiversity.

5.2 Recommendations

In order that the Biodiversity Network is secured, a clear programme of action is required. The following are critical initiatives that are recommended for implementation in parallel:

Enabling legal and policy instruments

1. 1. Compilation and submission of a Biodiversity Plan in terms of sections 40 – 50 of the NEM: Biodiversity Act, Act 10 of 2004 in line with the draft Guidelines for Publishing Bioregional Plans and in partnership with SANBI. It is imperative that some form of legal status now becomes attached to the internationally significant biodiversity represented in the Biodiversity Network. Indeed, it may be necessary to investigate further legal options through NEMA that enable a tempering of existing development rights in the context of critically endangered and endangered habitats.
2. On the basis of the draft submission of the Biodiversity Plan, institute a City protocol through a By-Law in line with the identification of geographic areas requiring EIAs in terms of section 24 of NEMA that would inform specific EIA requirements in relation to the City's fine-scale Biodiversity Plan.

Strategic land use and development frameworks

3. The findings of this study require adequate integration into the Citywide Spatial Development Framework, as well as the eight local District Development Plans that are in the process of being developed. This should also ensure the integration of the Cape Metropolitan Open Space System and the Biodiversity Network at the local level.
4. While biodiversity off-sets will not really be applicable to most of the network sites due to their ecosystem status, alignment is required between the City's draft land use guidelines and draft Biodiversity Off-sets policy and that which has been developed by the Western Cape Provincial Government (2007) in order to provide absolute clarity to decision-makers and land-owners.

Decision-support for land use decision-making:

5. The continued development of a decision-support system for land use decision-making, including the Red-flagging system proposed for the City's internal Land use Information System. This system will enable the implementation of the protocol to be established in Recommendation 2 (above).

Information Management Systems

6. Systematic updating of all data layers (including the rivers and wetlands layer) will be required every three to five years and should focus on integrating the status quo assessment results as well as the SANBI CREW (Custodians of Rare and Endangered Wildflowers) project's database.
7. Ground truthing and *status quo* assessment of all category A sites (including rivers and wetlands), prioritising within this all critically endangered and endangered types will enable the ongoing refinement of the Network.

Planning, implementation and monitoring and evaluation

8. The City requires a plan that enables the implementation of the spatial vision – the Biodiversity Network – on the ground in the medium to long-term. This plan needs to be developed and implemented together with the key CAPE partners. The established prioritisation criteria, together with zoning and ownership information, could be used to inform the plan. Further, the implementation “Toolkit” developed in 2002 provides a range of options for the implementation of the Biodiversity Network.
9. Local communities must be engaged and mobilised in securing and managing identified critical biodiversity areas. Enabling local action for biodiversity will be the single-most important initiative that has the potential to gain the local-level political support for the conservation of the Biodiversity Network. The City's Local Action for Biodiversity project needs to be focused on driving out this strategy.
10. A Stewardship strategy focusing on the conservation of privately-owned land in the City will need to be developed for the next five years and implemented in partnership with CapeNature.

The most important ingredient of success will be the City's adoption of a spatial vision that includes the conservation and celebration of its unique and internationally important biodiversity, one that sees future generations enjoying the results of our collective and bold action.

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