Msunduzi Municipality

Environmental Services Plan – Areas of biophysical importance

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1. INTRODUCTION

1.1. Background to assessment

The Msunduzi Municipality (Msunduzi)in conjunction with the national Department of Environmental Affairs and Tourism (DEAT) and the provincial Department of Agriculture and Environmental Affairs (DAEA) have appointed SRK Consulting (SRK) and their proposed Team to prepare an Environmental Management Framework (EMF) for the Msunduzi Municipal Area. As part of this project, the Institute of Natural Resources was appointed to assist in identifying areas required to maintain ecosystem goods and services in Msunduzi as part of the development of an Environmental Services Plan (ESP).

1.2. Description of study area

Msunduzi covers an area of approximately 640 km^2 and covers a wide range and diversity of land uses from urban, industrial and residential to large areas of afforestation and agriculture. Seven vegetation types occur within the study area (Figure 1) ranging from Drakensberg Foothill Moist Grasslands and indigenous forests in the west and north to dry eastern valley bushveld in the east of the Municipality (Figure 1).

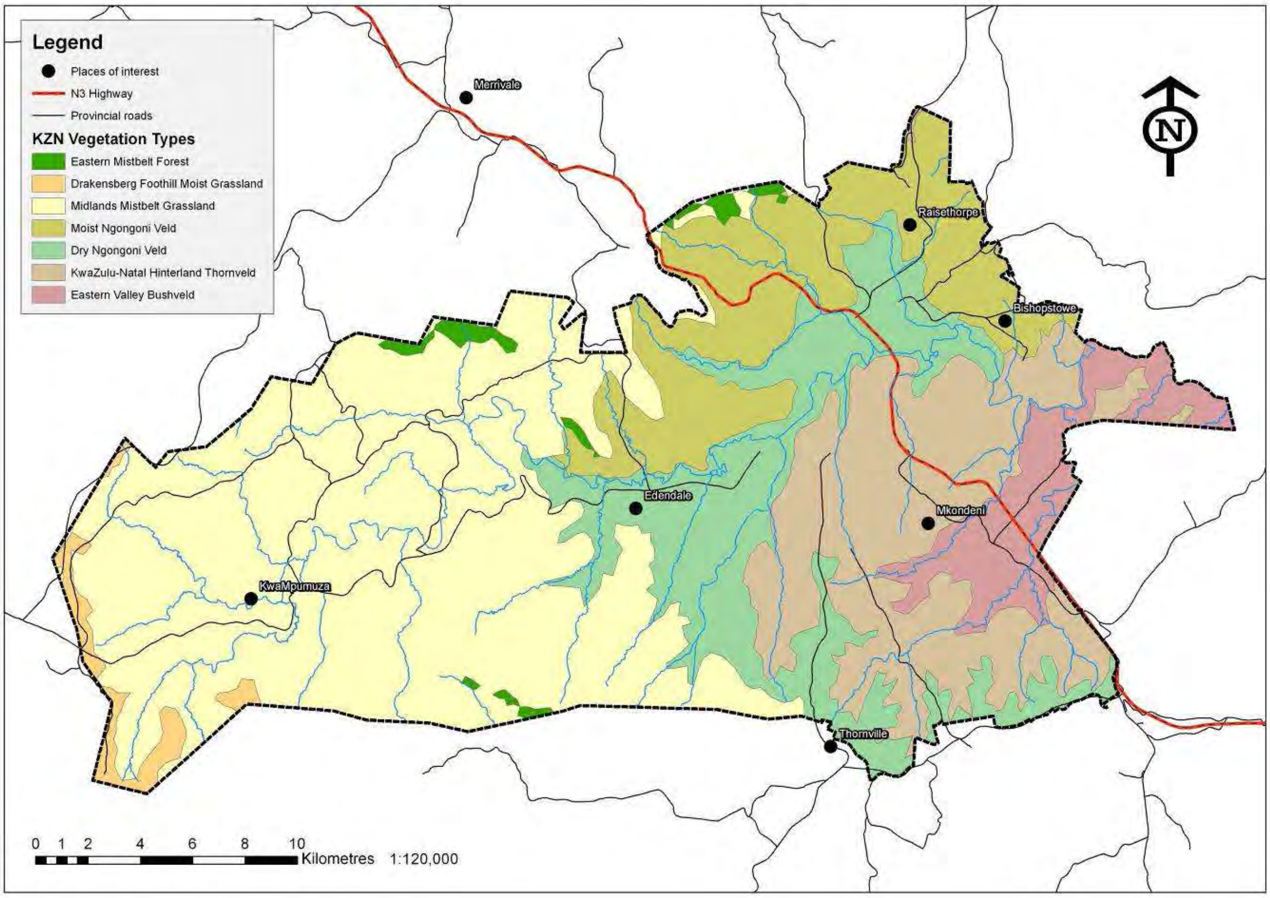


Figure 1. Map of the study area showing vegetation types occurring within Msunduzi.

As with many built up landscapes, large natural tracts of undeveloped land in Msunduziare limited and are becoming scarcer over time. Remnants of the natural environment increasingly occur as a mosaic of large and small patches, survivors of environments that have been carved up to develop new forms of productive land use for humans. This is particularly evident within the basin in which Pietermaritzburg town is situated with very little natural habitat remaining in these areas (Figure 2). Remaining natural fragments range from large blocks (such as those occurring on the hills around KwaMpumuza and the valley east of Mkondeni), to tiny remnants surrounded by intensive land use. Together they provide for the habitats upon which the conservation of much of the flora and fauna in the Municipality now ultimately depends.

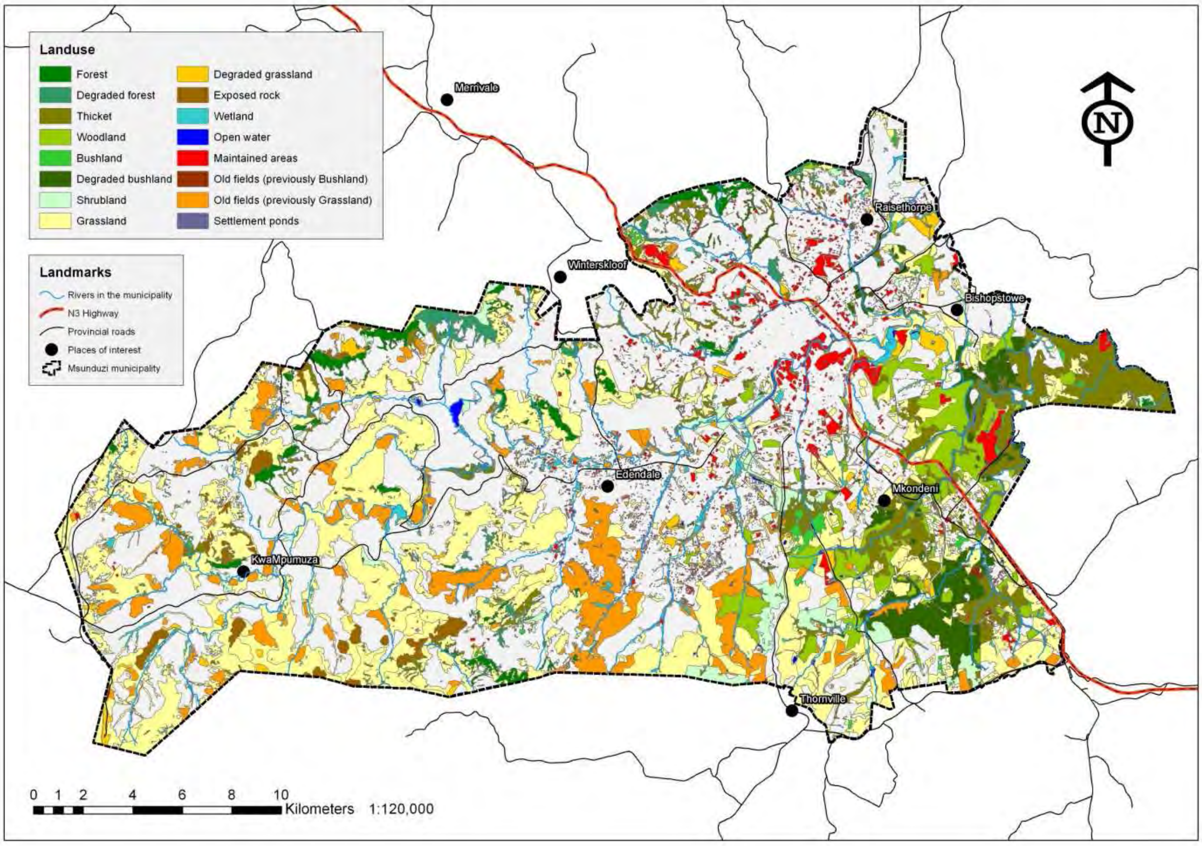


Figure 2. Map of Msunduziindicating the extent of untransformed landuse classes in the municipality (Macfarlane, 2008).

This transformation and fragmentation of the landscape has a major consequence for biodiversity conservation which includes a loss of species from fragments and entire landscapes, changes in the composition of faunal assemblages, and changes to ecological processes involving plant and animal species. Isolation of habitats, a fundamental consequence of the process of fragmentation, also influences the status of animal populations and communities in developed landscapes, making them more susceptible to natural and anthropogenic disturbances.

Despite current levels of fragmentation and transformation, sufficient habitat still remains to allow conservation targets for all but two vegetation types (Dry Ngongoni Veld and Moist Ngongoni Veld) and two plant species (*Dierama nixonianum* and *Senecio burnensis*) to be achieved. The high levels of current transformation does however mean that much of the remaining habitat is required to meet conservation targets as reflected by the dominance of high levels of irreplaceability for important biodiversity attributes across much of the municipality (Figure 3). Focussed interventions and careful decisions around land use zoning and management is therefore essential to prevent further loss of species and to ensure that biodiversity targets can be achieved.

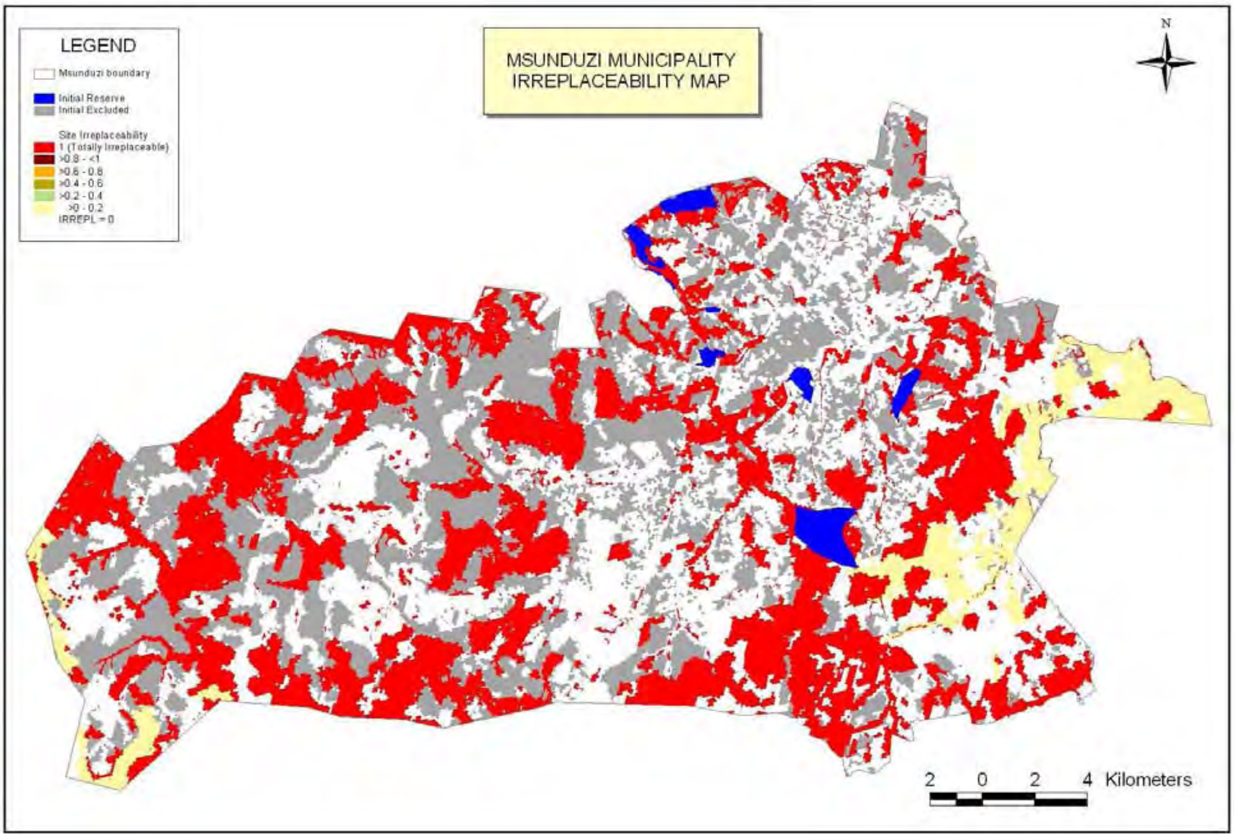


Figure 3. Map of Msunduzi indicating irreplaceability values of untransformed land (Macfarlane, 2008).

1.3. Scope of Work

Given the context in which the municipality finds itself, a real challenge remains to design and implement land-use strategies that will ensure the conservation of natural resources in the face of competing demands for land use. One strategy is to design and implement an ESP aimed at supporting the conservation and maintenance of threatened biodiversity within the municipality. The focus of this assessment was therefore to build on the work undertaken as part of the specialist biodiversity report (Macfarlane, 2008) to develop an input to the ESP which identifies priority areas for biodiversity conservation.

It is important to note that other social factors that should be considered in designing the ESP such as recreational and educational opportunities, aesthetic value and other practical considerations such as mechanisms to manage such areas has not been specifically addressed as part of this study but should be considered during planned refinement of the proposed open space system.

1.4. Specialist team

Mr. Douglas Macfarlane was responsible for project conceptualization, coordination, management and report compilation. He was supported by Mr. Leo Quayle who provided technical GIS support required to draft the ESP mapping.

2. METHODOLOGY

2.1. Clarifying objectives

Although the Municipality currently has no clear requirements for an ESP, they do recognize the role that such a system can play in sustainably managing natural resources in the Municipality. In this regard, Mr. Rodney Bartholomew (Municipal Manager: Conservation and Environment, Development Services), when questioned about the specific objectives relating to the development of an ESP, made reference to the IUCN definition of nature conservation which is 'the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations, while maintaining its potential, to meet the needs and aspirations of future generations'. This definition acknowledges that conservation is far more complex and comprehensive than simply preserving wildlife and "natural" areas and that the human habitat is now the biosphere as a whole.

The provision, protection and management of urban open space essentially talks to the quality of the urban environment and unfortunately if this is provided on an ad hoc basis the result is likely to be space lacking any meaningful functional, physical and visual integration into the urban structure. **A key objective in drafting an ESP for the Municipality has therefore been to design an open space system that maximizes the ecological viability of the ecosystems contained within the Municipality to ensure the persistence of biodiversity over the long term.** This is particularly important in a developing country with scarce resources such as South Africa where the open space system also provides an alternative source of many urban services to the costly engineering solutions so often adopted in developed countries that have greater resources (eThekwini Municipality, 2003).

In developing an ESP, it was also agreed that a broad-brush approach would be used during this first phase, so as to limit the risk of excluding potentially valuable areas. The intention is then , through a process of consultation with I&AP's, to define more detailed evaluation criteria (including social issues) to prioritise and if necessary eliminate areas deemed to be of lesser importance.

2.2. Prioritizing untransformed areas for biodiversity conservation

The first step in drafting the ESP was to identify a suite of priority areas to act as the backbone of the ESP. This was done by including existing protected areas and key areas for biodiversity conservation based on their importance for meeting conservation targets. The approach used to identify and classify priority areas is discussed in more detail below.

2.2.1. Incorporating protected areas

Protected areas form the logical first step in developing an ESP for the Municipality. A map indicating the location of existing protected areas in the municipality thus formed the first building block in the process. This includes two types of protected areas i.e. formal (Type 1) protected areas – those underpinned by strong legislation and effective management and Type 2 protected areas, i.e. those underpinned by weak or non-existent legislation. Given the current protection measures implemented in these areas, it makes sense that these areas be identified as starting point for developing an ESP for the Municipality. Those protected areas occurring within the municipality are summarized in Table 1 and distribution reflected in Figure 4.

Table 1. Protected areas (Type 1 & 2) occurring in the Msunduzi Municipality.

Name	Type	Extent (Ha)	Description
Queen Elizabeth Park	1	93.5	This park is managed by Ezemvelo KZN Wildlife on 99 year lease but the land is owned by Msunduzi Municipality. The park was proclaimed under the Provincial ordinance as a park and provides important habitat for a range of important species such as the Natal leaf-folding frog, Black-headed dwarf chameleon and Hilton Daisy. The park also acts as the headquarters for Ezemvelo KZN Wildlife and is used as a recreational area by the general public.
Bisley Valley Nature Reserve	2	358.4	This reserve was proclaimed in terms of the town planning scheme as a Nature Reserve in 1986. The reserve is owned by Msunduziwho are responsible for management of the reserve. The nature reserve was initially proclaimed to preserve and protect biodiversity and to provide recreational opportunities to Pietermaritzburg residents. Important species known from this reserve include the modest millipede, Shaw's earthworm, the javelin flat-backed millipede, and corn crake. There are a number of walking trails, bird hides and a resource centre for day visitors and basic overnight accommodation for 16 visitors.
Ferncliff Nature Reserve	2	147.6	This reserve was proclaimed in terms of the town planning scheme as a Nature Reserve in 1986. The reserve is owned

Name	Type	Extent (Ha)	Description
			by Msunduziwho are responsible for management of the reserve. The reserve was established largely due to conservation significance of the site, representing one of last remaining remnants of Mistbelt Forest in the Pietermaritzburg area. This forest also represents the type locality for a range of invertebrate species. The nature reserve offers a number of trails, picnic sites and an education resource centre for day visitors. Cannot accommodate overnight visitors.
Worlds View Conservation Area	2	31.7	This conservation area was proclaimed in terms of the town planning scheme as a Conservation Area in 1995. The site encompasses indigenous Mistbelt grasslands between worlds view road and old Howick road. The site was proclaimed largely because of its biological diversity and presence of rare and endangered species such as the Hilton Daisy. Only a portion of this site falls within the demarcated Msunduzi Municipal boundary.
Hesketh Conservation Area	2	92.5	This conservation area has been proclaimed in terms of the town planning scheme as a Conservation Area. The site represents an area of Southern Tall grassveld, located above the Maritzburg Golf Course in the Scottsville area. The site was proclaimed largely due to the need to protect areas of this veld type. The site is particularly well known for its ground orchids and other plant species.
Alexandra Park	2	71.4	This park was donated to the Municipality by a resident for the management as a park for urban residents. Protection of this area is written into the title deeds. The park is widely used for recreational use – there are few environmental components of any value.
Wylie Park	2	10.6	This park was also donated to the Municipality by a resident for the management as a park for urban residents. The site is perhaps most important for its horticultural value as an arboretum which is also used for passive recreation.
Pietermaritzburg National Botanical Gardens	2	47.7	The botanical gardens are managed and owned by National government. The area is an important arboretum and used for passive recreation but does have some untransformed land with some biodiversity value.

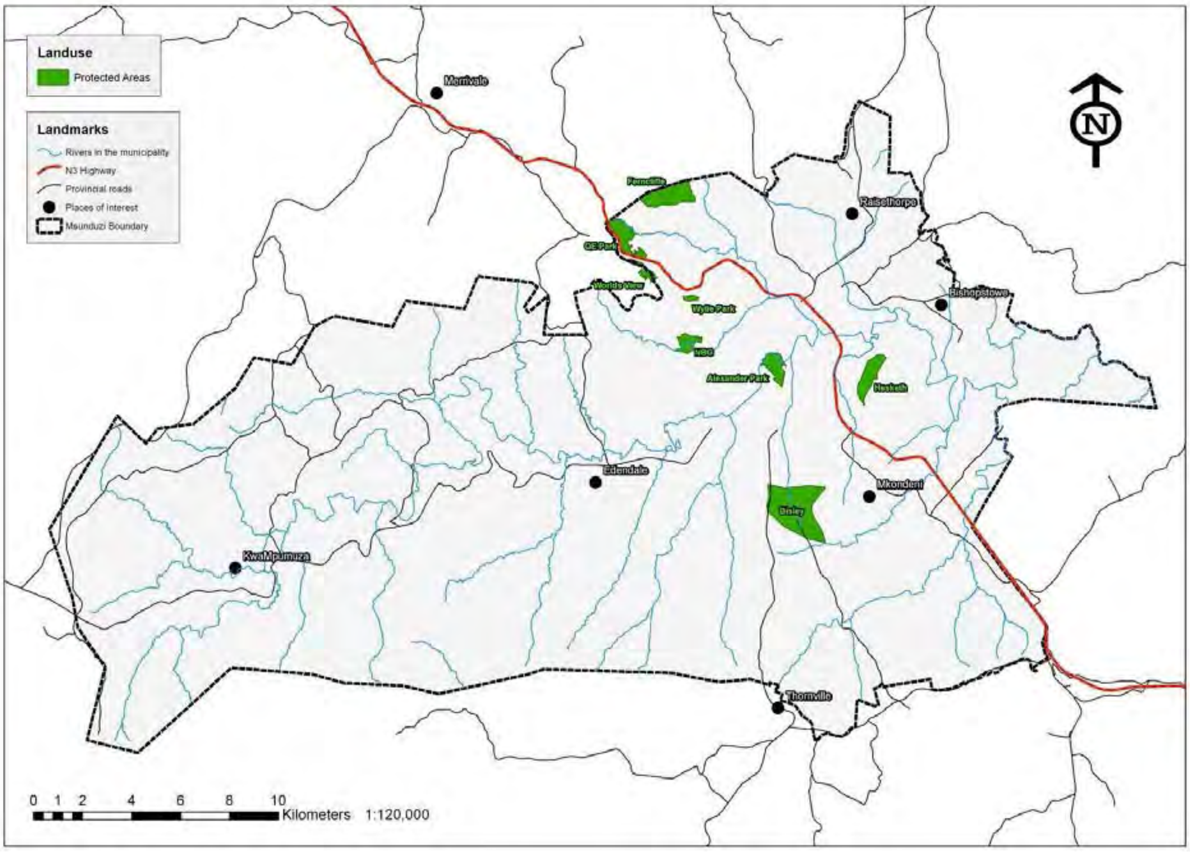


Figure 4. Location and extent of protected areas in the Msunduzi Municipality.

2.2.2. <u>Identifying key areas of natural habitat</u>

Protection of a representative set of natural areas that are regarded as high priority for biodiversity protection should be included as part of the 'backbone' of the ESP. Ideally, these areas would include large, intact blocks of representative habitat, but in a largely transformed landscape, such as that occurring within the municipal boundary, many small remaining areas are now essential to meet biodiversity targets for a range of species.

The systematic conservation plan developed for the Municipality was used as the basis for identifying key areas of natural habitat for inclusion in the ESP (Macfarlane *et al,* 2008). One of the primary outputs of the systematic conservation plan was a map indicating the irreplaceability of untransformed land in the Municipality (Figure 3). This map is divided primarily into 1 ha hexagonal grid cells called 'planning units' with additional planning units based on the extent of natural forest and wetland systems, as well as the protected areas. Each cell has an associated 'Irreplaceability Value' which is a reflection of the planning unit's importance with respect to the conservation of biodiversity. Irreplaceability reflects the planning unit's ability to meet set 'targets' [1]for selected biodiversity 'features'. The irreplaceability value is scaled between 0 and 1.

Irreplaceability value – 0. A planning unit with an irreplaceability value of 0 indicates that a planning unit is not required to meet any biodiversity feature target, and thus there is unlikely to be a biodiversity concern with the development of the site. There is no need from a biodiversity perspective to include such areas in the ESP, unless they can form part of a linkage between areas of key habitat (See Section 2.3.2).

Irreplaceability value – 1. These planning units are referred to as totally irreplaceable, for without the protection of these units, the conservation target of the feature(s) within its extent will not be met.

Irreplaceability value > 0 but < 1. Some of these planning units are required to meet biodiversity conservation targets. If the value is high (e.g. 0.9) then most units are required (few options available for alternative choices). If the value is low, then many options are available for meeting the biodiversity targets. It must be remembered though, that the development of one of these sites affects the irreplaceability value of all of the remaining negotiated sites within the planning domain as a whole. Although not identified as key habitats, these areas are potentially important linkages between key habitats (See Section 2.3.2)

A simple classification system was therefore applied to the outputs of the conservation plan to specifically identify key habitats for biodiversity conservation. Given that all features with an irreplaceability value of 1 are required to meet conservation targets, all mapped units with scores = 1 were earmarked for inclusion in the ESP by classifying them as "**Key Areas**". The distribution of these areas is presented in Figure 5, below.

[1] Area-based targets for habitat conservation are set for important biodiversity features including vegetation types and species habitats. Targets reflect the area of suitable habitat that is required to help ensure the conservation of biodiversity attributes within the study area.

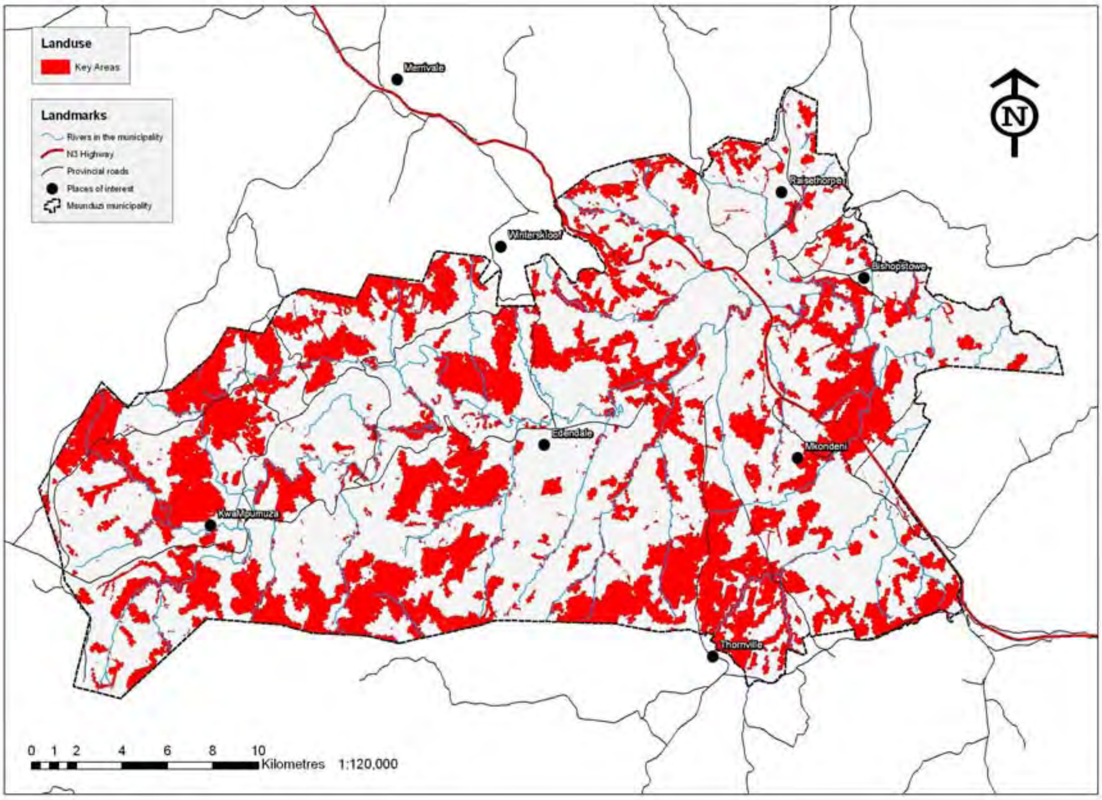


Figure 5. Distribution and extent of key areas for biodiversity conservation in the Msunduzi Municipality.

In order to provide additional information for planning and prioritization, sites were further ranked from 1 to 5 by averaging summed irreplaceability values calculated using Marxan for each feature (Macfarlane, 2008). These values represent the frequency with which planning units were selected by the conservation planning software in order to meet biodiversity targets. The following ranking system was applied:

1. Priority 1: Top 1% of planning units;
2. Priority 2: Next 4% of planning units;
3. Priority 3: Next 15% of planning units;
4. Priority 4: Next 30% of planning units.
5. Priority 5: Remaining 50% of planning units (not specifically required to meet targets)

This approach helps to highlight those sites that are more important than others in maintaining biodiversity within the Municipality that could be prioritized for acquisition or management. The result of this classification is indicated in Figure 6 below.

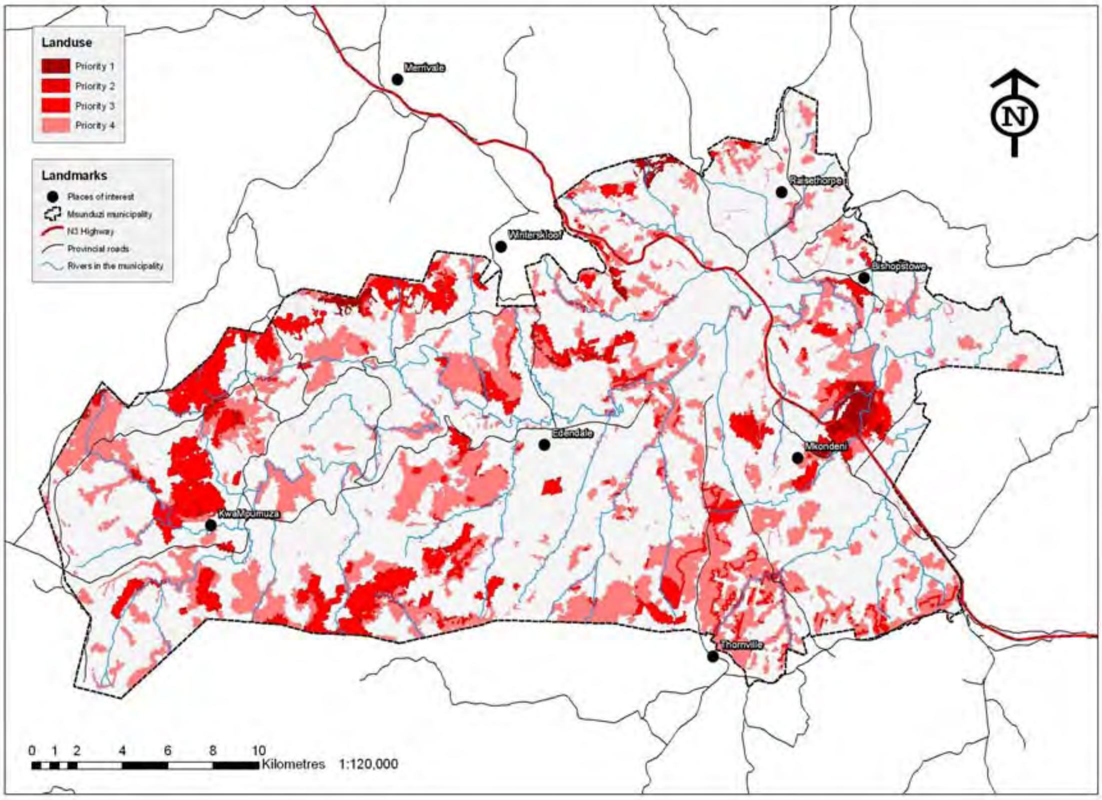


Figure 6. Classification and ranking of natural habitat based on the necessity for meeting conservation targets.

Remaining areas of untransformed land may still play an important role in (i) meeting conservation targets or (ii) acting as linkages between priority conservation areas. Although not identified as key habitats, these areas are potentially important linkages between key habitats and were considered further in Section 2.3.

2.3. Identification of linkages to maintain and restore connectivity

Once priority habitats had been identified, the next step involved identifying appropriate linkages to maintain and restore connectivity and increase the resilience of the proposed ESP. A review of relevant literature was undertaken to define design criteria that were then used to identify a suite of appropriate linkages.

2.3.1. Review of scientific literature

Bennet, (1998, 2003) in the book entitled “Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation” provides a synthesis of available science and current thinking on linkages for biodiversity conservation. This reference formed the primary reference used to inform this study. A summary of pertinent points provided in the text, and supported by a range of other sources is summarized below:

2.3.1.1. The importance of connectivity

Maintenance of connectivity within and between ecosystems in the landscape is well recognized as contributing significantly to biodiversity conservation, particularly in highly transformed landscapes (Bennet, 1998, 2003). Connectivity, in this context, can be defined as 'the degree to which the landscape facilitates or impedes movement among resource patches' (Taylor *et al*. 1993 in Bennet, 1998, 2003). Various authors have demonstrated the importance of maintaining connectivity, with close correlations having been demonstrated between the extent of unbroken surface and species richness within ecosystems as well as the population viability of these species (Bond *et al.*, 1988).

Maintaining connectivity is important for maintaining the viability of existing populations for a number of reasons. Firstly, increased connectivity increases immigration rates to isolated habitats. This can contribute to the maintenance of higher species richness and diversity by supplementing declining populations and reducing their risk of extinction (Bennet, 1998, 2003). Increased movement also facilitates genetic mixing and prevents inbreeding, which decreases the genetic diversity and thus contributes to the long-term survival of the species (Williams *et al.*, 2005). Corridors may also allow the re-establishment of areas following local extinctions (Bennet, 1998, 2003). This is demonstrated by Samways and Taylor (2004) who found that newly rehabilitated riparian buffer zones enabled dragonflies to re-colonize previously isolated habitats and to reconnect with isolated populations, within as little as one year.

Within populations, corridors allow the connection of breeding, feeding and refuge sites crucial to maintain the population viability of many species (Sheldon *et al.*, 2003). For many semi-aquatic reptile species, such as the Nile crocodile, Nile monitor and Cape terrapin for example, connectivity between aquatic habitats is regarded as vital as these species often cross land in order to find suitable hibernating spots or patches of permanent water in the dry season (Cowan, 1995). A range of snake species, such as *Lycodonomorphus rufulu*, *Lamprophis aurora* and *Psammophylax rhombeatus* hibernate in aggregations, thus requiring connectivity in order for individuals to congregate (Cowan, 1995).

Although fine scale corridors enable short distance or regional movements, they also play a role in sustaining long distance migrations. Many birds, for example, including little bitterns, ringed plover, common sandpiper and greenshanks, use riparian vegetation (in buffers) as migratory routes

(Cowan, 1995). This is likely to be particularly important in urban areas, which are major obstacles in a bird's migration route. In such areas, corridors, such as those created by establishing buffers along water courses may provide the only suitable pathway through these obstacles along which these species can travel (Biohabitats Inc., 2007).

Despite the numerous reported advantages of corridors, it is worth noting that there are also a range of reported disadvantages. These range from facilitating the spread of unwanted species and abiotic disturbances, to high management costs that may reduce funds available for alternative conservation actions. A summary of reported advantages and disadvantages of corridors is presented in Table x below.

Table 2. Reported advantages and disadvantages of linkages for biodiversity conservation (Bennet, 1998, 2003).

Reported Advantages	Reported disadvantages
Assist in the movement of individuals through disturbed landscapes, including • Wide ranging species that move between habitats on a regular basis; • Nomadic or migratory species that move between irregular or seasonally varying resources; • Species that move between habitats at different stages of their life cycles	Increase immigration rates to isolated habitats which could: • Facilitate the spread of unwanted species such a pests, weeds and exotic species; • Facilitate the spread of disease; • Introduce new genes which could disrupt local adaptations
Increase immigration rates to isolated habitats which could: • Maintain higher species richness and diversity; • Supplement declining populations, thus reducing their risk of extinction; • Allow re-establishment following local extinction; • Enhance genetic variation and reduce the risk of inbreeding occurring.	Increase exposure of animals to: • Predators, hunting or poaching by human or other sources of mortality • Competition or parasites.
Facilitate the continuity of natural ecological processes in developed landscapes.	Act as 'sink habitats' in which mortality exceeds reproduction, and thus functions as a 'drain' on the regional population.
Provide habitat for many species including: • Refuge and shelter for animals moving through the landscape; • Plants and animals living within linkages.	Facilitate the spread of fire or other abiotic disturbances.
Provide ecosystem services such as maintenance of water quality, reduction of erosion, and stability of hydrological cycles.	Establishment and management costs could reduce the resources available for more effective conservation measures, such as the purchase of habitats for endangered species.

Despite the possible disadvantages, it is worth noting that many of these would apply equally to large intact landscapes. Indeed, habitat connectivity is a characteristic of natural environments. As such, protection or restoration of connectivity is not an artificial change in landscape: rather, it is the loss of connectivity and isolation of natural environments that is a result of human interference. There is also clear evidence that isolation of populations and communities through the loss of intervening habitat has a detrimental effect. Following the 'precautionary principle' therefore demands that where knowledge is limited, **the prudent approach is to retain existing natural linkages due to the large range of potential benefits they provide**.

2.3.1.2. Corridors and climate change

The importance of maintaining connectivity has also been highlighted in the face of climate change and in response; corridors are being increasingly incorporated in a range of strategic conservation planning initiatives (2009 Biodiversity Planning Forum). This is because the distribution ranges of many species will change, challenging the ability of our present fixed conservation areas to protect them (Williams *et al.*, 2005). For example two-thirds of the 330 endemic *Proteaceae* species of the fynbos biome are projected to experience complete range dislocation by 2050 (Midgley *et al.*, 2002). The critically endangered riverine rabbit, endemic to the central Karoo, is another species likely to be significantly affected by climate change, with an expected 96% loss of its current suitable habitat due to climate change (Hughes *et al.*, 2008). Although no specific information is available on the susceptibility of species with the Msunduzi Municipality, climate change will undoubtedly affect the potential viability of local species populations.

Bennet, (1998, 2003) highlights a number of reasons why linkages may play an important role in safeguarding against climate change that includes:

1. Assisting plants and animals to extend their geographic range to track suitable climatic conditions. Linkages most likely to be suited to help plants and animals extend their geographic ranges are those that link habitats across an elevational gradient to facilitate range shifts.

2. Helping to maintain the continuity of species populations through their present geographic range, thus maximizing a species ability to persist within those parts of its range where climatic conditions may remain suitable. This recognizes that redistribution of plants and animals within an existing range is more feasible than range shifts to new areas.

3. By interconnecting existing protected areas, they may help to maximize the resilience of the present conservation network. In this regard, linkages that maintain large continuous

habitats or that maintain connectivity between a number of protected areas along an environmental gradient is likely to be most valuable.

Maintenance of corridors is therefore likely to be one of the most important strategies for biodiversity conservation in response to climate change.

2.3.1.3. Factors to consider when designing linkages

When designing and prioritizing corridor networks, there are a range of factors that affect the functionality of the corridor and should be considered (Bennet, 1998, 2003). These are briefly described below in order to provide guidance on corridor design criteria to be used in this study.

Spatial scale at which linkage maintains ecological processes

Linkages can be established at a range of scales from local; operating over metres (e.g. streams, roadsides, underpasses etc) to landscape scale; operating over kilometers (e.g. rivers & associated riparian vegetation, broad links between reserves etc) and regional or biogeographic scales; operating over hundreds of kilometers (e.g. major river systems; mountain ranges etc).

While linkages that maintain natural ecological processes and continuity of species distributions at the biogeographic and regional scale are likely to be most important at a national level, such linkages can usually not be established at a local (e.g. Municipal) scale. Within the study area, opportunities for establishing corridors at the landscape and local scale should therefore be considered.

Level of redundancy of the linkage and associated habitat

Highest priority should be given to those situations where there are no feasible alternatives for maintaining connectivity, where the loss of existing linkages would be essentially irreplaceable, or where no other habitat systems conserve a particular community of animals (Bennet, 1998, 2003). Corridors are therefore likely to be most important in situations where large parts of the landscape has been modified and is inhospitable to native species ((e.g. within built-up areas).

Degree of threat to species or communities in the habitats to be linked

Priority should be given to developing linkages that connect species or communities that warrant special conservation attention. Decisions should however be informed by known causes of species declines, mobility of species concerned and habitat requirements of the species concerned.

Present condition of the linkage

Tracts of natural vegetation have greater conservation potential as linkages than comparable areas of land that require partial or major restoration. Priority should therefore be given to largely undisturbed areas of natural vegetation.

Range of species that the linkage will benefit

In general, links that enhance the conservation status of a group of species, or entire communities of animals should receive higher priority than those that function for one, or only a few species. This is partially related to the size of the linkage as discussed further in this document.

Capacity of the linkage to provide other ecological and environmental benefits

Linkages that provide a range of environmental benefits, without compromising their role of ensuring connectivity of wildlife, should be prioritized over those that only have a single purpose. Streamside corridors are particularly important in this regard, as discussed further in section 2.3.1.5.

2.3.1.4. Determining appropriate widths of linkages

The width of linkages is particularly important as it influences most of the aspects that affect the functionality of the corridor. Indeed, maximizing width is regarded as one of the most effective options to increase the effectiveness of corridors for wildlife conservation (Bennet, 1998, 2003). There are no generic widths that can be easily applied in the design of linkages in the Municipality however. Some generic principles should however be considered in corridor design and include:

- Reduction in edge effects can be most effectively minimized by increasing the width or size of corridors;
- Increased width typically incorporates a large area with potential greater diversity of habitats that is likely to act as a useful link for a wider variety of species and;
- Larger widths increase the likelihood of the corridor providing appropriate requirements for species requiring large amounts of space or specialized feeding and habitat requirements.

The following 'rules of thumb' have been proposed by Harris and Scheck for deciding on an appropriate corridor width (1991 in Bennet, 1998, 2003):

- *'for the movement of individual animals where much is known of their behavior and the corridor is tended to function over weeks or months, the appropriate width can be measured in metres;*
- *For the movement of a species, when much is known of its biology and when the corridor is expected to function over years, the width should be measured in 100's of metres;*
- *When the movement of entire assemblages is considered and / or when little is known of the biology of the species concerned, and/or the corridor is intended to function over decades, the appropriate width must be measured in kilometres'*

There is therefore no generic solution for a linkage that will meet the requirements of all species. A link for one species may be ineffective for others that move at different scales. Different widths of ecological linkages are therefore required to promote movements at different scales to cater for the full range of species occurring in a landscape (Bennet, 1998, 2003).

2.3.1.5. Importance and design of riparian corridors

Riparian vegetation along stream lines forms a natural hierarchical system of natural linear habitats through the landscape that represent a natural choice for corridor selection. Such areas typically persist even in highly developed areas due to factors such as flood risk that reduce their utility for alternative land uses. Selecting riparian corridors as linkages is a useful approach for biodiversity conservation for a number of reasons:

- Riparian vegetation is well known to be a rich habitat for fauna, being an interface between aquatic and terrestrial environments;
- Adjacency of aquatic and terrestrial environments is important for species that require both habitats for their life cycles (e.g. frogs and dragonflies);
- Riparian ecosystems frequently support species adapted to streamside habitats that are not found in terrestrial habitats (e.g. otters);
- Fertile alluvial soils and greater availability of water contributes to higher productivity on riparian zones. This typically leads to greater structural diversity and volume of vegetation which may support greater numbers of species and individual populations than terrestrial areas (Bennet, 1998, 2003).

Apart from their value as wildlife corridors, buffer zones established along stream lines have a range of other important ecological functions and values in the landscape that add to their importance. For example:

- Vegetation slows runoff into streams and increases the rate at which water infiltrates the soil;
- Riparian vegetation and wetlands can moderate flood levels by providing floodwater storage;
- Filtration of sediments from adjoining landuses that can reduce the loss of storage capacity of downstream dams;
- Trapping of nutrients before they reach the stream, thus improving water quality;
- Stabilizing stream banks and preventing erosion;
- Shading rivers and streams thereby reducing water temperature, thereby increasing the levels of dissolved oxygen, thereby influencing the capacity of water resources to support aquatic biodiversity.

The effectiveness of riparian buffer zones on providing a range of services is dependent on a range of characteristics such as vegetation structure and density, slope of the buffer and soil characteristics. Perhaps the most important variable affecting functioning however is the width of the buffer applied, with some functions adequately performed by narrow buffers while others require extremely wide buffers. Recommended buffer widths for a range of recognized buffer functions are illustrated in Figure 7 below.

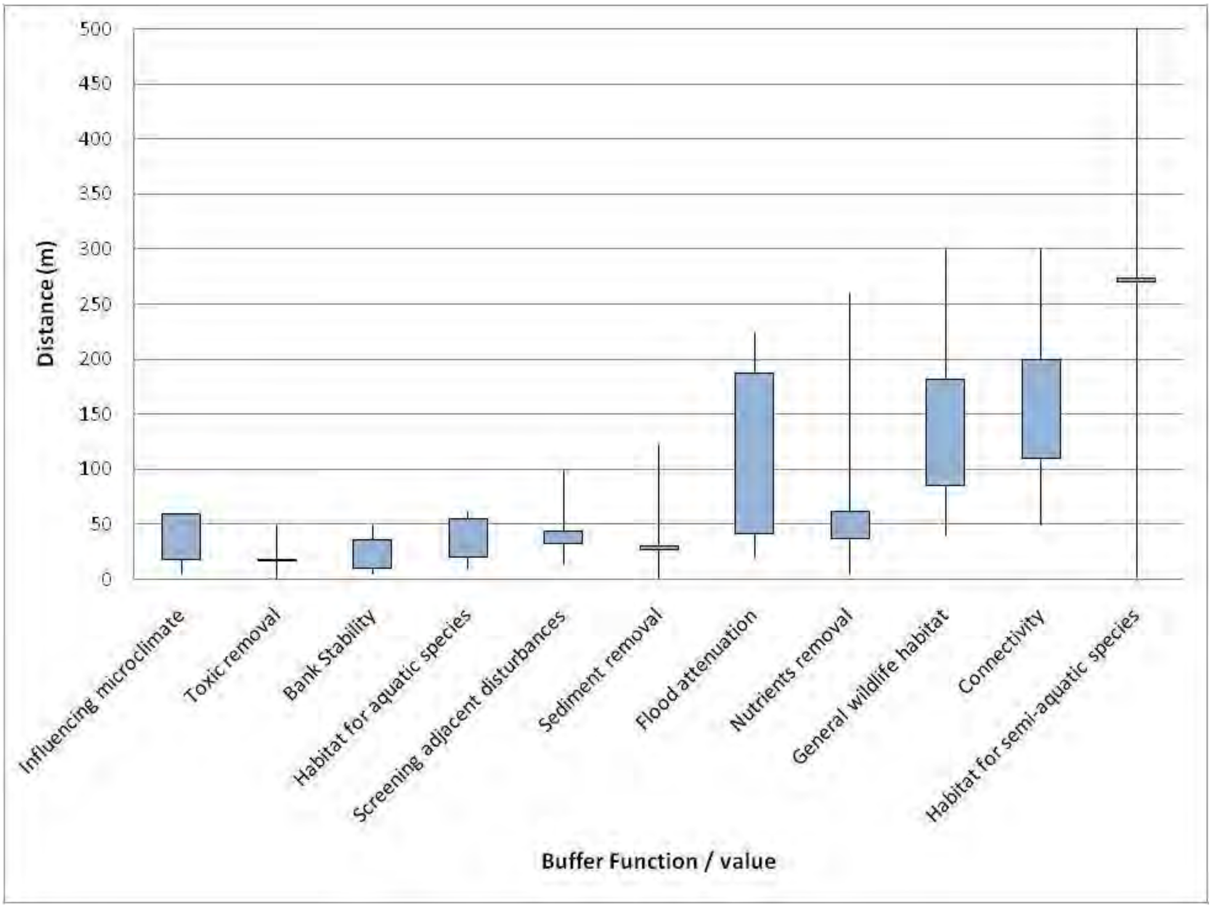


Figure 7. Summary of recommended buffer widths for the provision of different buffer functions and values. Boxes represent average upper and lower recommended widths while lines represent upper and lower ranges (note that upper range for habitat for semi-aquatic species is 2200m). (Source: Macfarlane *et al.*, 2009)

This figure shows that buffer widths of between 90 and 200m are typically required to provide appropriate habitat for general wildlife and to maintain connectivity while larger buffers may be required to cater for specific needs of important semi-aquatic species. Widths required to reduce water quality impacts on the other hand are typically far smaller, typically ranging from 10 – 60m. The effect of increasing buffer width on pollutant levels and wildlife habitat value is elegantly presented by Desbonnet *et al.* (1993, 1994) as illustrated in Table 3 below.

Table 3. Summary of sediment and pollutant removal effectiveness and wildlife habitat value based on buffer width (Desbonnet et al 1993, 1994)

Buffer Width	Pollutant Removal Effectiveness	Wildlife Habitat Value
5m	Approximately 50% or greater sediment and pollutant removal	Poor habitat value, useful for temporary activity of wildlife.
10m	Approximately 60% or greater	Minimally protects stream habitat, poor wetland habitat, useful for

Buffer Width	Pollutant Removal Effectiveness	Wildlife Habitat Value
	sediment and pollutant removal	temporary activity of wildlife.
15m	Greater than 60% sediment and pollutant removal	Minimum general wildlife and avian habitat value.
20m	Greater than 70% sediment and pollutant removal	May have use as a wildlife travel corridor for some species as well as minimal to fair wildlife habitat.
30m	Approximately 70% or greater sediment and pollutant removal	May have use as a wildlife travel corridor for some species as well as minimal to fair wildlife habitat.
50m	Approximately 75% or greater sediment and pollutant removal	Minimum to fair general wildlife habitat value.
75m	Approximately 80% or greater sediment and pollutant removal	Fair to good general wildlife and avian habitat value.
100m	Approximately 80% or greater sediment and pollutant removal	Good general wildlife and avian habitat value; may protect significant wildlife habitat value.
200m	Approximately 90% or greater sediment and pollutant removal	Excellent general wildlife and avian habitat value; likely to support diverse community.
600m	Approximately 99% or greater sediment and pollutant removal	Excellent general wildlife and avian habitat value; likely to support diverse community; protection of significant species.

2.3.2. Methodology applied in identifying and mapping linkages

Riparian vegetation along stream lines forms a natural hierarchical system of natural linear habitats through the landscape that represent a natural choice for corridor selection. Such areas typically persist even in highly developed areas due to factors such as flood risk that reduce their utility for alternative land uses. These zones also provide a range of functions other than those necessary for biodiversity persistence and maintenance which provides additional incentives for protecting such areas.

The first step in developing an appropriate network of linkages was therefore to identify riparian corridors for inclusion in the ESP. Once these had been defined, the suitability of these linkages in maintaining connectivity between key areas of natural habitat was reviewed and used to update and improve the proposed corridor network based on species-specific requirements. The process followed in identifying and mapping these linkages is described in more detail below.

2.3.2.1. Identification and mapping minimum riparian corridors

The key question in mapping preliminary riparian corridors was: What width should be applied? As illustrated in Table 3, widths of buffers have implications for both water quality and wildlife habitat value, together with a range of other functions and values provided. Buffers of 20m provide a reasonable level of protection for water quality while providing a minimum width for wildlife movement. These buffers, together with an accuracy buffer for mapped wetlands were therefore identified as minimum riparian corridors around mapped wetlands and streamlines in the study area.

Development within areas prone to flooding is also typically restricted, with the National Water Act requiring 1:100 year flood lines to be established and shown on township development plans to inform development planning (SRK Consulting, 2009). In discussion with Mr. Rodney Bartholomew it was agreed that, due to the constraints to development in these areas and potential benefits associated with wider corridors for wildlife species, that such areas should be included in the ESP. The indicative flood buffer zone coverage for a 1:100 year recurrence interval flood (SRK Consulting, 2009) was therefore combined with the preliminary buffers applied to refine minimum riparian corridors for the study area. Minimum riparian corridors delineated through this process are classified in Figure 8 and presented together with Key areas in Figure 9.

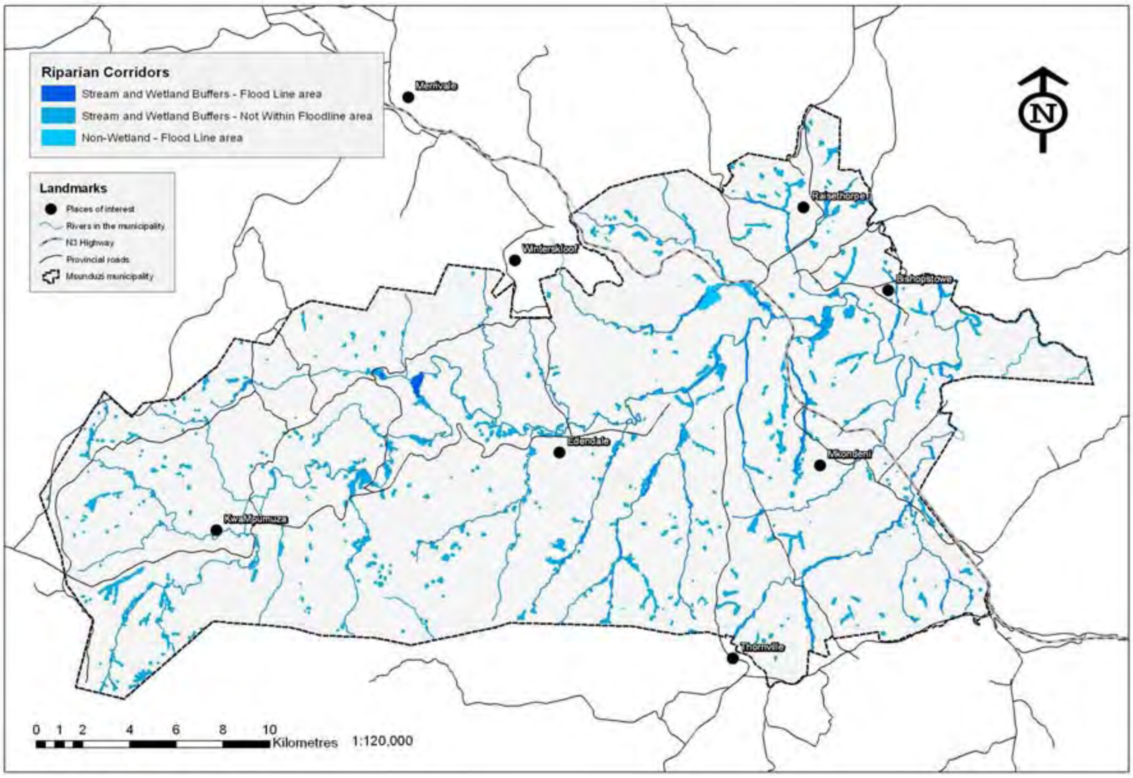


Figure 8. Map indicating different classes of riparian corridors included in the ESP mapping.

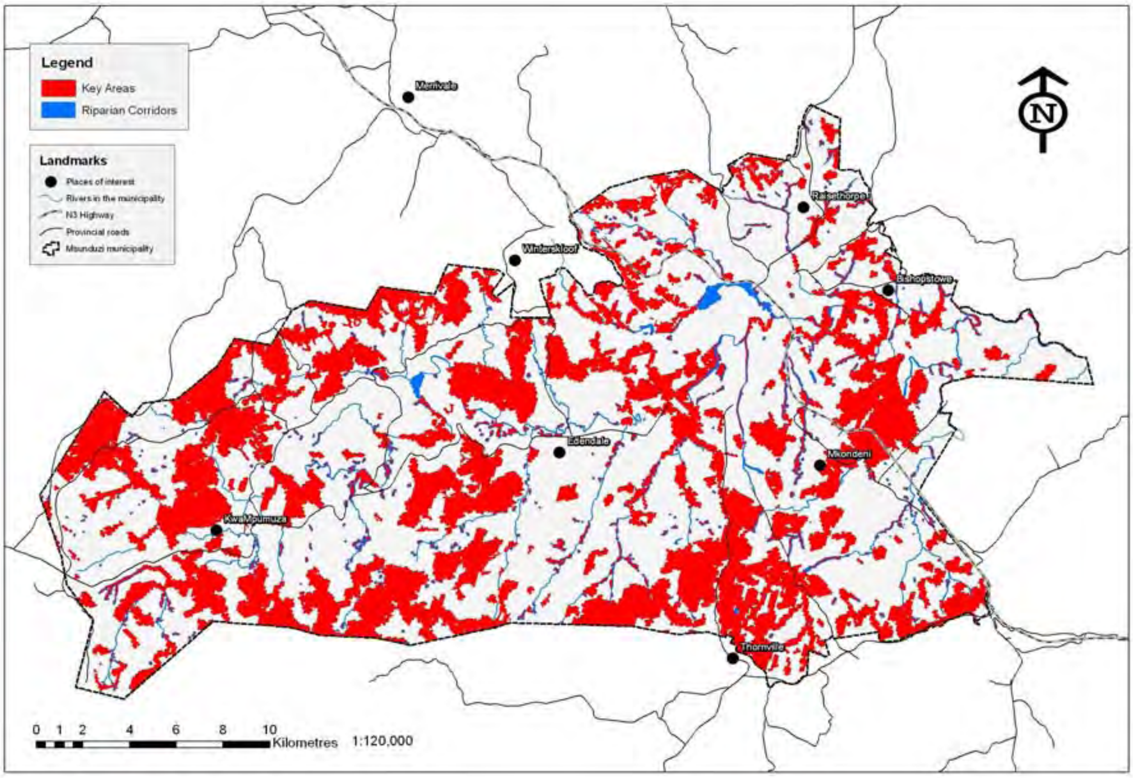


Figure 9. Map indicating key areas together with minimum riparian corridors defined for the study area.

These corridors include both transformed and untransformed areas and serve to highlight areas where existing and future development should be carefully managed to limit impacts on aquatic systems and help maintain natural vegetation as corridors for indigenous species.

2.3.3. Identification and mapping of additional terrestrial corridors to meet specific species requirements

Once initial riparian corridors had been established, the need for establishing additional terrestrial corridors was evaluated. This involved systematically assessing the importance of (i) proposed riparian corridors and (ii) additional terrestrial corridors as linkages between areas of priority habitat where the species were recorded. While it is recognized that connectivity may be important for plant species, this has been partially addressed through the identification of minimal critical patch size used to identify priority areas during the systematic conservation planning process. The assessment was therefore limited to animal species. The following criteria were used to identify priority species for the creation of terrestrial corridors:

- Mobility of the species – corridors are likely to be more important for mobile species that move over kilometers than for species that move over metres during their lifetime;
- The ability of the species to disperse through mechanisms other than terrestrial habitats (e.g. via stepping stones of suitable habitat, along a waterway);
- The relative restrictions to movement in transformed areas (e.g. ability to move through residential lots / agricultural fields)

The results of this assessment is presented in Annexure 1 and helped to identify species where incorporation of additional terrestrial corridors was required. For each of the priority species, the distribution of priority habitats was overlaid in GIS over the draft ESP to help determine the need for additional terrestrial corridors. This was informed by:

- The degree to which core areas were already linked through the ESP;
- Availability of suitable habitat to link core areas (level of transformation, available habitat);
- Presence of restrictive barriers (e.g. N3) that could affect the effectiveness of proposed corridors;
- Distance of separation between core areas.

Where linkages were deemed adequate, no additional terrestrial corridors were proposed. In the few instances where linkages between existing key areas was inadequate, and the creation of additional corridors was feasible (suitable habitat still available; distance between areas limited), additional terrestrial corridors were created. A brief summary of the assessment and any new corridors included is presented in Table 4, below.

It should be noted that the N3 and other major roads do act as a significant barriers to many species. This assessment has not specifically looked at how restrictions to movement associated with road networks can be overcome. This should however potentially be a focus in key areas such as the Mkondeni Valley, where the N3 acts as a significant barrier between important biodiversity areas on either side of the highway.

Consideration was also given to the need to introduce additional linkages in response to pressures from Climate Change. Given the large extent of areas covered by the ESP mapping, reasonable level of connectivity and inclusion of some large areas with good altitudinal variation, no additional areas were specifically identified to increase resilience in response to the threat of climate change.

Table 4. Species for which terrestrial corridors were identified as important and steps taken to improve linkages between identified core areas.

Scientific name	English Name	Corridor design considerations	Riparian corridors	Terrestrial corridors	Map reference – See Annexure 2	Adequacy of preliminary network?	Modifications to preliminary ESP Mapping
Bradypodion melanocephalum	Black-headed dwarf chameleon	Although slow moving, corridors would be useful in promoting the maintenance of remaining populations of this species. Given the species ability to use a range of habitat types, even somewhat degraded areas (e.g. areas infested by alien plants) may act as suitable corridors for this species. Riparian corridors may also be effective in maintaining connectivity between remnant habitat patches.	Y	Y	Map 1	The preliminary ESP already provides good connectivity between QE Park (Priority area) and other potential habitat for the species in Ferncliff Nature Reserve (See point 1). A number of the secondary areas identified as important for this species are also already included in the ESP Mapping, many of which are already adequately connected (e.g. areas along the South-facing slopes of the Edendale valley – See Point 2). Areas of potential habitat are also reasonably well connected in the hills along the northern borders of the Edendale area (See point 3).	No additional terrestrial corridors required
Crocidura maquassiensis	Makwassie musk shrew	Corridors are potentially important for this species, although habitat characteristics of the corridor are likely to affect use by this small shrew. Given the species preference for wetland areas and moist grassland, maintenance of riparian corridors may provide a reasonable level of connectivity between areas of suitable habitat.	N	Y	Map 2	The preliminary ESP already caters for the protection of much more habitat than is required to meet conservation targets (7% of priority 2 areas). Areas of potential habitat just north of Edendale are already well connected (See point 1). Suitable habitat near QE Park is also reasonably well connected, with no additional terrestrial corridors required in this area (See point 2). Potential habitat also occurs near Raisthorpe & Bishopstowe (See point 3). The preliminary ESP does not adequately cater for the species in this area but the preliminary ESP already caters for most habitat requirements of this species. No further corridors were therefore considered in this area.	No additional terrestrial corridors required

Scientific name	English Name	Corridor design considerations	Riparian corridors	Terrestrial corridors	Map reference – See Annexure 2	Adequacy of preliminary network?	Modifications to preliminary ESP Mapping
Dasophrys natalensis	Natal robberfly	Given the mobility of this species, corridors between forest patches are likely to contribute to the conservation of this species.	N	Y	Map 3	Priority habitat for this Mistbelt forest margin species was identified as the Ferncliff Nature Reserve (See point 1). This habitat is connected in the upper reaches but is separated to a large degree by timber plantations. This connectivity can be improved by including a narrow, wooded riparian corridor to connect these two areas.	Narrow wooded riparian habitat through commercial plantations added to ESP network.
Dasophrys umbripennis	Shaded-winged robberfly	Given the mobility of this species, fine-scale corridors between forest patches are likely to contribute to the conservation of this species.	N	Y	Map 4	Priority habitat for this Mistbelt forest margin species was identified as the Ferncliff Nature Reserve (See point 1). This habitat is connected in the upper reaches but is separated to a large degree by timber plantations. This connectivity has already been improved through the inclusion of the corridor for *D. natalensis.*	See above
Ischiolobos mesotopos	Midlands robberfly	Given the mobility of this species, fine-scale corridors between grassland patches are likely to contribute to the conservation of this species.	N	Y	Map 5	Only a very small area (30Ha) of the nearly 3000Ha of suitable habitat identified for this species. Large areas of suitable habitat will already be protected by the preliminary ESP. Most areas are already well connected, such as grasslands in the upper reaches of the Edendale Valley (See point 1). Some areas are less well connected (See point 2) but already represent large areas of intact habitat for the species.	No additional terrestrial corridors required
Microchaetus caementerii	Large Pietermaritzburg earthworm	Connectivity is likely to be important for the persistence of this species.	N	Y	Map 6	All areas of priority habitat for this species have been incorporated into the planned ESP (See point 1). These areas are well connected with no need for additional terrestrial corridors.	No additional terrestrial corridors required

Scientific name	English Name	Corridor design considerations	Riparian corridors	Terrestrial corridors	Map reference – See Annexure 2	Adequacy of preliminary network?	Modifications to preliminary ESP Mapping
Microchaetus papillatus	Green giant earthworm	Connectivity is likely to be important for the persistence of this species although corridors may include agricultural lands (rather than only pristine areas).	N	Y	Map 7	Priority habitat occurs as three priority areas near Mkondeni. Existing levels of transformation and the presence of a highway between two of these sites suggests that little can be done to improve levels of connectivity between these priority areas.	No additional terrestrial corridors required
Orycteropus afer	Aardvark	Maintenance of corridors between areas of suitable habitat (open grassland areas) is regarded as very important for this species. Corridors would however need to be of suitable habitat as this species is unlikely to move through heavily transformed areas (other than agricultural lands).	N	Y	Map 8	This species is predicted to occur primarily in the grassland areas in the upper reaches of the Edendale valley. Most of the large intact grassland areas that remain have been incorporated into the preliminary ESP (E.g. See Point 1). These already adequately meet habitat targets for the species. Although the addition of additional habitat could improve connectivity (E.g. Points 2 & 3), the addition of additional corridors cannot be adequately justified.	No additional terrestrial corridors required
Philantomba monticola bicolor	Blue duiker	Corridors may be potentially beneficial for this species. It should be noted however that management considerations (controlling snaring, dog poaching etc) are likely to be more important in maintaining habitat populations than linking suitable habitats with terrestrial corridors. Riparian corridors typically include woody vegetation and may also act as useful links between areas of suitable habitat.	Y	Y	Map 9	The preliminary ESP already makes adequate provision for connectivity between areas of priority habitat for this species (E.g. points 1 & 2). No additional terrestrial corridors were therefore required.	No additional terrestrial corridors required
Poecilogale albinucha	Striped weasel	Maintenance of corridors may be potentially beneficial for this mobile species.	Y	Y	Map 10	As with *Orycteropus afer*, this species is predicated to occur primarily in the upper reaches of the Edendale valley. Large areas of intact habitat have already been	No additional terrestrial corridors required

Scientific name	English Name	Corridor design considerations	Riparian corridors	Terrestrial corridors	Map reference – See Annexure 2	Adequacy of preliminary network?	Modifications to preliminary ESP Mapping
						included in the preliminary ESP with reasonably high connectivity (E.g. areas 1 & 2). There is no clear need to introduce additional corridors to improve connectivity for this species.	
Pronolagus crassicaudatus	Natal red hare	Connectivity is likely to be important for the maintenance of isolated populations of this species. Habitat should however be of suitable habitat (grassland / rocky grassland) to facilitate movement between populations.	N	Y	Map 11	The preliminary ESP already includes the most suitable rocky outcrops for this species. Connectivity between priority habitat is already reasonably good (E.g. point 1), with no need for further terrestrial corridors.	No additional terrestrial corridors required
Stagira purpurea	Purple cicada	Given the mobility of this species, corridors between forest patches are likely to contribute to the conservation of this species.	N	Y	Map 12	This species is known to occur in Swartkop Forest, an area included in the preliminary ESP (See point 1). The other known locality is in Doreen Clark Nature Reserve, just outside the Municipality and within a residential area. No viable corridors exist between these two areas. Management should rather focus on managing these two important sites.	No additional terrestrial corridors required
Tritogenia shawi	Shaw's earthworm	Connectivity is likely to be important for the persistence of this species.	N	Y	Map 13	Priority 1 habitat for this species has been highlighted as Bisley nature reserve (See point 1). This species is also predicted to occur across much of the areas around Mkondeni. Connectivity for this species, together with a range of other species occurring in both Bisley and in priority areas below Mkondeni could be substantially improved by maintaining a corridor of untransformed habitat between these two key areas (Point 2).	A small section of untransformed habitat between Bisley Nature Reserve and the Mkondeni area was included to improve connectivity for this species and a range of other species using this

Scientific name	English Name	Corridor design considerations	Riparian corridors	Terrestrial corridors	Map reference – See Annexure 2	Adequacy of preliminary network?	Modifications to preliminary ESP Mapping
							area.

2.3.4. Inclusion of existing public open space (POS)

The existing POS system only covers a small portion of the Msunduzi Municipality, having previously been limited to the extents of the old city boundary. This POS consists of a range of different POS categories which includes:

- Conservation areas: POS designated for conservation purposes;
- Passive POS: Areas designated for passive social activities such as walks, picnicking, etc;
- Active POS: Areas designated for active social and recreational activities such as golf courses, sports fields and children's parks;
- Private POS: Areas designated as POS but under private ownership;
- Afforestation: Timber plantations owned by the Municipality but used for a range of recreational activities such as walking and mountain biking.

The existing extent of these areas, together with the different classes of POS is presented in Figures 10 and 11. It is worth noting that nearly half of the current POS is transformed with only 16% designated with conservation as the primary use (Table 5)

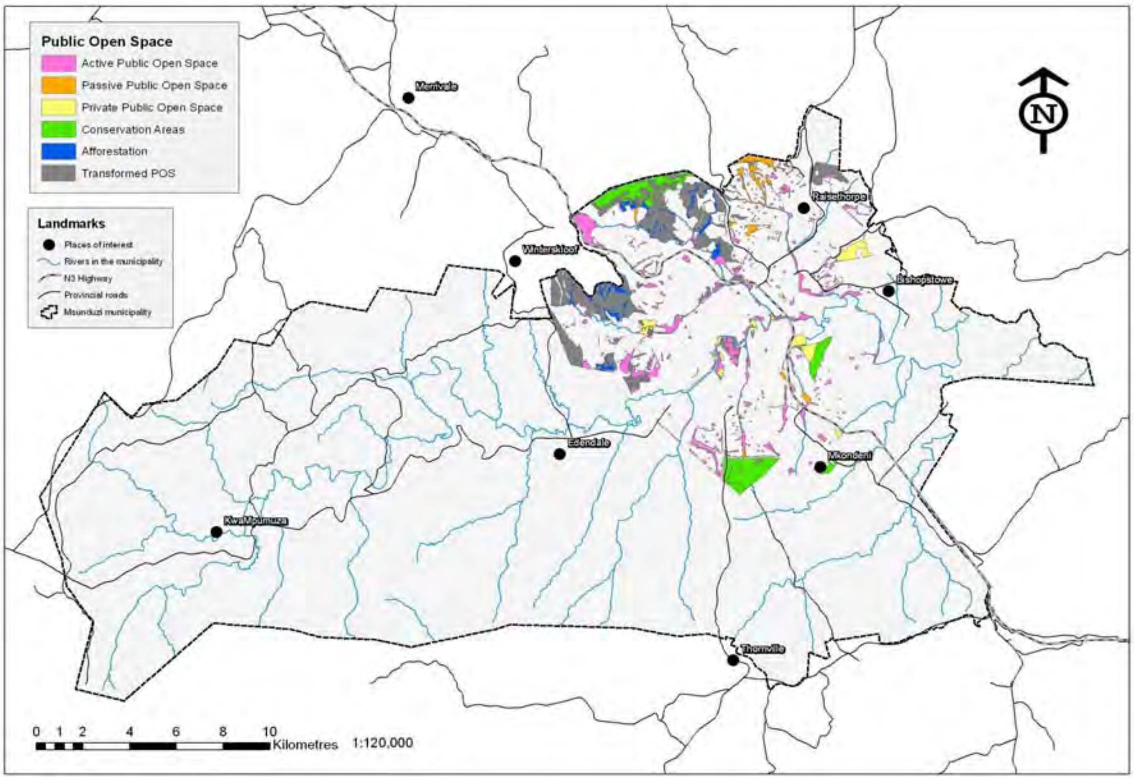


Figure 10. Location and extent of mapped public open spaces in the Msunduzi Municipality.

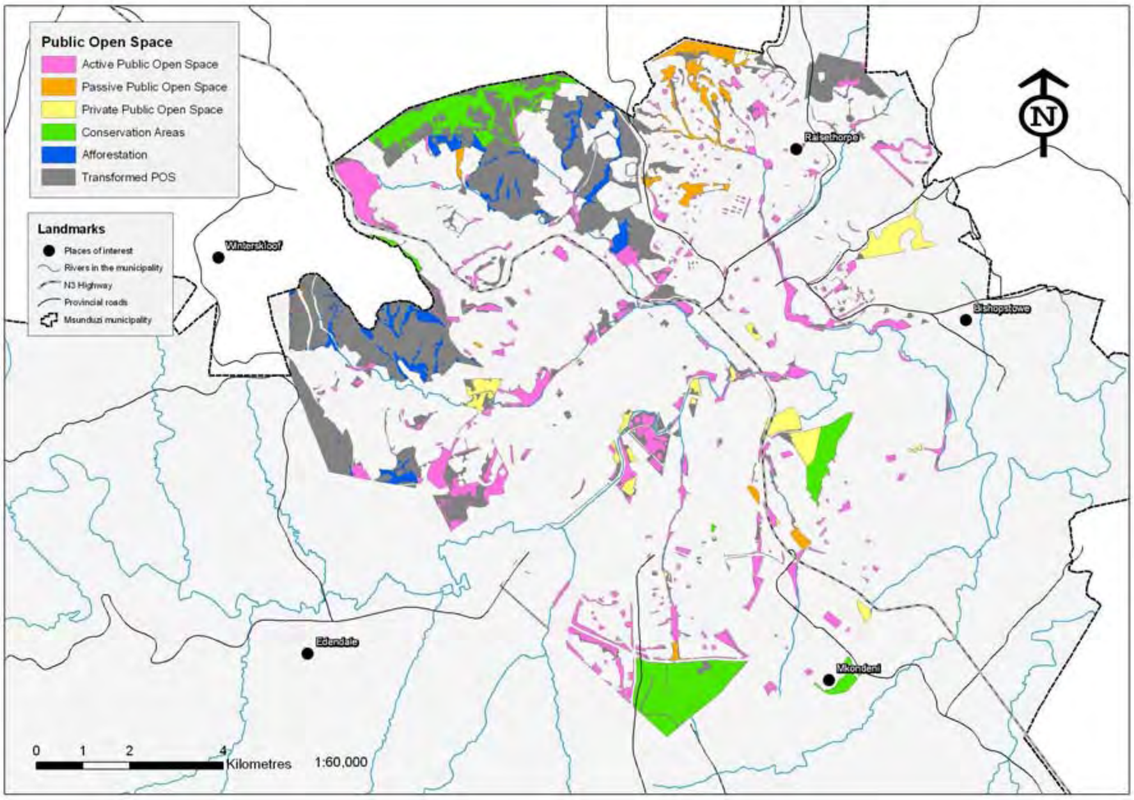


Figure 11. Close-up view indicating the types of POS in the portion of the Municipality in which POS areas have been defined.

Table 5. Relative proportion of different POS categories in the existing POS network.

POS Category	Area (Ha)	Area (%)
Afforestation	213.9	6%
Active POS	770.9	22%
Conservation	547.5	16%
Passive POS	142.8	4%
Private POS	211.1	6%
Transformed	1644.6	47%
Total	**3531.0**	

From a biodiversity perspective, only untransformed areas are likely to contribute meaningfully to biodiversity conservation in the Municipality. The existing POS coverage was therefore combined with a map of untransformed land to differentiate between transformed and untransformed POS to help highlight POS of greater value for biodiversity conservation. It should however be noted that some areas of transformed habitat (e.g. areas currently infested by alien invasive plants) could be rehabilitated to provide suitable linkages for biodiversity.

The ESP mapping and associated classification is presented in Figure 13, and formed the basis for discussions with key stakeholders.

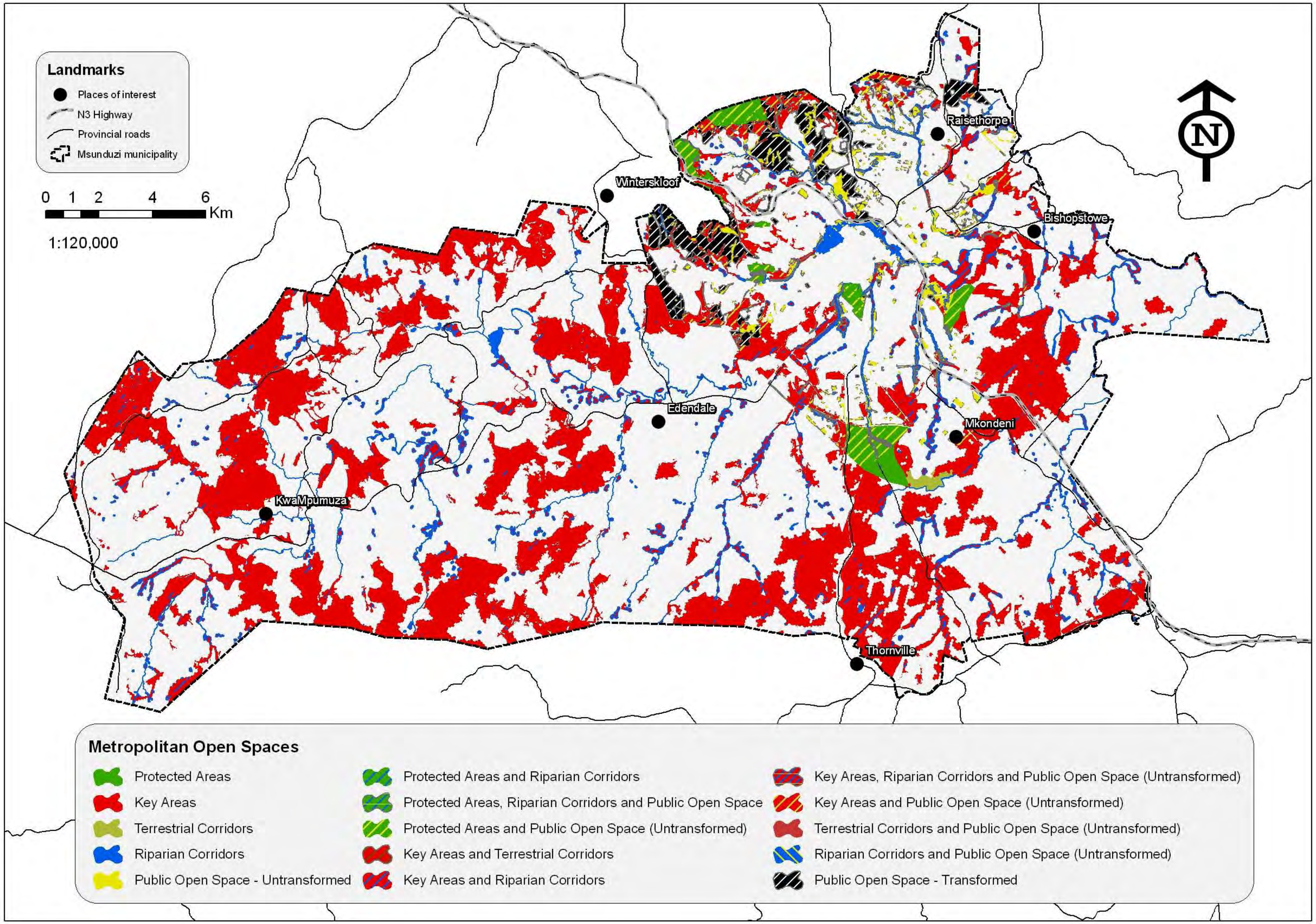


Figure 12. Proposed ESP mapping for biodiversity protection in the Msunduzi Municipality. Areas of existing public open space that are currently transformed are also indicated but have not been included in the ESP mapping as they are unlikely to contribute towards biodiversity objectives.

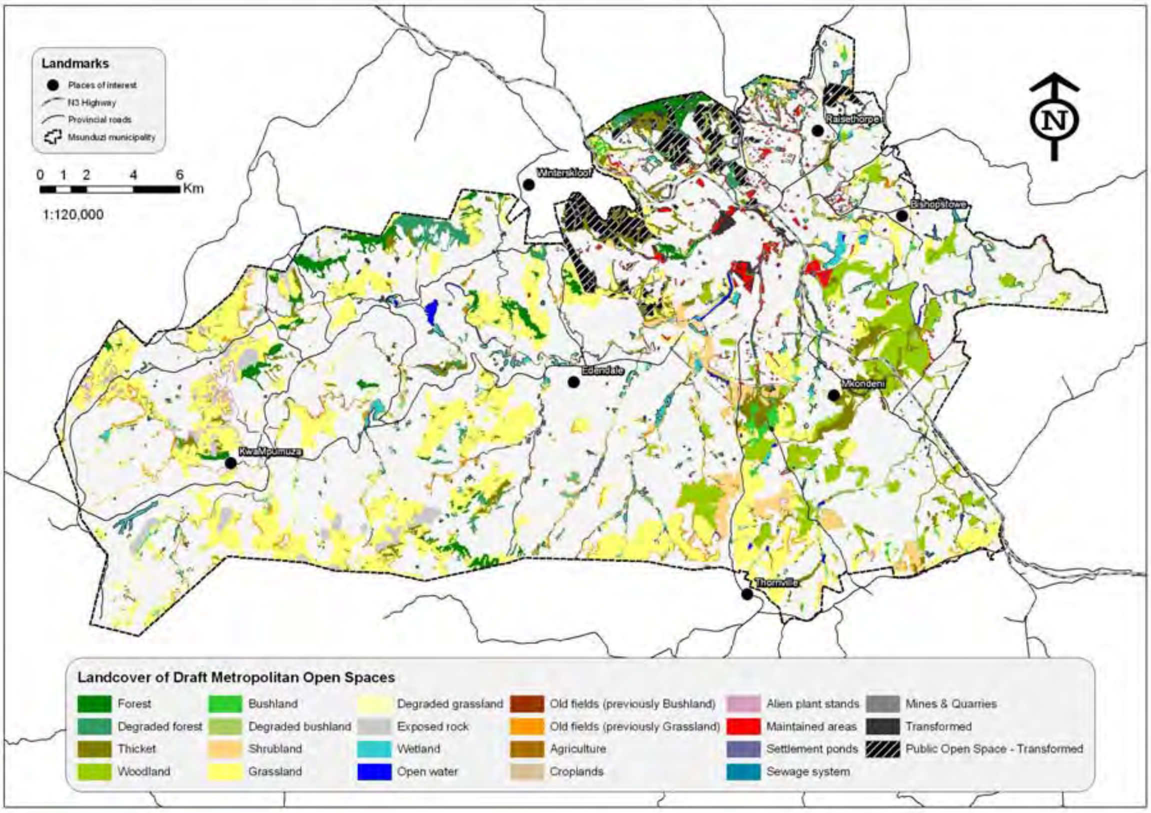
2.4. Stakeholder workshop to present inputs to the ESP

Once the inputs to the ESP had been developed, a workshop was held with representatives of the Msunduzi Municipaliy, DAEA, Ezemvelo KZN-Wildlife and SRK to present the draft coverage and to discuss actions required to refine and implement the ESP. Recommendations made at this meeting were used to help inform the recommendations provided in section 4 of this report.

2.5. Allocating landcover classes to areas incorporated in the ESP mapping

Once the spatial extent of the areas for inclusion in the ESP had been agreed, this map was intersected with the map of landcover classes (Figure 13) to ensure that attributes of landcover type were included as attributes in the ESP mapping. This therefore provides further information on vegetation characteristics of the proposed ESP.

Figure 13. Map indicating landcover of areas included as part of the ESP mapping.



2.6. Incorporation of indicative land values

Since land values are likely to affect actions required to ensure that priority components of the ESPare safeguarded, indicative values of untransformed land within the Municipality were calculated. This was based on the 2008 valuation role provided by the Msunduzi Municipality. A brief explanation of the process followed to develop a land valuation coverage is outlined below.

Step 1: The Municipality was broken down into 60 different principalities that reflected areas of broadly similar economic status. This was based on a planning unit coverage provided by the Municipality.

Step 2: Market values of areas of untransformed land were extracted from the valuation role as a basis for estimating the value of untransformed land within each principality.

Step 3: Average values (R/Ha) were calculated for each principality based on the information available in the valuation role.

Step 4: Availability of data was rated within each principality to provide an indication of the accuracy of estimates given. These ranged from good (large number of properties with values used) to Poor (few values available).

Step 5: A meeting was held with Mr. J.S. Zwart, (Manager: Real Estate and Valuations for the Msunduzi Municipality) to review and refine average values for each principality based on his understanding of relative property values (rated according to development potential) in the Municipality. These values were then used to create a map (Figure 14) illustrating indicative values of untransformed land within different principalities.

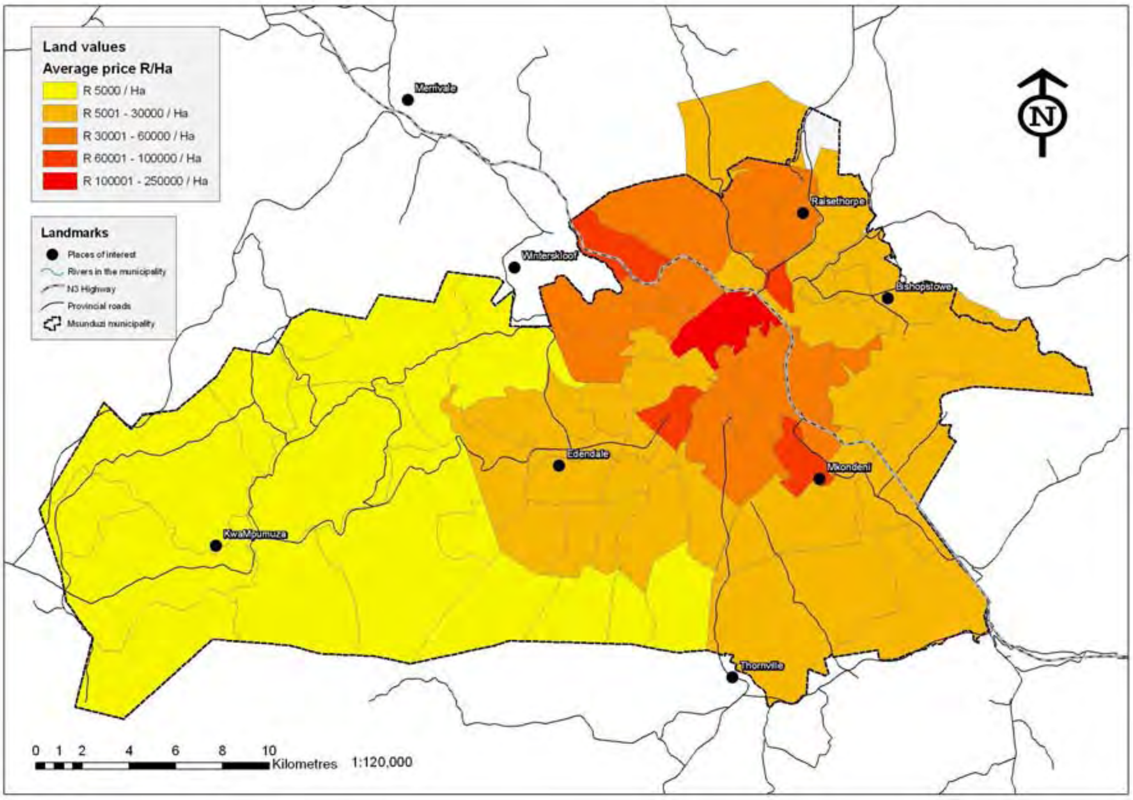


Figure 14. Relative indicative rateable values of untransformed land within each principality.

Note: While this map provides an indication of land prices, it does not take a range of factors into consideration. For example, land values are likely to vary according to slope, vegetation type, development constraints (e.g. environmental importance, ecosystem goods and services) and access to services, which have not been factored into this assessment.

3. RESULTS

3.1. Area of Open Space Assets in ESP Mapping

The ESP mapping developed as part of this study is presented in Figure 10. The areas for inclusion in the ESP cover an area of 20 723.5 Ha, that represents approximately 32.7 % of the Msunduzi Municipality. This consists of a number of different features, ranging from protected areas through to riparian and terrestrial corridors. The extent covered by each of these features is presented in Table 6 below.

Table 6. Extent of features included in the ESP Mapping.

Feature	Extent (Ha)	Extent (%)
Protected Areas	256.3	1%
Public Open Space – Untransformed	494.1	2%
Key Habitats	14017.5	68%
Riparian Corridors	2515.3	12%
Terrestrial Corridors	65.7	0%
Key Habitat and Riparian Corridors	1964.3	9%
Key Habitat and Public Open Space	558.2	3%
Key Habitat, Riparian Corridor and Public Open Space	124.5	1%
Protected Area and Riparian Corridor	18.3	0%
Protected Area and Public Open Space	517.8	2%
Protected Area, Riparian Corridor and Public Open Space	41.5	0%
Terrestrial Corridor and Public Open Space	2.6	0%
Riparian Corridor and Public Open Space	147.3	1%
Total	20723.5	
Transformed Public Open Space	1470.1	N/A

3.2. Landcover classes included in the ESP Mapping

The extent and relative proportion of different landcover classes is presented in Table 7, below.

Table 7. Extent of each landcover classes in the ESP Mapping.

Landcover class	Extent (Ha)	Extent (%)
Agriculture	2.0	0%
Alien plant stands	234.9	1%
Bushland	197.4	1%
Degraded bushland	276.1	1%
Degraded forest	470.6	2%

Landcover class	Extent (Ha)	Extent (%)
Degraded grassland	158.7	1%
Exposed rock	592.6	3%
Forest	901.2	4%
Grassland	9268.4	45%
Maintained areas	474.1	2%
Mines & Quarries	1.3	0%
Old fields (previously Bushland)	1.4	0%
Old fields (previously Grassland)	635.6	3%
Open water	257.7	1%
Settlement ponds	2.1	0%
Sewage system	0.1	0%
Shrubland	960.0	5%
Thicket	1963.9	9%
Transformed	1344.9	6%
Wetland	903.0	4%
Woodland	2077.6	10%
Transformed Public Open Space	1470.1	N/A

4. RECOMMENDATIONS / WAY FORWARD

This project has hopefully contributed towards the design of an open space system for Msunduzi that caters for the need for biodiversity conservation and maintenance of ecological goods and services for Msunduzi residents and downstream users. Much work is still required however for the adoption of and management of an open space network that caters for the needs of users and conservation priorities. Some of the key challenges and actions that need to be taken to ensure that the ESP becomes a useful tool for biodiversity protection are outlined below:

1. **Refinements to the ESP:** This desktop study has been undertaken to develop an ESP that caters for the important biodiversity elements occurring or predicted to occur within the Msunduzi Municipality. Much work still needs to be done however to include other aspects such as social and recreational aspects. Management implications associated with the implementation of an ESP also need to be considered and used to review and revise the ESP and / or implementation plan prior to formal adoption by the Municipality.

2. **Developing an implementation plan for the ESP:** Once the ESP has been refined, steps towards implementation need to be clearly defined and prioritized. Developing a formal implementation plan in conjunction with relevant stakeholders that addresses a number of the proposed actions defined below would be a potentially useful tool to drive this process.

3. **Support from political leadership:** This is perhaps the most important consideration for the effective implementation of an ESP for Msunduzi Municipality. A key opportunity in this regard, would be to better quantify the goods and service values of areas included in the ESP and to use this as a tool for promoting the need for sound management of open space assets. This has indeed been the approach adopted in the DMOSS which is now referred to as an Environmental Services Management Plan (EThekwini Municipality, 2003). Design and implementation of appropriate incentive schemes to encourage sound management should be another key consideration.

4. **Support and partnerships with local communities and initiatives:** This is a key element, particularly given the local context in which most of the proposed ESP is under private or communal tenure. All stakeholders using and managing open spaces will therefore need to collaborate to achieve open space management within the Municipality. Gaining buy-in and support for the initiative through appropriate consultation processes will be an essential first step in this regard. Prioritizing areas where community groups and NGOs can take responsibility for managing priority areas should also be considered and promoted.

5. **Effectiveness of the ESP:** It will be important to ensure that the desired biodiversity benefits are being retained within areas set aside in terms of the ESP. Possible means of verification include:

    - Auditing protected areas to establish the current protection status of each reserve including an audit (i) of their proclamation status and ownership; (ii) to identify which reserves require intervention, and (iii) identify the nature of the intervention / protection required for each reserve.

    - Monitoring use of corridors: This would be particularly beneficial for assessing the effectiveness of riparian corridors and terrestrial corridors designed specifically for promoting connectivity between specific species populations. Academic institutions such as the University of KwaZulu-Natal should be in a position to assist in undertaking further research on this matter.

6. **Status and tenure of land**: Maintaining and managing open spaces requires commitment by those responsible for managing open space assets to implement appropriate management actions. Securing commitment to sympathetic land management can be achieved through a number of possible interventions which should be investigated. These include:

- Implementing planning instruments (such as that intended through the EMF process) to limit development in priority areas;
- Aligning land use zoning schemes (SDF's, LUMS etc) with conservation objectives;
- Providing financial incentives or rates rebates for sound management of priority open space resources.
- Entering into co-operative management agreements between private land owners and government / conservation bodies;
- Purchase or acquisition by the Municipality or KZN Wildlife (e.g. those areas identified as the highest priority for biodiversity conservation) which could perhaps be offset through a process of selling areas of POS included in the ESP but of low social or biodiversity benefit;
- Providing disincentives (through financial instruments) for poor management or developments that impact on the ESP (e.g. alien plant encroachment in areas with rates rebates)

In order to inform appropriate interventions, a database should be compiled to identify priority cadastral land parcels for securing as part of the open space system. This could include consideration of conservation priority, acquisition costs and other factors and should be guided by a similar process to that adopted by eThekwini Municipality.

7. **Management responsibility & adequacy of resources:** For the ESPto deliver on its objectives of biodiversity conservation, it will be important to establish suitable institutional arrangements to guide the approach to open space management. As a starting point, a mandate for the oversight and management of open spaces would need to be designated to an appropriate municipal entity. This entity (potentially the Municipal Conservation & Environment Unit) would then need to be assigned the responsibility for the management and expansion of the network of open spaces, particularly those for which the municipality is directly or partially responsible. Appropriate skills will also be required to coordinate management and monitoring activities to ensure appropriate management and protection of the open space resource. Apart from skills, adequate budgets will also need to be allocated to achieve management objectives.

8. **Integration with other programmes in sustainable land management:** As with the DMOSS, this should be a key focus area to ensure that planning initiatives are appropriately aligned with the objectives of the planned ESP. This will need to include incorporating environmental concerns and guidelines into the Land Use Management System (LUMS) to

guide the development of urban land uses in a manner that supports the open space system and optimizes the delivery of environmental services to Municipal residents. Integration with other development planning initiatives such as spatial development frameworks will also need to be investigated.

9. **Community education and awareness:** The implementation of an ESP is new for Msunduzi and as such, appropriate communication will be necessary to inform and involve stakeholders in the refinement and implementation of the system. The Municipality will need to determine the most appropriate means of communication and information dissemination to support community education and awareness and may include not only electronic and printed media but the erection of appropriate signage at key open space resources.

10. **Broader conservation initiatives**: In human-dominated landscapes, processes and impacts arising from outside remnant habitats are likely to be as important, or more important, than processes within the habitat in determining conditions for fauna (Janzen 1986; Saunders *et al.* 1991 in Benet, 1998, 2003). Identifying and implementing other approaches to limit impacts on the ESP is another important consideration. For example, this may entail the inclusion of additional mitigation measures for development taking place adjacent to areas designated in terms of the ESP to ensure that impacts on the ESP areas are minimized.

11. Planning and integration across Municipal boundaries: Actions taken within the Municipality should be aligned as far as possible with initiatives in adjoining Municipalities. Given that eThekwini Municipality have successfully implemented a ESP, interaction with those responsible for the design and implementation of the system is particularly encouraged

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