

**VEGETATION AND FLORAL ASSESSMENT OF THE MONTANA SPRUIT FOR THE PROPOSED CONFINEMENT OF THE 1:100 YEAR FLOODPLAIN, PORTIONS 28- 42, 137 AND 138 OF DOORNPOORT 295 JR, GAUTENG**

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## **EXECUTIVE SUMMARY**

City of Tshwane Municipality have received complaints regarding the flooding of the Montana Spruit in Pretoria since the mid 90s. They now propose remedial action to prevent this problem. Consequently, they have appointed SSV Consulting Engineers and Project Managers (SA) to manage this project. The remedial action involves the confinement the 1:100 year floodline, widening and flattening of the floodplain and canalization of the spruit channel where necessary. This proposed development will cover an approximate area of 22.45 hectares on portions 28-42, 137 and 138 of Doornpoort 295-JR, Pretoria.

The study site is situated in Marikana Thornveld which is an endangered vegetation unit. The study site has also historically supported Red Data species. GDACE has therefore requested that a plant and vegetation analysis of the site be undertaken in search of primary vegetation, sensitive habitats and Red Data species. Consequently, Strategic Environmental Focus (Pty) Ltd was appointed by SSV Consulting Engineers and Project Managers (SA) to undertake such an investigation.

There were access restrictions encountered during the fieldwork and this limited the sampling that could take place during the first site visit on 27 March 2007. A second site visit was then undertaken on 11 June 2007 when the remainder of the study area was evaluated.

The site includes areas of high sensitivity which comprise the riparian area, flood plain, potential wetlands and moist grassland. The residential areas on the eastern portion of the site are classified as low sensitivity, while the remainder of the vegetation on the site is classified as medium sensitivity.

The nature of the proposed activities will impact on the areas of high sensitivity, in specific the riparian areas. The activity should only be allowed to proceed once an approved environmental management plan, detailing the rehabilitation of the riparian area and surrounding vegetation as well as alien invasive plant eradication and monitoring plans, has been implemented. Furthermore, the proposed activity must adhere to the storm water management plan.

As the study did not occur within the appropriate flowering season of Red Data plants. It is recommended that a Red Data scan be undertaken in the flowering season before the development is approved.

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## 1. INTRODUCTION

The rapid rates of development in Gauteng mean that less suitable land is left available for development, and in turn marginally suitable areas are coming under the strain of development. In numerous instances development occurs too near rivers and even within the 1:100 year floodplain. These developments often then experience serious flooding within their properties. According to Environment Canada (2004), most flooding occurs when the volume of water in a river or stream exceeds the capacity of the channel. All rivers are subject to fluctuations in flow.

Factors affecting the quantity of water reaching the stream are the shape, size, soil type, topography of the drainage basin as well as rainstorm frequency and intensity (Environment Canada, 2004). Though these factors are usually constant, the absorptive or shedding properties of the soil vary with vegetation cover, season, and previous rainfall (Environment Canada, 2004).

Within urban areas, stormwater runoff can cause the flooding of local rivers as well as of the urban area itself (Environment Canada, 2004). Urbanization drastically alters the drainage characteristics of natural catchments, or drainage areas, by increasing the volume and rate of surface runoff (Environment Canada, 2004). While the impact on major river systems may be minimal, the carrying capacity of small streams may be quickly exceeded, causing flooding and erosion problems.

In the past, planning and developments did not consider the natural environment including riparian habitats and this led to the over-exploitation and destruction of important natural environments. Since then various legislation has been passed governing, limiting and encouraging the best possible use of natural resources to avoid environmental degradation. The most applicable of these to this study are;

- The National Water Act (Act No. 36 of 1998). It includes the protection of aquatic and associated ecosystems, biodiversity and the regulation of water use and activities in wetlands, rivers and lakes.
- Draft Red Data Policy for Environmental Impact Evaluations (DACEL 2001b) This policy has developed a priority ranking of Red Data plants species for the Gauteng Province based on a set of selected criteria. This policy is based on the following principles: conservation of all populations and associated ecological processes of threatened and endemic plant species to Gauteng; conservation of pollinators associated with these species. The policy discourages the translocation of Red Data species and encourages the conservation of areas adjacent to Red Data plant populations and the creation of buffer zones.
- Nature Conservation Ordinance 12 of 1983. This regulates nature conservation in Gauteng.

- National Environmental Management (Act 107 of 1998). One of the principles of this act states that development must be socially, environmentally and economically sustainable. Sustainable development requires consideration of all relevant factors including the following;
  - That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied; and
  - That pollution and degradation of the environment are avoided, or where they cannot be altogether avoided, are minimised and remedied.

In line with this legislation and the NEMA regulations, developers are now required to conduct ecological assessments of floral and faunal communities and their associated habitats in order to identify and suitably allocate areas for potential conservation and development.

### **1.1 Project Description**

City of Tshwane (CTMM) proposes to undertake remedial action for the flooding in the area through;

- The confinement of the 1:100 year floodline of the Montana Spruit;
- The canalisation of the spruit; and
- Flattening and widening of the floodplain

This will span across an approximate areas of 22.45 hectare on portions 28 to 42, 137 and 138 of Doornpoort 295 JR.

This will affect the Riparian zone. Riparian land is very valuable as it is the most fertile and productive part of a landscape (Land for Wildlife, 2002). The interaction between land and water in the riparian zone provides a range of micro-habitats that support a diverse range of flora and fauna. Highly fertile soils and moist conditions increase the establishment and growth of a diverse range of plant species (Land for Wildlife, 2002). In addition to being productive, riparian land is often a vulnerable part of the landscape as it is susceptible to damage from agricultural and urban development, weed invasion and natural events such as floods (Land for Wildlife, 2002). This combination of productivity and vulnerability means that careful management of riparian habitats is necessary for the maintenance of biodiversity and ecological function.

## 1.2 Terms of Reference

As per GDACE requirements, the following activities were to be carried out.

- 1) A vegetation assessment which entailed the following;
  - That the location and extent of all plant communities be mapped;
  - That the ecological sensitivity of each plant community be indicated. All good condition natural vegetation must be designated as ecologically sensitive;
  - A plant species list must be provided for each plant community with medicinal and invasive / exotic status indicated. The number of forb / herb, grass, shrub and tree species must be indicated for each plant community; and
  - The condition of any grassland on site must be assessed and the location and extent of primary grassland mapped. All primary grassland must be designated as ecologically sensitive.
- 2) A plant assessment which entailed the following;
  - A survey for Orange and Red List plant species;
  - The survey should take place during the flowering season of *Eulophia leachii* and *Schizoglossum umbelluliferum*;
  - Surveys must encompass the site and all relevant adjacent properties; and
  - Populations of Red and Orange List plants must be designated as sensitive in a sensitivity map. Buffers must be consistent with Red List plant buffers.

## 1.3 Limitations

The following limitations were experienced whilst conducting the fieldwork;

### 1. *Inaccessibility*

Due to location: a limitation to sampling was the inaccessibility of the spruit. The entire spruit along Tsamma Road was fenced off with the only access through adjacent landowner's properties.

Due to legal limitations: this was in the form of a legal dispute between the municipality and landowners along the spruit. This meant that landowners were reluctant to grant access to the spruit

### 2. *Site disturbances*

Due to Burning: The site had been recently burnt on certain portions making plant and vegetation community identification difficult.

Due to dam and culvert creation: This caused areas of the floodplain, and surrounding

vegetation to be cleared away with only a few areas of uniform vegetation left to sample.

### 3. *Methodologies applied*

The methodologies employed during this study were applicable at the time of the study and represent the author's best scientific and professional knowledge.

### 4. *Unsuitable timing of study*

The study was conducted towards the end of the flowering period of most plants. This meant that red data plants might not have been in flower, geophytic plants have their leaves below ground and most of the grasses have lost their inflorescences. This made plant identification difficult and may have caused important flagship species that are indicators of ecological condition and plant community dynamics, to be overlooked.

## **2. BACKGROUND INFORMATION**

### **2.1 Location**

The proposed confinement of the Montana Spruit will be focused on portions 28 to 42, 137 and 138 of Doornpoort 295 JR, Gauteng. This study area is situated within the urban boundary. It runs parallel to Breed Street (on the right) and occurs on either side of the Montana Spruit, with Tsamma road passing through it (refer to Figure 1).

### **2.2 Land Use**

The current land use along the Spruit is residential housing on portions 28 to 42 and 138, with vacant land on portion 137.

### **2.3 Climate**

Data from the nearest weather station (University Experimental Farm) reveal that the study area is characterized by summer rainfall with dry winters. Mean annual precipitation is between 600-700mm and frost can be expected in winter. Average temperatures in summer months reach 35.8°C and in winter months decrease to -1.0°C.



Figure 1: Locality Map



## 2.4 Geology and Soil

The area is mostly underlain by the Mafic intrusive rocks of the Rustenburg Layered Suite of the Bushveld Igneous Complex. The main rock types include gabbro, norite, pyroxenite and anorthosite with shale and quartzite also featuring. The soil types are mainly vertic melanic clays with some dystrophic / mesotrophic plinthic catenas as well as some freely drained deep soils.

## 2.5 Regional Vegetation

The site falls within the Grassland Biome (Rutherford and Westfall, 1994) and within the Marikana Thornveld vegetation unit (Mucina & Rutherford, 2006). The dominant vegetation within the regional Marikana Thornveld is open *Acacia karoo* woodland which occurs in valleys, slightly undulating plains and lowland hills. Shrubs are mostly found in a dense distribution along drainage lines or in habitat protected from fire. It is an endangered vegetation unit with less than 1% statutorily conserved (Mucina & Rutherford, 2006).

## 2.6 Gauteng Conservation Plan (C-plan)

The Gauteng Department of Agriculture, Conservation and Environment (GDACE) compiled a conservation plan in order to reach the conservation targets for the Province. The conservation plan indicate that the study site contain important habitat for faunal and flora species and are thus of conservation concern (GDACE, 2005).

# 3. VEGETATION ASSESSMENT

## 3.1 Methodology

Areas of uniform vegetation were identified from aerial images of the site. A site visit was then undertaken on the 27th March 2007 to assess these areas. Access to the study site was limited. Sampling was undertaken to determine the following outcomes:

- Plant Species lists;
- Ecological condition and functionality;
- Red data plants;
- Vegetation dynamics;
- Riparian vegetation index (RVI); and
- Level of disturbance and transformation.

The methodology involved Braun-Blanquet sampling in 8m x 8m quadrants along the spruit. This was conducted at 3 locations to evaluate species type and abundance in the riparian zone. The RVI assessments were conducted according to the guidelines set out by Kemper (2001). This was done as a method of further assessing the riparian vegetation condition along the perennial Montana spruit.

Stratified line transects were walked through portions 31, 32 and 137. This enabled an

evaluation of the level of disturbance and transformation onsite and in search of red data plants and sensitive habitats. Line transect sampling was used to determine vegetation dynamics, ecological condition and functionality. During these activities; areas of indigenous riparian vegetation were identified and a Riparian Vegetation Index (RVI) assessment was conducted. An RVI was conducted on portion 32 of farm Doornpoort at this time.

A second site visit was undertaken on 11 June 2007. Stratified line transects were walked through the rest of the site (area not previously covered), where an evaluation of the level of disturbance and transformation onsite was undertaken. A scan for Red Data plants and sensitive habitats was also conducted. Line transect sampling was used to determine vegetation dynamics, ecological condition and functionality. During these activities; areas of indigenous riparian vegetation were identified and an RVI assessment was conducted. An RVI was performed on portion 129 of farm Doornpoort during this second phase of fieldwork.

Based on the above findings, the ecological sensitivities of the study sites were determined. The sensitivity of each site was quantified by assessing the ecological function and conservation importance of the sites. These are defined as follows:

High ecological function: These are sensitive ecosystems that have a low resistance or resilience towards disturbance factors or are highly dynamic systems that are considered to be stable and important for the maintenance of ecosystem integrity and offer ecosystem services. These are therefore not suitable for development and must be protected.

Medium ecological function: These are relatively important ecosystems at gradients of intermediate disturbances. An area directly adjacent to sensitive or pristine vegetation may also be considered to be of medium ecological importance as it serves as an important buffer zone. Low density development may often be allowed here, depending on the species occurring.

Low ecological function: These are degraded and highly disturbed sites with little or no ecological function. These are often suitable for development.

High conservation importance: When the species richness of the vegetation is high, this provides a suitable habitat for a number of threatened species. For this reason; these are not suitable for development and should be protected.

Medium conservation importance: Ecosystems with intermediate levels of species diversity and whose vegetation does not support any threatened species are considered to be of medium conservation importance. Here low-density development may be allowed if the suitable mitigation measures are taken to protect important plants.

Low conservation importance: These are areas with little or no conservation potential

and are usually devoid of indigenous species. They are dominated by exotic species and are considered suitable for development.

## 4. RESULTS

### 4.1 Description of Affected Environment

Upon evaluating the landscape, distinct vegetation categories were found to exist on site:

1. Riparian vegetation within the riparian zone:
2. *Acacia* thornveld community; and
3. Grassland communities.

The vegetation communities are described below with the corresponding photo plates. Figure 2 illustrates the location and extent of these communities on site. The plant species observed on site are listed in Appendix 1. A sensitivity map that illustrates the sensitivity of the site is displayed in Figure 3.

#### 4.1.1 Riparian vegetation

Riparian vegetation occurs along the spruit within the riparian zone. It has largely been disturbed and invaded by exotics, but some fairly undisturbed pockets still exist. The riparian vegetation also includes the flood plain, invaded by pioneer plants. A riparian vegetation assessment was undertaken at two sites along the spruit (Figure 2). Results indicated that it was in a degraded state and largely made up of exotic species. It is mainly composed of trees, bushes, grasses and sedges. Commonly occurring indigenous plants include the *Acacia sp.*, *Coryza sp.*, *Pognotharia squarrossa*, *Berkheya sp.*, *Rhus sp.*, *Setaria sp.*, *Cyperus sp.* and *Cynodon dactylon*. Evidence of geophytes was also present but identification was difficult out of the flowering season. The vegetation assemblage is disturbed and of low sensitivity. However, the riparian area in which this vegetation occurs is not.

Riparian vegetation encompasses the stream channel and the portion of the landscape from the high water mark towards the uplands where vegetation may be influenced by elevated water tables, flooding, or the ability of soils to hold water. The riparian area on the study site appears to be largely modified as a considerable loss of natural habitat, biota and basic ecosystem functions has occurred. However, riparian areas, even in a degraded state play an integral role in the protection of water resources by:

- Sediment trapping;
- Nutrient trapping;

- Bank stabilization and bank maintenance;
- Contributes to water storage;
- Aquifer recharge;
- Flow energy dissipation;
- Maintenance of biotic diversity and
- Primary production.

Riparian areas are protected under the National Water Act (Act No. 36 of 1998) and therefore must be considered as highly sensitive. The current assessment therefore designates the riparian area as having a *High Ecological Function and Conservation Importance*. This portion of the site is thus of high sensitivity (Figure 3).



Photo plate 1: Floodplain invaded by pioneers

#### 4.1.2 *Acacia*-thornveld vegetation community

The *Acacia* thornveld community comprised highly disturbed areas to areas with little or no disturbance. Some portions were heavily trampled and grazed areas within the *Acacia* thornveld community with evidence of cattle grazing in this area. Other disturbances include trampling, burning and exotic plant invasions. The grasses that previously occurred as part of this vegetation community are being excluded leaving the soil bare or with short trampled grass patches. No red data plants or habitat were observed within this community and invasions from *Protasparagus laricinus* are heavily encroaching on the *Acacia* thornveld communities. *Hypoxis* sp. are scattered throughout the bush thicket These communities are considered to be of *Low Conservation Importance* , however this vegetation provide habitat to numerous faunal and avifaunal

species and acts as buffer around riparian areas that limit negative edge effects on the river. The vegetation is thus of a *High Ecological Function* which contributes to a medium sensitivity classification of this vegetation (Figure 3)



Photo plate 2: Burnt *Acacia* thornveld vegetation

#### 4.1.3 Grassland vegetation communities

There are two main grassland communities within the study area, the moist grasslands and the grassland pockets within the *Acacia* thornveld matrix.

The moist grassland is dominated by tall *Themeda-Eragrostis-Setaria* species. Here suitable breeding and nesting habitat is present for Red Data species namely the vulnerable Grass Owl and the African Marsh Harrier bird species. These moist grasses may also offer suitable habitat for *Trachyandra erythorrhiza*, a near-threatened Red Data plant. The moist grasslands on site are consequently of *High Conservation Importance*. Their location surrounded by open areas of the land means that they serve as refuge sites for faunal species. Their *Ecological Functionality* is therefore **High** and the vegetation is thus classified as areas of high sensitivity (Figure 3).

A wetland delineation was not done, however two additional moist grassland areas display wetland characteristics. The potential wetland communities comprise mainly tall *Typha capensis* reeds. They surround the permanently saturated areas like the dams along the spruit. These sections of the spruit are highly sensitive. Wetlands are valuable for a number of direct and indirect benefits such as water purification, sustained stream flow, flood reduction, ground water recharge / discharge, erosion control, biodiversity conservation, chemical cycling and water supply. They are also protected under the National Water Act (Act No. 36 of 1998). Consequently, these areas have a *High*

*Conservation Importance* and *High Ecological Function* and are classified as high sensitivity (Figure 3).



Photo plate 3: Moist grassland



Photo plate 4: Wetland vegetation

The *Themeda-Hyparrhenia* grassland pockets that occur within the *Acacia*-thornveld matrix are ecologically less sensitive. They may be important for temporary faunal inhabitants and for foraging purposes but are entirely surrounded by disturbed or degraded *Acacia* thornveld. Their *Ecological Functionality* is therefore *Medium*. Their *Conservation Importance* is *Low*, as they do not host any sensitive species or habitat. Overall, this vegetation is thus of medium sensitivity (Figure 3).



Photo plate 5: *Themeda-Hyparrhenia* grassland

The landscaped gardens areas along the spruit have been as a result of residential buildings, through uprooting of natural vegetation and the creation of landscaped gardens. Dumping of soil and dam creation along the spruit has also occurred. From a vegetation perspective, they do not contain any plants that are worthy of conservation however, they may still provide shelter, nesting sites and movement corridors for fauna. Their **Conservation Importance** is **low** but **Ecological Functionality** is **Medium**. They are areas directly adjacent to sensitive vegetation / features and serve as an important buffer zone. However, from a vegetation point of view, these areas are classified as low sensitivity (Figure 3)

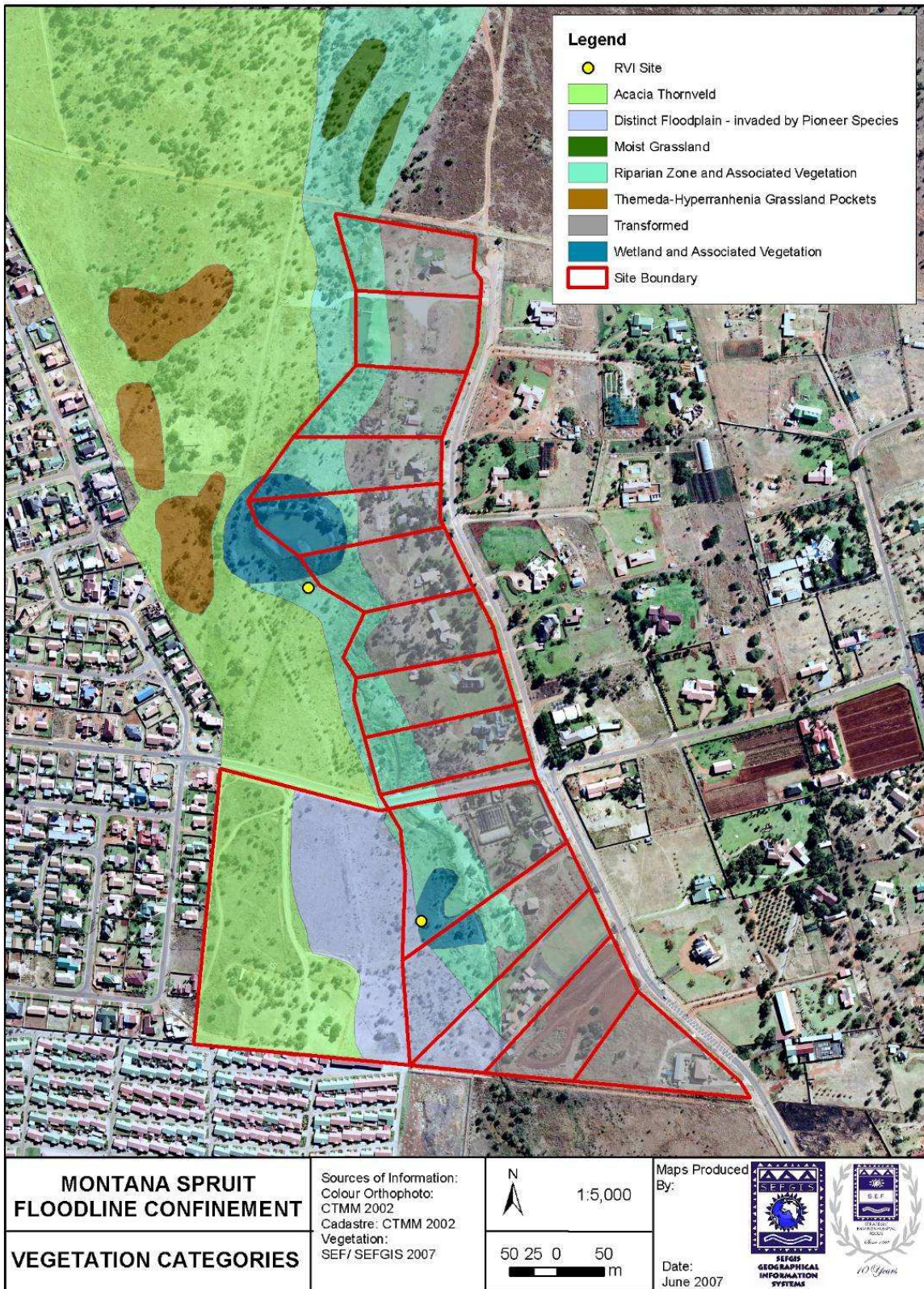


Figure 2: Vegetation communities on site



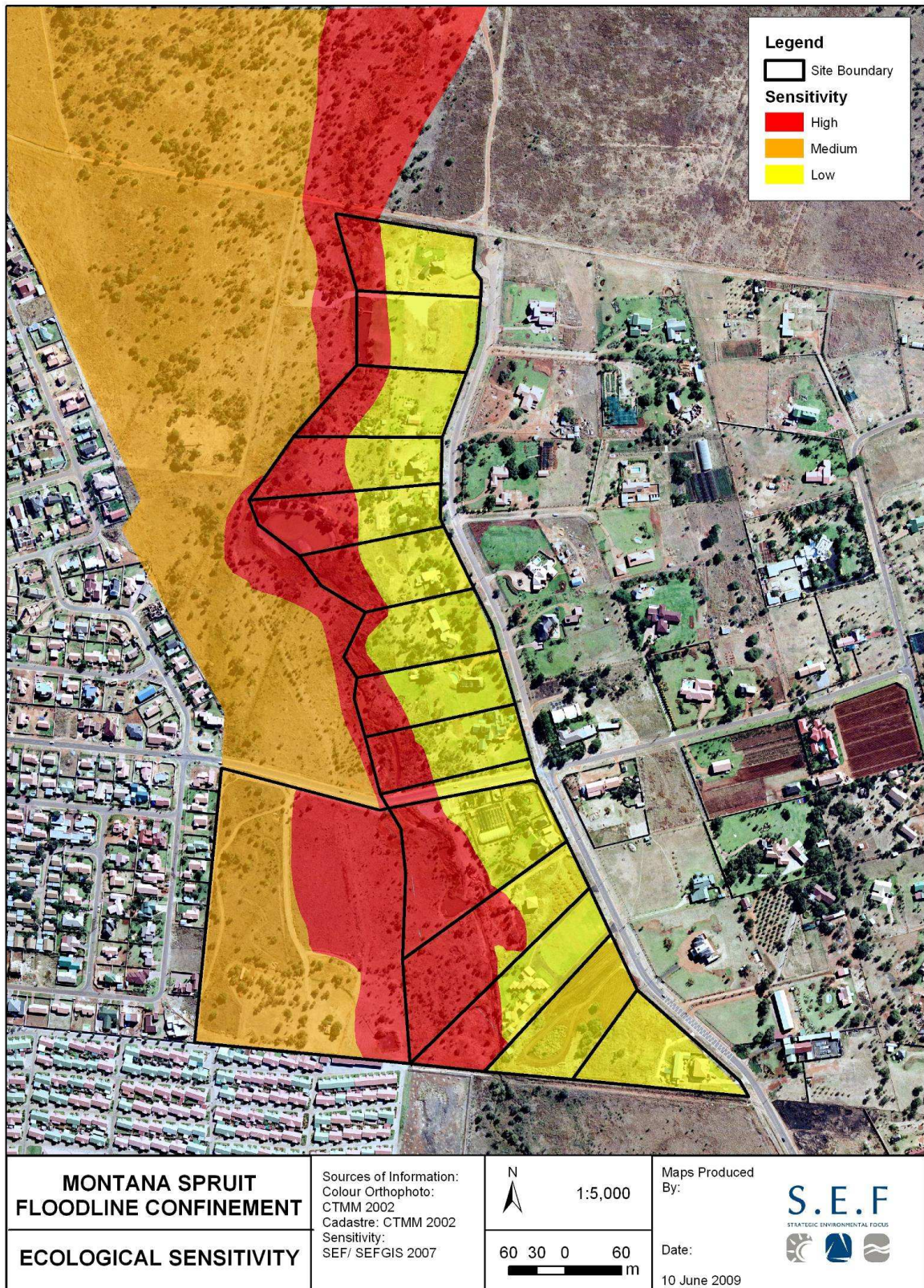


Figure 3: Site Sensitivity Map

## 4.2 Red Data Assessment

According to GDACE (2006), certain Red/Orange List plant species have been recorded from the quarter degree grid square in which the study site is situated. None were seen on site at the time of the study. Of the list released by GDACE (2006), suitable habitat for three species was present on site (Appendix 2). This habitat was however compromised and has been disturbed through burning, cattle grazing and trampling. The occurrence of these species is therefore unlikely. Furthermore, no protected plant species that are listed as protected under Schedule 11 (Nature Conservation Ordinance No. 12 of 1983 for the Regional Legislation Service-Gauteng) was identified on the site during the site visits.

No faunal assessment was carried out and no red data faunal species were found on site during this study. Though no avifauna assessment was undertaken, suitable habitat for Red Listed birds (Appendix 3) was noted on site.

According to GDACE (2006), certain Red Data reptiles and amphibian species have been recorded in the area (Appendix 4). None were seen on site at the time of the study. However, potential suitable habitat for the Giant Bullfrog (*Pyxicephalus adspersus*) may be present on site. This is a near threatened species and suitable habitat warrants conservation.

As per GDACE (2006) records, the historically occurring red data mammals are listed in Appendix 5. There were no sightings of these animals and their occurrence is unlikely given the disturbances surrounding the study site. However, the study site should be appropriately rehabilitated to encourage the return of any potential mammal inhabitants

Personal communication with land owner, Mr Bernard Green of Portion 30 Doornpoort alerted the ecologist to the presence of the last remaining porcupine in the area, a pair of cane rats and bush babies on his property.

## 4.3 Declared Weeds and Invader Plants

Concern is growing over the way in which alien/exotic plants are invading large areas within South Africa. Invasive species are a major threat to the ecological functioning of natural systems as well as the productive use of the land, and should ideally be removed if they are serving no ecological function. In terms of the amendments to the regulations under the Conservation of Agriculture Resources Act, 1983 (Act No. 43 of 1983), landowners are legally responsible for the control of invasive alien plants on their properties. There are currently 198 alien species listed as declared weeds and invaders, these have been divided into three categories (Henderson, 2001):

- **Category 1 plants are prohibited and must be controlled.**

- **Category 2 plants** (commercially used plants) may be grown in demarcated areas proving that there is a permit and that steps are taken to prevent their spread; and
- **Category 3 plants** (ornamentally used plants) may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading there of, except within the flood line of watercourses and wetlands.

The exotic species found within the study area are listed in Appendix 6 with their status also included.

## 5. CONCLUSION AND RECOMMENDATIONS

Although the site visit was not conducted at an ideal time of year, it was evident that the site hosted distinct vegetation communities. The riparian, potential wetland and moist grassland communities are classified as highly sensitive habitats on site. They have a *High Ecological function and High Conservation Importance* and must be protected as far as possible.

Inevitably, these portions will be disturbed by the proposed activity of confining the spruit. If this activity continuous, an environmental management plan as well as remediation plan, should be submitted to ensure that the spruit and the riparian vegetation is rehabilitated to its natural and functional state. In addition, the storm water management plan and mitigation measures as set out by the storm water management plan (SEF, 2007) must be adhered to. Furthermore, the restructuring of the spruit will disturb faunal habitat. The floodplain and potential wetland areas could provide suitable habitat for the Giant Bullfrog (*Pyxicephalus adspersus*), although no evidence of their occurrence was identified on the site.

The timing of the study, out of the flowering season of Red Data plants, meant that insufficient red data sampling has been done. Follow-up red data scans are recommended during the flowering season between September and January, before any development may occur. If red data species are found on site, the relevant authorities must be informed and should any species (including faunal species such as the Giant Bullfrog) be seen on site once construction has begun, then construction must be halted and the advice of an ecologist must be sought.

The alterations to the spruit will cause clearing of riparian vegetation which opens niches for exotic plant invasion. The removal of alien invasive plants is legislated and must be carried out with the appropriate method for each species type. An alien invasive monitoring plan should be implemented to ensure that the spruit is monitored for the spread of invasive species for a number of years after the completion of the proposed activity.

## 6. GLOSSARY

- Alien species:** Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity
- Biodiversity:** Biodiversity is the variability among living organisms from all sources including inter alia terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
- Biome:** A major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions, but not including the abiotic portion of the environment.
- Conservation:** The management 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. The wise use of natural resources to prevent loss of ecosystem function and integrity.
- Ecosystem:** Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.
- Endangered:** A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
- Endemic:** Occurring in a particular region, and nowhere else.
- Environment:** NEMA defines “environment” as “the surroundings within which humans exist and that are made up of the land, water and atmosphere of the earth; micro organisms, plant and animal life; any interrelationships among and between them and the physical, chemical aesthetic and cultural properties and conditions that influence human health and well-being”.
- Forb:** A herbaceous plant other than grasses
- Habitat:** Type of environment in which a plant or animal lives.
- Indigenous:** Any species of plant, shrub or tree that occurs naturally in South Africa

**Invasive species:** Naturalised alien plants that have the ability to reproduce, often in large numbers. Aggressive invaders can spread and invade large areas

**Rare species:** Species, which have naturally small populations, and species, which have been reduced to small (often unstable) populations by man's activities.

**Threatened species:** Species, which have naturally small populations, and species, which have been reduced to small (often unstable) populations by man's activities.

**Red Data:** A list of species, fauna and flora that require environmental protection. Based on the IUCN definitions.

**Soil:** A mixture of organic and inorganic substances, the composition and structure of the latter is derived from the parent rock material. Soil also contains bacteria, fungi, viruses and micro-arthropods, nematodes and worms.

**Species diversity:** A measure of the number and relative abundance of species (see biodiversity).

**Species richness:** The number of species in an area or habitat.

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## 8. APPENDICES

### Appendix 1. List of plant species occurring within the study area

Scientific Name	Common Name	Medicinal Value	Exotic Inavder
<i>Acacia erioloba</i>	Camel Thorn		
<i>Acacia exuvialis</i>	Flaky Thorn		
<i>Acacia karoo</i>	Sweet Thorn	Yes	
<i>Acacia nebrownii</i>	Water Thorn		
<i>Acacias sp.</i>			
<i>Agrave americana</i>	American agave		Yes
<i>Andropogon schirensis</i>	Stab Grass		
<i>Aristida junciformis</i>	Gongoni Three Awn Grass		
<i>Aristida sp.</i>	Three Awn Grass		
<i>Arundo donax</i>	Spanish Reed		Yes
<i>Asclepias fruticosa</i>	Shrubby Milkweed		Yes
<i>Berkheya radula</i>			
<i>Bidens pilosa</i>	Blackjack		Yes
<i>Conyza albidia</i>	Tall Fleabane		Yes
<i>Conyza boonariensis</i>	Flaxleaf Fleabane		Yes
<i>Conyza canadensis</i>	Horseweed Fleabane		Yes
<i>Cymbopogon excavatus</i>	Broad-Leaved Turpentine Grass		
<i>Cymbopogon plurinodis</i>	Narrow-Leaved Turpentine Grass		
<i>Cynodon dactylon</i>	Couch Grass		
<i>Cyperus rotundus</i>	Purple nutsedge		Yes
<i>Cyperus sp.</i>			
<i>Digitaria eriantha</i>	Common Finger Grass		
<i>Eragrostis bicolor</i>	Speckled Vlei Grass		
<i>Eragrostis plana</i>	Tough Love Grass		
<i>Eragrostis sp.</i>			
<i>Hakea sp.</i>			
<i>Heteropogon contortus</i>	Spear Grass		
<i>Hyparrhenia hirta</i>	Common Thatching Grass		
<i>Hypoxis sp.</i>			
<i>Mariscus congestus</i>			
<i>Melia azedarach</i>	Syringa		Yes
<i>Nothoscordum gracile</i>	Fragrant False-Garlic		Yes
<i>Panicum maximum</i>	Guinea Grass		
<i>Paspalum notatum</i>	Bahia Grass		Yes

Scientific Name	Common Name	Medicinal Value	Exotic Inavder
<i>Pennisetum macrorumum</i>	Riverbed Grass		
<i>Pognotharia squarrosa</i>	Herringbone Grass		
<i>Protasparagus laricinus</i>	Wild Asparagus		Yes
<i>Rhus pyroides</i>	Common Wild Currant	Yes	
<i>Rhus zeyheri</i>	Blue Currant		
<i>Schizachyrium sanguineum</i>	Red Autumn Grass		
<i>Scolopia zeyheri</i>	Thorn Pear		
<i>Senecio sp.</i>			
<i>Sesbania punicea</i>	Red Sesbania		Yes
<i>Setaria sphaecalata var sphaecalata</i>	Common Bristle Grass		
<i>Setaria sphaecalata var torta</i>	Creeping Bristle Grass		
<i>Solanum mauritianum</i>	Bugtree		Yes
<i>Sporobolus festivus</i>	Red Dropseed		
<i>Themeda triandra</i>	Red Grass		
<i>Trachypogon spicatus</i>	Giant Spear Grass		
<i>Typha capensis</i>			
<i>Verbena bonariensis</i>	Wild Verbena		Yes
<i>Xanthium strumarium</i>	Large Cocklebur		Yes
<i>Zinnia peruviana</i>	Redstar Zinnia		Yes



Appendix 2: List of Red Data Plants

Scientific Name	Status	Habitat
<i>Ceropegia humifructus</i>	Data deficient	Unknown
<i>Schisoglossum umbelluliferum</i>	Declining	Deep black turf in open woodland mainly in the vicinity of drainage lines
<i>Trachyandra erythorrhiza</i>	Near Threatened	Marsh area, grassland usually in turf marshes

Appendix 3: List of Red Data Birds potentially occurring on site

Common Name	Status	Habitat	Main Threat
Lesser Kestrel	Vulnerable	Semi-arid grassland often near urban areas	Habitat loss
Grass Owl	Vulnerable	Rank grassland along the spruit, marshes, sparse acacia woodland	Habitat loss
African Marsh Harrier	Vulnerable	Wetlands and grassland	Habitat loss
Melodius Lark	Near Threatened	Open grassland dominated by <i>Themeda triandra</i> or <i>Hyparrhenia hirta</i> with a high basal cover	Habitat loss

Appendix 4: List of potential herpetofauna (amphibians and reptiles) on site

Species Name	Common Name	Red Data Status	Habitat	Suitable habitat on site
<i>Pyxicephalus adspersus</i>	Giant Bullfrog	Near Threatened	Occurs in grassland, savanna, nama karoo and thicket. It breeds in seasonal shallow, grassy pans, non-permanent vleis, margins of waterholes and dams.	wetland, dams
<i>Homoroselaps dorsalis</i>	Striped Harlequin Snake		Prefers grassland and is associated with termite mounds, it is a secretive and burrowing snake.	None
<i>Python sebae</i>	African Rock Python		Inhabits primarily rock outcroppings on savanna and can also be found alongside streams, rivers, and lakes.	Marginally suitable habitat

Appendix 5: List of Red data mammals that historically occurred on site

Common Name	Scientific Name	Red Data Status	Habitat	Likelihood of occurrence
South African Hedgehog	<i>Atelerix frontalis</i>	near threatened	Temperate habitats with ground cover for nesting	none
Schreiber's long-fingered bat	<i>Miniopterus schreibersii</i>	near threatened	caves and subterranean habitats, savanna, shrubland and grassland	none
Darling's horseshoe bat	<i>Rhinolophus darlingi</i>	near threatened	caves and subterranean habitats, savanna, woodland	none
Geoffroy's horseshoe bat	<i>Rhinolophus clivosus</i>	near threatened	caves and subterranean habitats, savanna, shrubland and grassland	none
Temminck's hairy bat	<i>Myotis tricolor</i>	near threatened	caves, forest, shrubland, savanna grassland	none
Juliana's golden mole	<i>Neamblysomus julianae</i>	vulnerable	Sour lowveld bushveld, clay thorn bushveld, rocky highveld grassland, subterranean habitats and gardens.	possible
Short-eared trident bat	<i>Cloeotis percivali</i>	critically endangered	caves and subterranean habitats, mixed woodland savanna	none
Water rat	<i>Dasymys incomtus</i>	near threatened	wetland areas	possible
Brown hyaena	<i>Hyaena brunnea</i>	near threatened	savanna, shrubland, grassland, sometimes urban areas	possible
Serval	<i>Leptailurus serval</i>	near threatened	savanna, grassland, wetland areas. Its niche is moist savanna and tall grass	possible
Spotted-necked otter	<i>Lutra maculicollis</i>	near threatened	aquatic environments: permanent streams, rivers, creeks and ponds	possible
White-tailed rat	<i>Mystromys albicaudatus</i>	endangered	temperate, requires sandy soils with good cover	none
Rough-haired golden mole	<i>Chrysospalax villosus</i>	critically endangered	subterranean: sandy soils at edge of vleis, wetland areas	possible
Rusty bat	<i>Pipistrellus rusticus</i>	near threatened	savanna, riparian forest, roosts in crevices of trees	none

Appendix 6. List of exotic and invasive species found on site (Henderson, 2001)

<b>Scientific Name</b>	<b>Common Name</b>	<b>Status</b>	<b>Declared Invader category</b>
<i>Agrave americana</i>	American agave	category 2	Invader
<i>Arundo donax</i>	Spanish Reed	category 1	Weed
<i>Asclepias fruticosa</i>	Shrubby Milkweed		
<i>Bidens pilosa</i>	Blackjack		
<i>Conyza albidia</i>	Tall Fleabane		
<i>Conyza bonariensis</i>	Flaxleaf Fleabane		
<i>Conyza canadensis</i>	Horseweed Fleabane		
<i>Cyperus rotundus</i>	Purple nutsedge		
<i>Melia azedarach</i>	Syringa	category 3	Invader
<i>Nothoscordum gracile</i>	Fragrant False-Garlic		
<i>Paspalum notatum</i>	Bahia Grass		
<i>Protasparagus laricinus</i>	Wild Asparagus		
<i>Sesbania punicea</i>	Red Sesbania	category 1	Weed
<i>Solanum mauritianum</i>	Bugtree	category 1	Weed
<i>Verbena bonariensis</i>	Wild Verbena		
<i>Xanthium strumarium</i>	Large Cocklebur	category 1	Weed
<i>Zinnia peruviana</i>	Redstar Zinnia		

Appendix 7. Riparian Vegetation Biomonitoring Site Assessment Form (Portion 32 of Doornpoort 295-JR).

MEASUREMENT	DESCRIPTION	HEIGHT CLASS
<b>CHANNEL DESCRIPTION</b>		
Channel Type	Single	
Active channel width	4m	
<b>RIPARIAN ZONE DESCRIPTION</b>		
Width of potential riparian zone		
LHB	2m	
RHB	8m	
Substrate		
<i>Bedrock</i>	0%	
<i>Rock/cobble</i>	6-25%	
<i>Soil</i>	26-50%	
<i>Gravel/sand</i>	6-25%	
<i>Sediment</i>	6-25%	
Percentage Vegetation Cover [F1]	50-75%	
<b>SITE CONDITION</b>		
Natural vegetation cover	Medium	
Disturbed vegetation cover	High	
Site disturbances [F2]	High	
<i>Floods, elevated flows</i>	High	
<i>Flow regulation (dam upstream)</i>	High	
<i>Weir / dam (local inundation)</i>	High	
<i>Roads, bridges, other infrastructure</i>	Medium	
<i>Erosion / sedimentation</i>	Low	
<i>Vegetation invasion (exotic, terr, reeds)</i>	High	
Surrounding land-use		
<i>Residential (urban)</i>		
<i>Dumping</i>		
<b>DISTRIBUTION AND EXTENT OF VEGETATION COVER</b>		
Cover		
<i>Trees</i>	25%	
<i>Shrubs</i>	20%	
<i>Reeds</i>	0%	
<i>Sedges</i>	15%	
<i>Grasses</i>	20%	
<i>Bare Ground</i>	20%	
Distribution [F3]		
<i>Trees (S1)</i>	PRESENT STATE Scattered	PERCEIVED REFERENCE STATE Continuous
<i>Shrubs (S2)</i>	Scattered	Scattered
<i>Reeds (S3)</i>	Clumped	Clumped
<i>Sedges (S4)</i>	Sparse	Scattered
<i>Grasses (S5)</i>	Continuous	Continuous
<i>Bare Ground (S6)</i>	Continuous	Sparse
<b>INVASION OF RIPARIAN ZONE [F5, 6, 7]</b>		
Exotic species (dominance by estimated biomass)		

<i>Protasparagus laricinus (terrestrial species)</i>	Medium	
<i>Asclepias fruticosa (terrestrial species)</i>	Very High	
<i>Bidens pilosa (terrestrial species)</i>	Medium	
<i>Verbena bonariensis</i>	High	
<i>Xanthium strumarium</i>	High	
<i>Nothocordium gracile</i>	Medium	
<i>Conyza sp.</i>	High	
<i>Sesbania punicea (terrestrial species)</i>	Medium	
Total extent of invasion	High	
Exotic species (dominance by recruitment)		
<i>Protasparagus laricinus (terrestrial species)</i>	20 individuals	1-2m
<i>Asclepias fruticosa (terrestrial species)</i>	60 individuals	< 1m
<i>Bidens pilosa (terrestrial species)</i>	10 individuals	< 1m
<i>Verbena bonariensis</i>	30 individuals	1-2m
<i>Xanthium strumarium</i>	30 individuals	1-2m
<i>Nothocordium gracile</i>	15 individuals	< 1m
<i>Conyza sp.</i>	5 individuals	1-2m
<i>Sesbania punicea (terrestrial species)</i>	5 individuals	1-2m
<b>RECRUITMENT OF INDIGENOUS RIPARIAN SPECIES</b>		
Extent of Recruitment [F7]	Medium	
Species richness		
Number of indigenous tree & shrub species	35 individuals	
Number of exotic tree and shrub species	17 individuals	
Total species	60	
<b>ASSESSOR GUT SCORE</b>		
Score	5 to 8	
Class	E	

Calculation of the RVI

The RVI formula is:

$$RVI = [(EVC) + ((SI \times PCIRS) + (RIRS))]$$

Where the following sub-indices apply:

*EVC* is extent of vegetation cover  
*SI* is structural intactness  
*PCIRS* is percentage cover of indigenous riparian species  
*RIRS* is recruitment of indigenous riparian species

Calculation of EVC

EVC (score out of 10) = {EVC1 + EVC2} / 2  
 EVC1 = F1 = 76-100% = EVC score of 10  
 EVC2 = F2 = Medium disturbance = EVC score of 6  
 EVC = {10 + 6} / 2 = 8

*Calculation of SI*

$$SI \text{ (score out of 1)} = \frac{[(SI1 + SI2 + SI3 + SI4 + SI5 + SI6)]}{5} \times 0.33$$

$$= \frac{[(3 + 3 + 3 + 2 + 3 + 3)]}{5} \times 0.33$$

$$SI = 1.122$$

*Calculation of PCIRS*

$$PCIRS \text{ (score out of 5)} = \frac{EVC}{2} - [(exotics \times 0.7) + (terrestrial \times 0.1) + (reeds \times 0.2)]$$

$$= \frac{4}{2} - [(7 \times 0.7) + (6 \times 0.1) + (1 \times 0.2)]$$

$$= 2 - (4.9 + 0.6 + 0.2)$$

$$= -3.7$$

*Calculation of RIRS*

RIRS (score out of 5) = 4 (High)

Therefore :  $RVI = \frac{EVC + (SI \times PCIRS) + (RIRS)}{3}$

$$= \frac{8 + (1.122 \times -3.7) + 4}{3}$$

$$= 7.8486$$

Appendix 8. Riparian Vegetation Biomonitoring Site Assessment Form (Portion 129 of Doornpoort 295-JR).

MEASUREMENT	DESCRIPTION	HEIGHT CLASS
<b>CHANNEL DESCRIPTION</b>		
Channel Type	Single	
Active channel width	4m	
<b>RIPARIAN ZONE DESCRIPTION</b>		
Width of potential riparian zone		
LHB	2m	
RHB	5m	
Substrate		
Bedrock	0%	
Rock/cobble	6-25%	
Soil	6-25%	
Gravel/sand	6-25%	
Sediment	6-25%	
Percentage Vegetation Cover [F1]	76-100%	
<b>SITE CONDITION</b>		
Natural vegetation cover	High	
Disturbed vegetation cover	High	
Site disturbances [F2]	High	
Floods, elevated flows	High	
Flow regulation (dam upstream)	High	



<i>Weir / dam (local inundation)</i>	High	
<i>Roads, bridges, other infrastructure</i>	Medium	
<i>Erosion / sedimentation</i>	Low	
<i>Vegetation invasion (exotic, terr, reeds)</i>	Very High	
Surrounding land-use		
<i>Residential (urban)</i>		
<i>Dumping</i>		
<b>DISTRIBUTION AND EXTENT OF VEGETATION COVER</b>		
Cover		
<i>Trees</i>	6-25%	
<i>Shrubs</i>	0%	
<i>Reeds</i>	26-50%	
<i>Sedges</i>	0%	
<i>Grasses</i>	26-50%	
<i>Bare Ground</i>	0%	
		PERCEIVED REFERENCE STATE
Distribution [F3]	PRESENT STATE	
<i>Trees (S1)</i>	Clumped	Clumped
<i>Shrubs (S2)</i>	Scattered	Scattered
<i>Reeds (S3)</i>	Clumped	Clumped
<i>Sedges (S4)</i>	Scattered	Sparse
<i>Grasses (S5)</i>	Continuous	Continuous
<i>Bare Ground (S6)</i>	Sparse	Sparse
<b>INVASION OF RIPARIAN ZONE [F5, 6, 7]</b>		
Exotic species (dominance by estimated biomass)		
<i>Protasparagus laricinus (terrestrial species)</i>	Very High	
<i>Asclepias fruticosa (terrestrial species)</i>	Very High	
<i>Bidens pilosa (terrestrial species)</i>	High	
<i>Verbena bonariensis</i>	High	
<i>Xanthium strumarium</i>	High	
<i>Nothocordium gracile</i>	Medium	
<i>Arundo donax</i>	Low	
<i>Sesbania punicea (terrestrial species)</i>	Medium	
<i>Total extent of invasion</i>	High	
Exotic species (dominance by recruitment)		
<i>Protasparagus laricinus</i>	60 individuals	1-2m
<i>Asclepias fruticosa</i>	60 individuals	< 1m
<i>Bidens pilosa (terrestrial species)</i>	30 individuals	< 1m
<i>Verbena bonariensis</i>	20 individuals	1-2m
<i>Xanthium strumarium</i>	20 individuals	1-2m
<i>Nothocordium gracile</i>	15 individuals	< 1m
<i>Arundo donax</i>	5 individuals	1-2m
<i>Sesbania punicea</i>	5 individuals	1-2m
<b>RECRUITMENT OF INDIGENOUS RIPARIAN SPECIES</b>		
Extent of Recruitment [F7]	Medium	
Species richness		
<i>Number of indigenous tree &amp; shrub species</i>	35 individuals	
<i>Number of exotic tree and shrub species</i>	17 individuals	
<i>Total species</i>	60	

ASSESSOR GUT SCORE	
Score	5 to 8
Class	E

#### Calculation of the RVI

The RVI formula is:

$$RVI = [(EVC) + ((SI \times PCIRS) + (RIRS))]$$

Where the following sub-indices apply:

*EVC* is extent of vegetation cover

*SI* is structural intactness

*PCIRS* is percentage cover of indigenous riparian species

*RIRS* is recruitment of indigenous riparian species

#### Calculation of EVC

EVC (score out of 10) = {EVC1 + EVC2} / 2

EVC1 = F1 = 76-100% = EVC score of 10

EVC2 = F2 = Medium disturbance = EVC score of 6

$$EVC: \{10 + 6\} / 2 = 8$$

#### Calculation of SI

$$SI \text{ (score out of 1)} = [(SI1 + SI2 + SI3 + SI4 + SI5 + SI6) / 5] \times 0.33]$$

$$= [(3 + 3 + 3 + 2 + 3 + 3) / 5] \times 0.33]$$

$$SI = 1.122$$

#### Calculation of PCIRS

$$PCIRS \text{ (score out of 5)} = [(EVC/2) - ((exotics \times 0.7) + (terrestrial \times 0.1) + (reeds \times 0.2))]$$

$$= [(4/2) - ((7 \times 0.7) + (6 \times 0.1) + (1 \times 0.2))]$$

$$= [2 - (4.9 + 0.6 + 0.2)]$$

$$= -3.7$$

#### Calculation of RIRS

RIRS (score out of 5) = 4 (High)

$$\text{Therefore : } RVI = [(EVC) + ((SI \times PCIRS) + (RIRS))]$$

$$= [8 + ((1.122 \times -3.7) + 4)]$$

$$= 7.8486$$