GOD'S WINDOW SKYWALK
Wetland Assessment

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S · E · F
STRATEGIC ENVIRONMENTAL FOCUS

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Declaration of Independence

I, **Willem Lubbe,** in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Have and will not have vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not;
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member;
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement; and
- Undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered.

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27 August 2014
Date

EXECUTIVE SUMMARY

Strategic Environmental Focus (Pty) Ltd (SEF) as independent environmental consultants and ecological specialists, was appointed by the Industrial Development Corporation (Pty) Ltd to undertake a wetland study for the proposed Skywalk at God's Window in Mpumalanga. The Mpumalanga Tourism and Parks Association (MTPA) has proposed a glass-bottomed, cantilevered Skywalk be built at the God's Window site. The terms of reference for the current study were as follow:

- Identify and delineate wetland areas associated with the proposed site according to the Department of Water Affairs' "Practical field procedure for the identification and delineation of wetlands and riparian areas"
- Determine the Present Ecological State (PES) of identified wetlands using the WET-Health approach;
- Determine the Ecological Importance and Sensitivity (EIS) of identified wetlands using the latest applicable approach as supported by the DWA;
- Identify possible impacts of unauthorised activities associated with wetlands within the study area and provide mitigation measures.

One hydro-geomorphic type, a hillslope seepage wetland connected to a watercourse was recognised within the study area. However, not all wetlands within the study area conformed to typical hydro-geomorphic types as a result of their unique landscape setting and attributes. Four individual hydro-geomorphic units were delineated and classified within and in the direct vicinity of the study area.

The ecosystem services performed by the identified wetlands were assessed through applying a Level 2 Wet-EcoServices assessment. Functions receiving the highest scores include streamflow regulation and the maintenance of biodiversity as the study area contained several areas with large populations of species of conservation concern. The wetlands' ability to contribute to ecosystem services within the study area is further dependent on the particular wetland's Present Ecological State in relation to a benchmark or reference condition. A Wet-Health Level 2 assessment of the wetlands within the study area assigned a Present Ecological State score for the particular hydro-geomorphic units. Combined area weighted Wet-Health results considered the majority of the identified wetlands to be largely unmodified (Present Ecological State Category A), while one wetland was considered to be moderately modified (Present Ecological State Category C).

The Ecological Importance and Sensitivity assessment was undertaken to rank wetlands in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- Biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

All of the HGM units in the study area were assigned high to very high scores for ecological importance and sensitivity as a result of the high concentrations of threatened species recorded on the cliff edges, vertical cliffs and mistbelt forests. HGM 3, the mistbelt forest associated wetlands was considered to have high importance from a hydrological perspective as it is likely to be an important recharge zone which support various ecologically sensitive areas within and surrounding the study area. Direct human benefit associated with the wetland includes tourism opportunities as well as the water supply to current tourism infrastructure derived from HGM 3.

The impact assessment identified a potential altered hydrological regime as the most significant impacts associated with the development of tourism infrastructure. Some of the mitigation measures discussed in the report included:

- Detailed geo-hydrological investigations should accompany core drilling exercises planned for further geotechechnical studies (investigating suitability of the geology for the envisaged tourism infrastructure). The geo-hydrology studies need to ascertain how much water-bearing features underlies the proposed footprint of the tourism infrastructure and how one can avoid impacts on these water-bearing features.
- As a result of the sensitivities on site, a conservative approach is highly recommended where the design of the infrastructure reduces the chances of negative impacts on surface and groundwater. This could likely be achieved through using a pilon design with a raised floor/foundation, allowing free flow of surface water and minimum disturbance to groundwater. The roof of the structure can be vegetated within indigenous flora and simulate natural run-off conditions while reducing the visual impact.
- A sensitive stormwater management plan must be developed in conjunction with a wetland specialist on completion of the detailed geo-hydrological studies.
- Design of a monitoring plan must be incorporated during the infrastructure design phase and be implemented well ahead of construction activities in order to build up adequate baseline data. As a minimum, HGM 2 and seepages associated with HGM 4 (below the construction footprint area) should be monitored. This would entail at least three fixed transects to be adopted on the cliff face below the construction footprint to monitor population containing species of conservation concern as well as groundwater supported hillsope seepages.

It is further recommended that the unique wetlands identified during the current study be studied and researched in more detail as information derived from such detailed studies could be utilized to enhance educational and tourism potential of the proposed development and help to define these wetlands within the international academic arena.

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1. INTRODUCTION

With South Africa being a contracting party to the Ramsar Convention on Wetlands, the South African government has taken a keen interest in the conservation, sustainable utilisation and rehabilitation of wetlands in South Africa. This aspect is also reflected in various pieces of legislation controlling development in and around wetlands and other water resources, of which the most prominent may be the National Water Act, Act 36 of 1998. As South Africa is an arid country, with a mean annual rainfall of only 450mm in relation to the world average of 860mm (DWAF, 2003), water resources and the protection thereof becomes critical to ensure their sustainable utilisation. Many wetlands perform various important functions related to water quality, flood attenuation, stream flow augmentation, erosion control, biodiversity, harvesting of natural resources, and others, highlighting their importance as an irreplaceable habitat type. Determining the location and extend of existing wetlands, as well as evaluating the full scope of their ecosystem services, form an essential part in striving towards sustainable development and protection of water resources.

1.1 Project Description

Strategic Environmental Focus (Pty) Ltd (SEF), as independent environmental consultants and ecological specialists, was appointed by the Industrial Development Corporation (Pty) Ltd to undertake a wetland study for the proposed Skywalk at God's Window in Mpumalanga. The Mpumalanga Tourism and Parks Association (MTPA) have proposed a glass bottomed, cantilevered Skywalk be built at the God's Window site. This is in order to enhance the tourist experience at the site, and to attract a growing number of tourists to the region. The idea of the Skywalk is premised on the existing Skywalk at the Grand Canyon in the United States of America.

A feasibility study has been completed on the project by AECOM, which indicated that the project is technically feasible and there is a market for such a tourist component in the Blyde River Canyon area.

1.2 Terms of Reference

The terms of reference for the current study were as follows:

- Identify and delineate wetland areas associated with the proposed site according to the Department of Water Affairs' "Practical field procedure for the identification and delineation of wetlands and riparian areas"
- Determine the functionality (using Wet-EcoServices) as well as the Present Ecological State (PES) of identified wetlands using the WET-Health approach;
- Determine the Ecological Importance and Sensitivity (EIS) of identified wetlands using the latest applicable approach as supported by the DWA;
- Identify possible impacts of proposed activities that could affect wetlands within the study area and propose mitigation measures.

1.3 Assumptions and Limitations

In order to obtain definitive data regarding the biodiversity, hydrology and functioning of particular wetlands, studies should ideally be conducted over a number of seasons and over a number of years. The current study relied on information gained during a four day field survey conducted during a single season, desktop information for the area, information obtained from provincial conservation authorities, as well as professional judgement and experience, which were deemed sufficient to carry out this study. In addition, soil form classification was made by a wetland ecologist and not a specialised soil scientist which could potentially make different interpretations of diagnostic horizons in some instances. Delineations of wetland areas were dependent on the extrapolation of data obtained during field surveys and from interpretation of orthophotos and other imagery. It should be noted that wetlands delineated extend further beyond the indicated study boundary and that only wetland areas within the study boundary were verified using field survey techniques. The inaccessibility of the terrain reduced the amount of wetlands that could be verified.

1.4 Methodology

Field surveys were undertaken on the 18th of October 2013 as well as the 20th to the 22nd of March 2014. The wetland delineation was based on the legislatively required methodology as described by DWAF (2005). In order to determine the functionality of wetlands, a Level 2 Wet-EcoServices (Kotze *et al.*, 2005) assessment was performed. A Level 2 Wet-Health assessment (Macfarlane *et al.*, 2008) was applied in order to determine the Present Ecological Status (PES) of wetlands within the study area through assigning PES categories to wetlands. Professional rope access technology by trained technicians was employed to access difficult and vertical terrain. For a more comprehensive study approach and specific methodologies employed during the current study, see Appendix A.

2. BACKGROUND INFORMATION

2.1 Locality

The study area is located at God’s Window in the Mpumalanga Province approximately 7km north-east of Graskop and falls in Quarter Degree Grid Cell (QDGC) 2430DD between 24°52’31.5” – 24°52’42.7” south and 30°53’19.0” – 30°53’14.3” east (Figure 1).

2.2 Climate

The study area experiences a strong seasonal summer rainfall although orographic effects enhance precipitation (mean annual precipitation is 1176mm). Mist is common along the escarpment although frost is experienced infrequently. Mean annual temperature is 16.6ºC (Mucina and Rutherford, 2006).

2.3 Geology

According to Aurecon (2013), the study area is underlain by sedimentary rocks of the upper and lower parts of the Wolkberg Group belonging to the Transvaal Sequence. The upper part of the Wolkeberg Group consists of the following three formations:

- Sadowa Formation, consisting of dark-grey to brown, well-bedded, micaceous shale with lenticular quartzite layers.
- Mabin Formation, consisting of white, grey to reddish brown, medium- to fine-grained quartzite with pebble fans and interlayered shale layers.

- Selati Formation, consisting of laminated micaceous and graphitic shale, locally interlayered with sandy shale, flagstone and quartzite.

According to ARQ (2013) the upper and lower undifferentiated Wolkberg Groups consist predominantly of conglomerates, quartzite and shale. The report further assumes a shallow sandy soil profile with rock close to surface (Aurecon 2013).

2.4 Regional Vegetation

The study area is situated within two Biomes, namely Afrotemperate, Subtropical and Azonal Forests Biome and the Grassland Biome. The Afrotemperate, Subtropical and Azonal Forests Biome is defined as multi-layered vegegtation which is dominated by trees with overlapping crown cover and the graminoids in the herbaceous layer are generally rare (Mucina & Rutherford, 2006). These forests are limited to regions with high water availability and persist in areas with mean annual rainfall of more than 725mm per annum during summer. The Grassland Biome is characterized by high summer rainfall and dry winters. Frequent frost during the winter nights as well as marked diurnal temperature variations is unfavourable for tree growth resulting in the Grassland Biome consisting mainly of grasses and plants with perennial underground storage organs, such as bulbs and tubers. A large number of Rare and Threatened plant species in the summer rainfall regions of South Africa is restricted to high-rainfall grassland, making this the vegetation type in most urgent need of conservation.

Biomes can further be divided into smaller units known as vegetation types and according to Mucina and Rutherford (2006), three vegetation types namely Northern Mistbelt Forest, Northern Escarpment Afromantane Fynbos and Northern Escarpment Quartzite Sourveld are located within the study area.

Northern Mistbelt Forest occurs in Limpopo, Mpumalanga and Swaziland along the Soutpansberg from Blouberg in the northwest to the Samadou Plateau in the northeast as well as along the Abel Erasmus Pass to Badplaas and Baberton. This vegetation type is also known as the Mpumalanga Afromontane Forest (Ferrar and Lotter, 2007). The vegetation consists of tall, evergreen afrotemperate mistbelt forests on east facing cliffs and sheltered kloofs. The most common canooy trees include *Xymalos monospora, Podocarpus latifolius, Combretum kraussii, Cryptocarya transvaalensis* and *Pterocelastrus galpinii.* The understory consists of species such as *Psycotria zombamontana, Canthium kuntzeanum, Gymnosporia harveyana, Peddiea Africana, Mackaya bella* and *Sclerochiton harveyanus.* Northern Mistbelt Forest is classified as Least threatnened with about 10% statutorily conserved in the Blyde River Canyon, Lekgalameetse, Songimvelo, Barberton and Starvation Creek Nature Reserves.

Northern Escarpment Afromontane Fynbos is located in the Limpopo and Mpumalanga Provinces where it is restricted to the peaks of Thabakgolo Mountains above Penge, southwards along the highest peaks to Mariepskop and Graskop. The dominant vegetation structure is shrubland which consists of sclerophyllous shrubs and herbs. Important taxa include small trees such as *Protea caffra, P.roupelliae,* succulent species such as *Aloe arborescens* and herbaceous species such as *Erica natalitia, Hypericum revolutum, Passerina montana, Cliffortia linearifolia, Erica revoluta, Erica simii, Euryops pedunculatus* and various *Helichrysum* species. Northern Escarpment Afromontane Fynbos is classified as Least Threatened with more than 56% of this vegetation type protected.

Northern Escarpment Quartzite Sourveld occurs in Limpopo and Mpumalanga Provinces where it occurs along the high-altitude crests of the Northern Escarpment from Haenertsburg to Blyde River Canyon and Kaapsehoop. The landscape is characteristically very rugged with steep east-facing cliffs which are dominated by species such as *Protea roupelliae, Faurea galpinii, Faurea rochetiana, Syzygium cordatum, Cyathea dregai, Vernonia myriantha.* Low shrub species includes *Athrixia phylicoides, Clutia monticola, Crotalaria doidgeae, Erica woodii, Euryops pedunculatus, Aloe arborescens, Crassula sarcocaulis* while the diverse herbaceous layer consists of species such as *Berkheya echinacea, Dicoma anomala, Eriosema angustifolium, Gerbera ambigua, Monsonia attenuate* and *Pearsonia sessilifolia.* Northern Escarpment Quartzite Sourveld is classified as Vulnerable with more than 38% transformed mainly by plantations. It is furthermore noted that this vegetation type coincides with the Wolkberg Centre of Endemism and is rich in endemic plants.

2.5 Wetland Vegetation Group

According to the National Biodiversity Assessment's Freshwater Component (Nel and Driver, 2012), the study area falls within the Mesic Highveld Grassland Group 9 wetland vegetation group which has a conservation status of Least Threatened according to the Wetland Vegetation Group's Ecosystem Threat Status.

2.6 Associated Watercourses

The study area is situated within the Southern Temperate Highveld freshwater ecoregion (FEOW, 2014). Further, the study area is located on the watershed of the Inkomati Water Management Area (WMA) and the Olifants WMA. Wetlands within the study that drains west of the watershed feed into the Lisbon River that in turn feed into the Blyde River and eventually feed the Olifants River. Water that drains east of the watershed feeds into the Ngwaritsana River which eventually feeds into Inyaka Dam.

2.7 National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas project represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). More specifically, the NFEPA project aims to:

- Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems; and
- Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

The first aim uses systematic biodiversity planning to identify priorities for conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development. The second aim comprises a national and sub-national component: The national component aims to align DWA and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems. The sub-national component aims to use three case study areas to demonstrate how

NFEPA products should be implemented to influence land and water resource decision-making processes at a sub-national level. The project further aims to maximize synergies and alignment with other national level initiatives such as the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation.

Based on current outputs of the NFEPA project, no FEPA wetlands were identified within the study area, although FEPA wetlands and wetland clusters were identified 450m north of the study area (Figure 2). Further, the Inkomati catchment is recognised as a Fish Support Area for *Barbus brevipinnis, Opsaridium peringueyi, Serranochromis meridianus* and *Varicorhinus nelspruitensis*, whereas the Olifants catchment is identified as a FEPA as a result of the presence of representative river ecosystem types of conservation importance (i.e. Mountain stream, upper foothills and lower foothills of the Northern Escarpment Mountains river ecosystem types). In addition, the Olifants catchment was identified as being a sub-quaternary identified as necessary for rehabilitation for threatened fish species, including *Barbus anoplus, Barbus lineomaculatus, Barbus treurensis* and *Opsaridium peringueyi*.

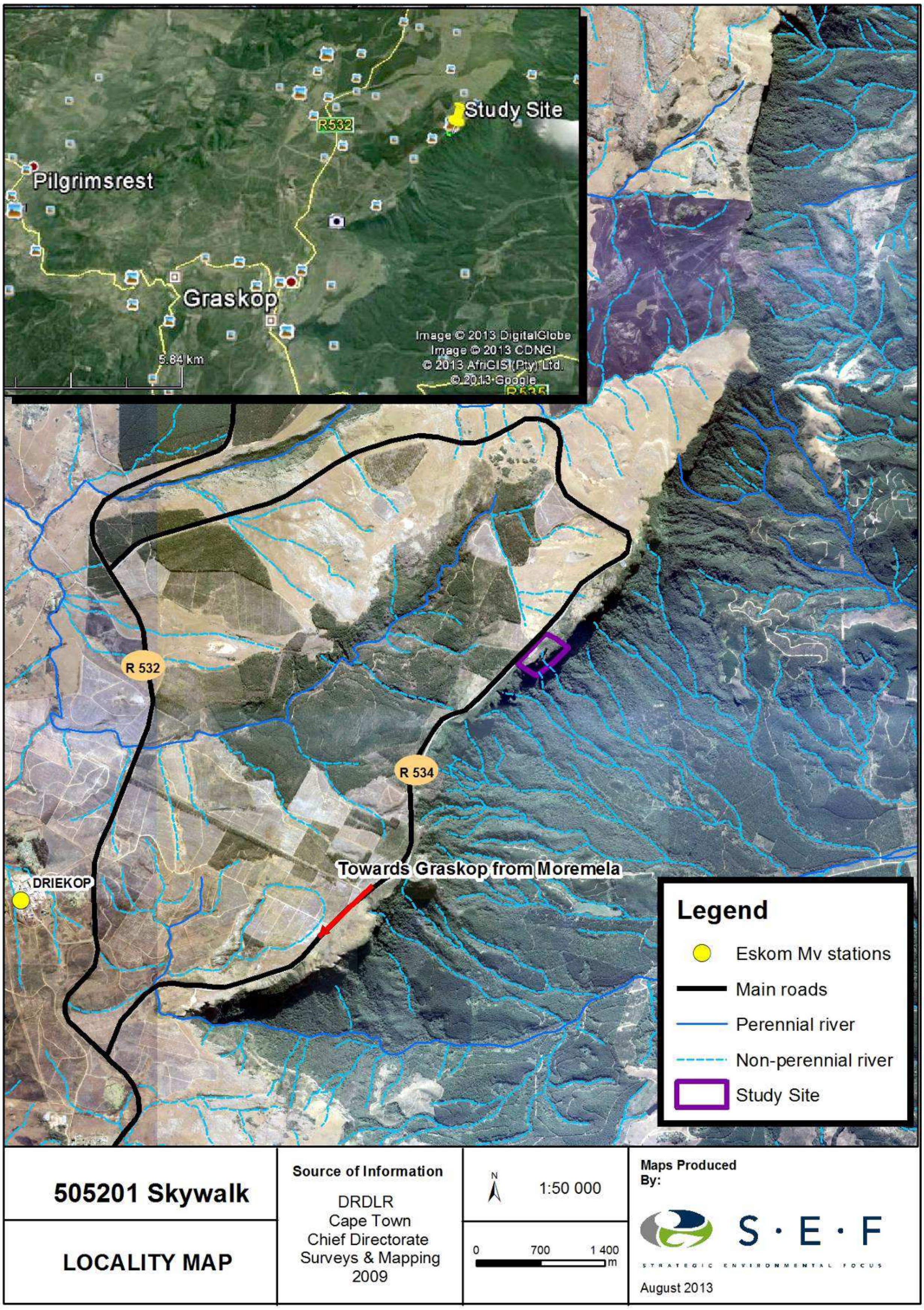


Figure 1: Locality map of the study area

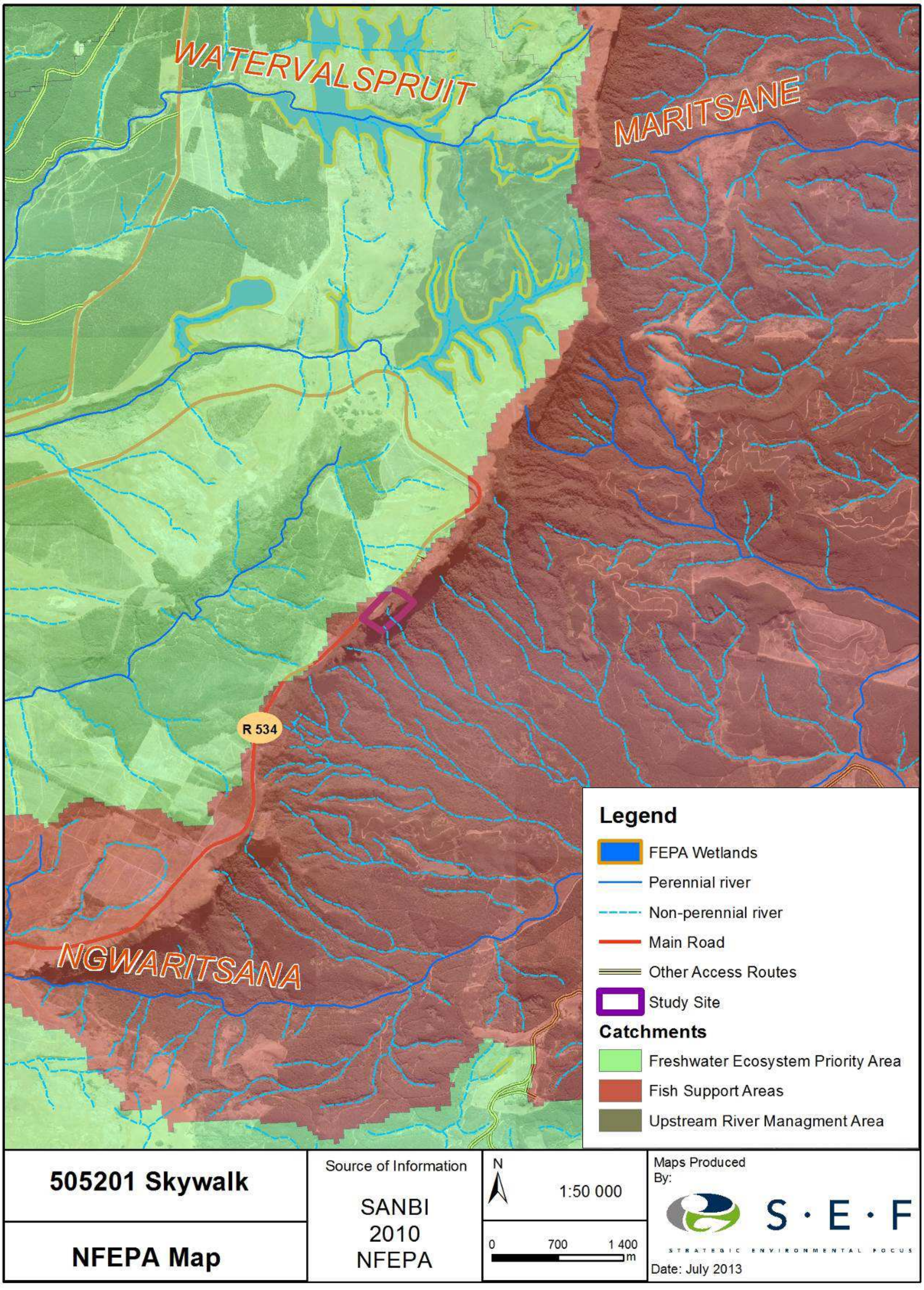


Figure 2: National Freshwater Ecosystem Priority Areas map

3. RESULTS

3.1 Wetland Soils

According to DWAF (2005), the permanent zone of a wetland will always have either Champagne, Katspruit, Willowbrook or Rensburg soil forms present, as defined by the Soil Classification Working Group (1991). The seasonal and temporary zones of the wetlands will have one or more of the following soil forms present (signs of wetness incorporated at the form level): Kroonstad, Longlands, Wasbank, Lamotte, Estcourt, Klapmuts, Vilafontes, Kinkelbos, Cartref, Fernwood, Westleigh, Dresden, Avalon, Glencoe, Pinedene, Bainsvlei, Bloemdal, Witfontein, Sepane, Tukulu, Montagu. Alternatively, the seasonal and temporary zones will have one or more of the following soil forms present (signs of wetness incorporated at the family level): Inhoek, Tsitsikamma, Houwhoek, Molopo, Kimberley, Jonkersberg, Groenkop, Etosha, Addo, Brandvlei, Glenrosa, Dundee (DWAF, 2005).

Temporary and seasonal wetland zones within the vicinity and within the study area contained Kroonstad, Longlands, Cartref (Photograph 1), Westleigh, Fernwood and Pinedene soil forms. Hydric soil forms sampled within permanent wetland habitat included Champagne and Katspruit soil forms. Terrestrial habitat within the wetland's catchment was dominated by Mispah soil forms.

Photograph 1: Augered Cartref soil form with three distinct horizons displayed, including lithocutanic on the left, lighter coloured E-horizon in centre and an organic rich orthic A horizon towards the right

Redoximorphic features were present within soil profiles of the wetland areas, including black, orange and red mottles as well as rhizospheres. Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of iron and manganese oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Redoximorphic features typically occur in three types (Collins, 2005):

- **A reduced matrix** - i.e. an *in situ* low chroma (soil colour), resulting from the absence of Fe^{3+} ions which are characterised by "grey" colours of the soil matrix (Photograph 2).
- **Redox depletions** - the "grey" (low chroma) bodies within the soil where Fe- Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur.
- **Redox concentrations** - Accumulation of iron and manganese oxides (also called mottles). These can occur as:
    - Concretions - harder, regular shaped bodies;
    - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours; and,
    - Pore linings – zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognised as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres.

Photograph 2: Dark organic rich topsoil in contrast to augered bleached E-horizon which has lost colouring materials such as iron oxides, organic matter and clay particles due to reduction

Soils associated with the mistbelt forest just north of the study area contained organic rich topsoils with faint red mottling and rhizospheres as well as gleyed subsoils (Photograph 3) which are likely indicative of permanent wet conditions within the mistbelt forest clumps along the escarpment. Cliff faces below the mistbelt forest contained overhangs and cave formations (Photograph 4) which were groundwater-supported developed potential peat soils from mosses and ferns (Photograph 5). However, these soils' organic content needs to be determined in a laboratory in order to qualify as peat.

Photograph 3: Grey gleyed horizon within mistbelt forest that is indicative of permanent wet conditions. Complete soil profile (*left*) and zoomed in section of gleyed material (*right*)

Photograph 4: Examples of hydrologically-suported caves and overhangs on cliff faces indicated by multiple arrows (*left*) and single large cave formation (*right*).

Photograph 5: Hydrologically-supported cave formation (*left*) developing potential peat soils derived mostly from mosses and ferns (*right*)

According to the DWAF (2005), soil wetness indicators (i.e. identification of redoximorphic features) are the most important indicator of wetland occurrence due to the fact that soil wetness indicators (redoximorphic features) remain in wetland soils, even if they are degraded or desiccated. It is important to note that the presence or absence of redoximorphic features within the upper 500mm of the soil profile alone is sufficient to identify the soil as being hydric (a wetland soil), or non-hydric (non-wetland soil) (Collins, 2005).

3.2 Wetland Vegetation

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act, Act 36 of 1998. Using vegetation as a primary wetland indicator however, requires undisturbed conditions (DWAF, 2005). A cautionary approach must be taken as vegetation alone cannot be used to delineate a wetland, as several species, while common in wetlands, can occur extensively outside of wetlands. When examining plants within a wetland, a distinction between hydrophilic (vegetation adapted to life in saturated conditions) and upland species must be kept in mind. There is typically a well-defined 'wetness' gradient that occurs from the centre of a wetland to its edge that is characterized by a change in species composition between hydrophilic plants that dominate within the wetland to upland species that dominate on the edges of, and outside of the wetland (DWAF, 2003). Graminoid-dominated seepage wetlands situated west of the study area did exhibit such a wetness gradient to some extent. However, as a result of the high rainfall experienced on the escarpment edge (orographic rainfall) combined with shallow soils, this typical gradient of wetness was obscured as many plants within the study area are well adapted to high moisture regimes.

According to SEF (2013), a diversity of vegetation communities were recorded within the relatively small study area. Wetland habitat was associated with sections of mistbelt forest, vertical cliff vegetation communities as well as cliff edge and fern-dominated communities. It should be noted that most of these vegetation communities and their species are usually not associated with wetlands. However, where vegetation communities overlapped with wetland habitat, they were referred to and described below.

Mistbelt forests

Mistbelt forests were recorded directly below the cliffs and in the deep gorge east of the proposed development within the study area as well as on the north-eastern boundary of the study area. The section of mistbelt forest located on the north-eastern boundary exhibited signs of wetness within the soil profile. The closed canopy was made up of large tree species such as *Afrocarpus falcatus* (Yellowood), *Xymalos monospora* (Lemonwood), *Cussonia spicata* (Cabbage Tree), *Schefflera umbellifera* (False Cabbage Tree) and *Psychotria capensis* (Black Bird Berry) (SEF, 2013). The shrub layer consisted of *Obetia tenax* (Nettle Tree) as well as a diversity of fern species including *Cyathea capensis* (Tree Fern) which is currently listed as Declining. Photograph 6 illustrates the mistbelt forest recorded on the north-eastern boundary of the study area while Table 1 summarizes the associated species (SEF, 2013). This forest section provided high heterogeneity in terms of soil structure, micro topography and exposed bedrock formations within close quarters. It is likely that water loving plants such as *Clivia caulescens* would utilise more saturated condition while species such as *Cussonia spicata* utilises elevated positions within the microhabitat to avoid more permanent saturated conditions.

Table 1: Summary of species recorded in the mistbelt forest associated with wetland habitat

Dominant species at the time of the survey:	Herbs: *Clivia caulescens* *Cyathea capenis* *Streptocarpus fenestra-dei* *Streptocarpus micranthus* *Peperomia* sp. Trees and shrubs: *Afrocarpus falcatus* *Psycotria capensis* *Schefflera umbellifera* *Myrsine africana* *Xymalos monospora* *Obetia tenax*
Plants of conservation concern confirmed to occur:	*Clivia caulescens* (NT) *Cyathea capensis* (Declining)
Plants of conservation concern for which suitable habitat was observed:	*Cryptocarya transvaalensis* (Declining) *Curtisia dentate* (NT) *Ocotea bullata* (EN) *Pterocelastrus rostratus* (Declining)
Provincially protected plants confirmed to occur:	*Clivia caulescens*
Provincially protected plants for which suitable habitat was found:	All species listed under plants of conservation concern are also provincially protected
Nationally protected tree species confirmed:	*Afrocarpus falcatus*
Alien species:	*Pinus* sp.

Photograph 6: Mistbelt forest section with multi-layered vegetation structure exhibiting permanent signs of wetness within the soil profile at various localities.

<u>Vertical cliff vegetation communities</u>

A cliff is defined as a high, steep or overhanging face of rock and due to the extreme nature of cliffs, these habitats have rarely been investigated from an ecological viewpoint. The biotic communities living on vertical cliffs are usually highly adapted to cope with temperature extremes and various moisture regimes (usually very wet or completely dry). The cliffs at God's Window form part of the Drakensberg escarpment range which includes over 250km of cliffs. Numerous rare, provincially protected as well as species of conservation concern were recorded on the cliff face within the study area and included *Schizochilus lilacinus* (Extremely Rare), *Monopsis kowynensis* (Vulnerable), *Aloe nubigena* (provincially protected), *Streptocarpus fenestra-dei* (Rare), *Clivia caulescens* (Near Threatened and provincially protected) as well as large populations of *Merwilla plumbea* (nationally protected and Declining) (Photograph 7). Many of the above mentioned species as well as numerous unidentified ferns and mosses were supported by groundwater discharging at various localities on the cliff faces, fissures, overhangs and cave formations within the study area. Table 6 summarises the species recorded on the vertical cliffs that were associated with wet conditions. It should be noted that many of these species were also associated with terrestrial habitat within the study area.

Table 2: Summary of plant species recorded on vertical cliffs within wetland habitat

Dominant species at the time of the survey:	<u>Herbs:</u> *Helichrysum galpinii* *Clivia caulescens* *Monopsis kowynensis* *Passerine montana* *Merwilla plumbea* <u>Trees and shrubs:</u> None
Plants of conservation concern confirmed to occur:	*Monopsis kowynensis* (VU) *Clivia caulesens* (NT)

	Merwilla plumbea (Declining) *Streptocarpus fenestra-dei* (Rare) *Schizochilus lilacinus* (Extremely Rare)
Plants of conservation concern for which suitable habitat was observed:	*Hesperantha brevicaulis* (Rare) *Gladiolus saxatilis* (Rare)
Provincially protected plants confirmed to occur:	All species of conservation concern are also provincially protected as well as the following additional species: *Aloe nubigena*
Provincially protected plants for which suitable habitat was found:	*Gladiolus saxatilis*
Nationally protected species confirmed:	*Merwilla plumbea*
Alien species:	*Pinus* sp.

Photograph 7: Sheer cliffs in the study area (*top left*) providing habitat for specially adapted species such as *Streptocarpus* (*top right*) the extremely rare *Schizochilus lilacinus (bottom left*) and *Mervilla plumbea* (*bottom right*)

Fern dominated and cliff edge vegetation communities

Seepage areas on top of the escarpment towards the south of the study area below the current parking lot and ablution facilities contained dense stands of *Pteridium* sp. (Bracken fern) ferns including invasive *Rubus* sp. on shallow organic rich soils (Photograph 8). These seepage areas also extended up to the cliff edge. According to SEF (2013), the edges of the cliffs were dominated by large stands of *Aloe arborescens* which provided suitable habitat for *Clivia caulescens,* currently listed as Near Threatened (Photograph 9). Cliff edges were high in species diversity and supported more tree species than the adjacent *Passerine montana/Pteridium aquilinum* scrubveld. Tree species confirmed within this vegetation unit included *Afrocarpus falcatus* (synonym: *Podocarpus falcatus*) (Small-leaved Yellowwood) which is nationally protected (SEF, 2013). Table 5 summarizes the floral species recorded within this vegetation unit. As per previous described vegetation communities it should be noted that many of these species were also more commonly associated with terrestrial habitat within the study area.

Photograph 8: Fern dominated seepage area close to escarpment edge

Photograph 9: *Aloe aborescens/Clivia caulescens* dominated cliff edge

Table 3: Summary of the floral species recorded on cliff edges

Dominant species at the time of the survey:	Herbs: *Clivia caulescens* *Agapanthus inapertus* *Selaginella dregei* *Dicranopteris linearis* *Aloe arborescens* Trees and shrubs: *Afrocarpus falcatus* *Psycotria capensis* *Schefflera umbellifera* *Myrsine africana* *Halleria lucida* *Schrebera alata*
Plants of conservation concern confirmed to occur:	*Drimia elata* (DDT) *Clivia caulescens* (NT)
Plants of conservation concern for which suitable habitat was observed:	*Hesperantha brevicaulis* (Rare) *Streptocarpus fenestra-dei* (VU)
Provincially protected plants confirmed to occur:	*Drimia elata* *Clivia caulescens*
Provincially protected plants for which suitable habitat was found:	*Hesperantha brevicaulis* (Rare)
Nationally protected tree species confirmed:	*Afrocarpus falcatus*
Alien species:	*Pinus* sp., *Rubus sp.*

3.3 Hydrology

The hydrology of the area seems interconnected and important in terms of regulating different moisture regimes in different areas, many of these areas serving as habitat harbouring a multitude of species of conservation concern. Lateral water movement seems likely to be an important component of the geohydrology of the area with groundwater-fed seeps occurring in several locations within and surrounding the study area. Later water movement is highly likely as a result of the horizontal plain of the sedimentary quartzite that dominate the site (Photograph 10). Figure 3 indicate potential flow paths as deducted from topography, geology and a multitude of observed springs and wetlands in the area.

Photograph 10: Horizontal plain of sedimentary quartzite that dominate the study area

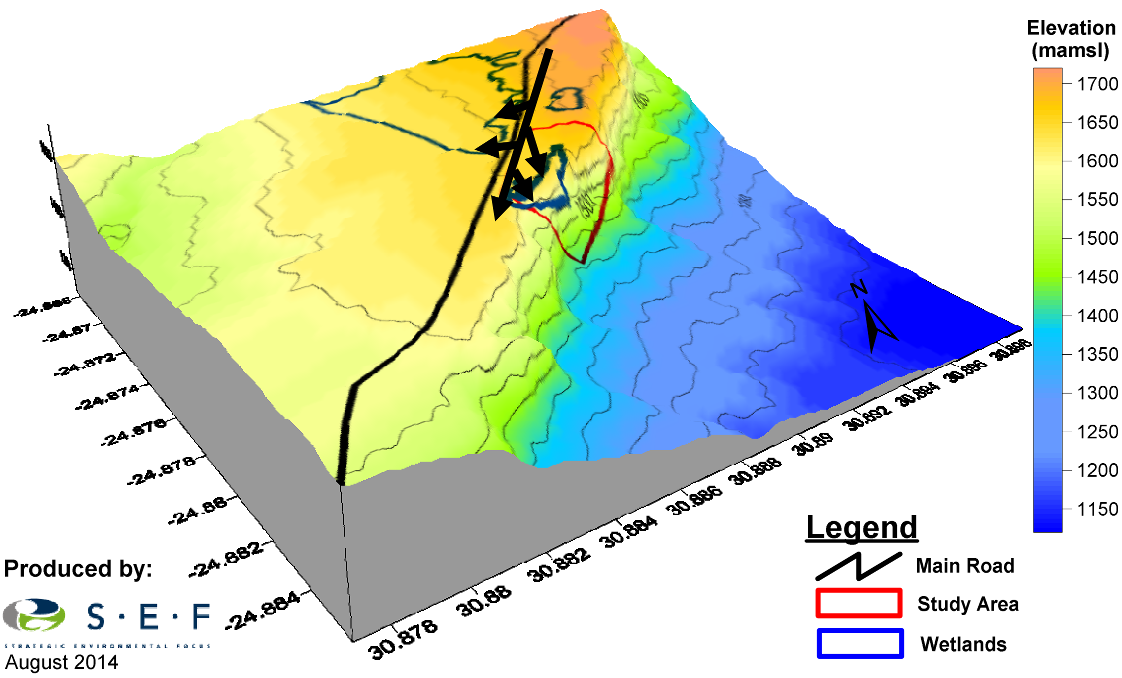


Figure 3: Digital Elevation Model illustrating potential geo-hydrological flowpaths as indicated by black arrows within study area and surroundings

3.4 Delineated Wetland Areas

According to the National Water Act (Act no 36 of 1998) a wetland is defined as, "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*." Wetlands typically occur on the interface between aquatic and terrestrial habitats and therefore display a gradient of wetness – from permanent, to seasonal, to temporary zones of wetness - which is represented in their plant species composition, as well as their soil characteristics. It is important to take cognisance of the fact that not all wetlands have visible surface water. An area which has a high water table just below the surface of the soil is as much a wetland as a pan that only contains water for a few weeks during the year.

Terrain unit which is another indicator of wetland areas refers to the land unit in which the wetland is found. Wetlands can occur across all terrain units from the crest to valley bottom. Many wetlands occur within valley bottoms, but wetlands are not exclusively found within depressions.

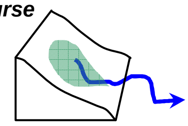
In practice all indicators should be used in any wetland assessment / delineation exercise, the presence of redoximorphic features being most important, with the other indicators being confirmatory. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland and to delineate the boundary of a wetland. According to the DWAF delineation guidelines, the more wetland indicators that are present, the higher the confidence of the delineation. In assessing whether an area is a wetland, the boundary of a wetland or a non- wetland area should be considered to be the point where indicators are no longer present. Wetland boundaries determined within the study area focused on identifying soil forms and soil hydric features such as the presence of mottling, a gleyed matrix and/or Fe and Mg concretions, with other indicators such as vegetation and terrain unit being utilised in a complimentary role.

One hydro-geomorphic type, a hillslope seepage wetland connected to a watercourse was recognised within the study area. However, not all wetlands within the study area conformed to typical hydro-geomorphic types as a result of their unique landscape setting and physical attributes. Four hydro-geomorphic units were delineated and classified within and in the direct vicinity of the study area. The HGM units identified within the study area are presented in Figure 4. HGM units encompass three key elements (Kotze *et al*, 2005):

1. Geomorphic setting. This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
2. Water source. There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
3. Hydrodynamics, which refers to how water moves through the wetland.

Table 4 describes some of the characteristics that form the basis for the classification of the HGM units within and surrounding the study area.

Table 4: Wetland hydro-geomorphic types typically supporting inland wetlands in South Africa and also present within the study area (adapted from Kotze et al., 2005)

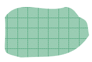
Hydro-geomorphic types	Description	Source of water maintaining the wetland[1]	
		Surface	Sub-surface
Hillslope seepage feeding a watercourse 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a watercourse.	*	***

[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings

Water source: * Contribution usually small

*** Contribution usually large

*/ *** Contribution may be small or important depending on the local circumstances



Wetland

HGM 1

This HGM unit represented a typical hillsope seepage wetland connected to a watercourse that was largely groundwater fed. It has a sloped concave landscape setting and was graminoid dominated.

HGM 2

HGM 2 was classified as a hillslope seepage connected to a watercourse that is situated close to the escarpment edge (including the cliff edge). The wetland is likely fed by a perched aquifer. According to Aurecon (2013) the presence of shallow rock may result in a shallow perched aquifer in the soil zone during the rainy season. The movement of groundwater on top of the hard rock is lateral and in the direction of the surface slope. The water recharged to the soil zone eventually emanates downstream while the remaining water is evapotranspirated or drained by some other means. The wetland contained organic rich shallow soils on a rock base that was fern dominated.

HGM 3

HGM 3, situated in a pocket of mistbelt forest on a raised ridge next to the escarpment edge, did not conform to a typical wetland unit as it contained elements of hillsope seepage wetlands as well as localised small depressions as a result of a hard rock base. Areas that exhibited wetland conditions (especially pedological signs of wetness) were separated by areas of raised solid rock. It is highly likely that these areas function as an important recharge area for wetlands and fountains in the direct vicinity including HGM 1, HGM 2 and HGM 4 (which represent discharge areas) (Figure 5). The dense vegetation structure of the mistbelt forest increases the amount of orographic precipitation being captured, especially mist. According to Mostert *et al*. (2008), similar mistbelt forests and conditions with relative comparable geology occur in the Soutpansberg. Mostert *et al*. (2008) states that the combination of frequent orographic rain and mist during the summer months leaves the available pockets of soil among the rock sheets drenched and sometimes flooded for extended periods. The deeper soil pockets and the half-weathered matrix of saprolite within the mistbelt can be regarded as the sponge areas, which slowly release water to feed mountain streams over extended periods (Moster *et al*., 2008). Several major discharge points (situated east and west

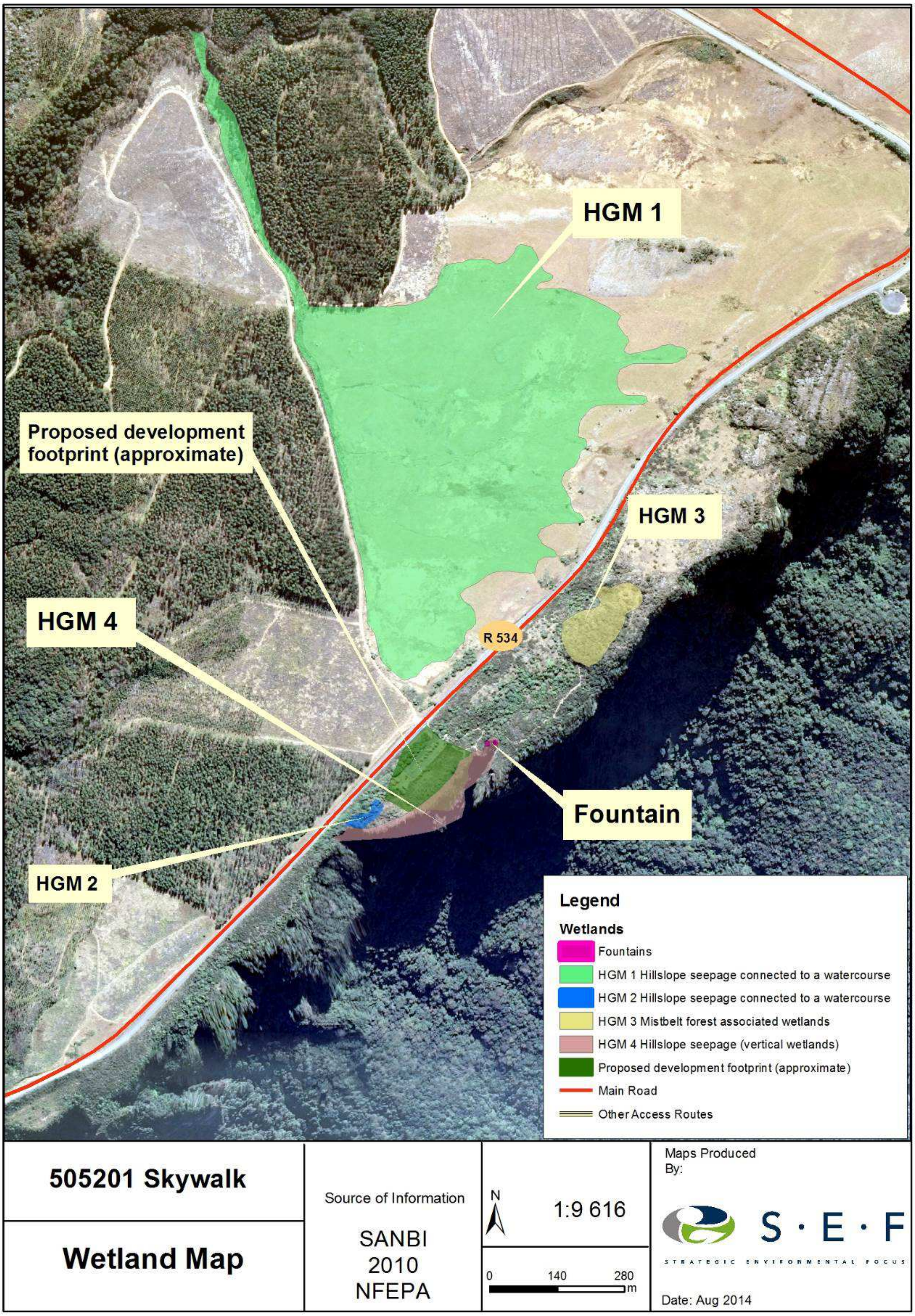


Figure 4: Wetland delineation of the study area

from the escarpment edge) including two major fountains as well as sections of HGM 1 are on the same elevation (approximately 1650 meters above mean sea level), which suggest horizontal water bearing fissures within the sedimentary rock. The whole pocket of mistbelt forest was delineated as a single combined HGM unit as it was not feasible to separate individual pockets of areas exhibiting wetland conditions.

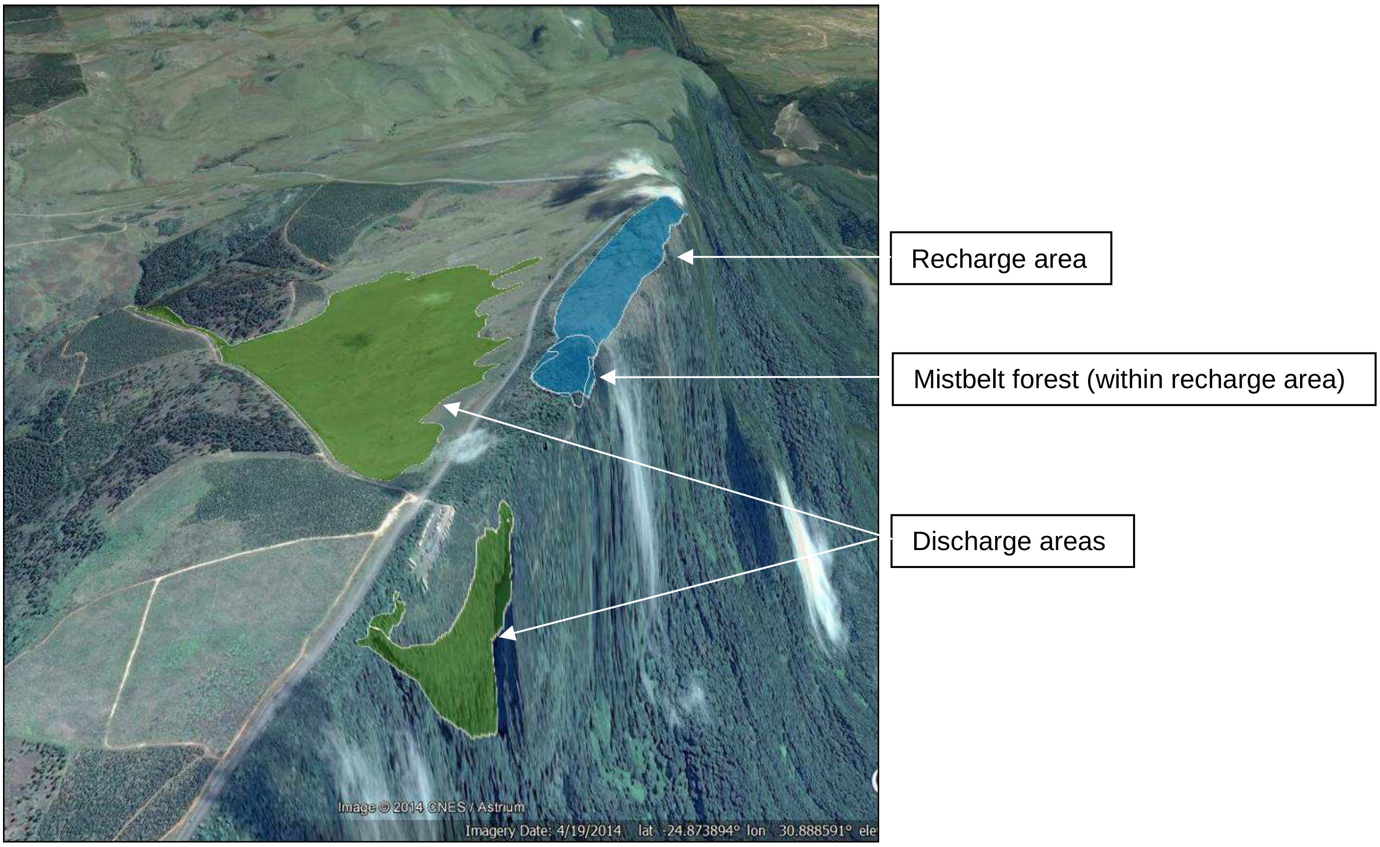


Figure 5: Potential recharge and discharge areas (Google, 2014)

<u>HGM 4</u>

HGM 4 consisted of several small hillslope seepage wetlands (vertical or hanging wetlands) areas located on cliffs, overhangs and caves that were also delineated as a combined HGM unit. The delineation of this HGM unit therefore combined the entire cliff habitat where several of these small wetland systems were observed. These small wetland systems were groundwater fed (springs) and contained a build-up of organic peat-like soils of up to twenty centimetres thick, likely derived from wind-blown and transported silt as well as organic material from several species of ferns and mosses (including several species of conservation concern). The largest of these wetland systems observed was approximately four square metres in extent with varying soil depth, retaining a considerable amount of water in the organic rich soils. It should be noted that not all springs within this vertical habitat contained all the necessary aspects to be classified as wetlands and were rather classified as headwater streams.

From a classification point of view, these small hillslope seepage wetland systems identified on the cliff face compare to hanging spring mires referred to in European literature (Wołejko, 2001; Dobrowolski, 2009; Hess and Range, 1906; Steffen, 1922; Steffen, 1931; Zurek, 1993). According to Dobrowolski (2009), spring mires belong to a rare group of geoecosystems that are supplied with groundwater (soligenous fens). They often cover small areas restricted to the zones of groundwater outflows and the supply may be both descending (hanging spring mires) and ascending (cupola spring mires) (Dobrowolski, 2009). Further, Wolejko (2001) describes the role of some of these soligenous fen systems in providing habitat for a large number of endangered species and rare plant communities.

4. FUNCTIONAL AND PRESENT ECOLOGICAL STATE ASSESSMENT

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services. Many of these functional benefits therefore contribute directly or indirectly to increased biodiversity within the study area as well as downstream of the study area through provision and maintenance of appropriate habitat and associated ecological processes (Table 5).

Table 5: Potential wetland services and functions in study area

Function	Aspect
Water balance	Streamflow regulation
	Flood attenuation
	Groundwater recharge
Water purification	Nitrogen removal
	Phosphate removal
	Toxicant removal
	Water quality
Sediment trapping	Particle assimilation
Harvesting of natural resources	Reeds, Hunting, etc.
Foraging	Water for animals
	Grazing for animals

Hydro-geomorphic units are inherently associated with hydrological characteristics related to their form, structure and particularly their position in the landscape. This, together with the biotic and abiotic character (or biophysical environment) of wetlands, means that certain wetland types are able to contribute better to some ecosystem services than to others (Kotze *et al.* 2005) (Table 6).

Table 6: Preliminary rating of the hydrological benefits potentially provided by a wetland given its particular hydro-geomorphic type (Kotze et al., 2005)

WETLAND HYDRO-GEOMORPHIC TYPE	HYDROLOGICAL BENEFITS POTENTIALLY PROVIDED BY THE WETLAND							
	Flood attenuation		Stream flow regulation	Erosion control	Enhancement of water quality			
	Early wet season	Late wet season			Sediment trapping	Phos-phates	Nitrates	Toxicants[2]
Hillslope seepage feeding a stream channel	+	0	+	++	0	0	++	++

[2]Toxicants are taken to include heavy metals and biocides

Rating:
- 0 Benefit unlikely to be provided to any significant extent
- \+ Benefit likely to be present at least to some degree
- ++ Benefit very likely to be present (and often supplied to a high level)

Each wetland's ability to contribute to ecosystem services within the study area is further dependant on the particular wetland's Present Ecological State (PES) in relation to a benchmark or reference condition. Present Ecological State scores were determined for various wetlands within the study area using Wet-Health Level 2 assessment. Through the use of a scoring system, the perceived departure of elements of each particular system from the “natural-state” was determined. The following elements were considered in the assessment:

- Hydrologic: Flow modification (has the flow, rates, volume of run-off or the periodicity changed);
- Geomorphic (Canalisation, impounding, topographic alteration and modification of key drivers);
- Biota (Changes in species composition and richness, Invasive plant encroachment, over utilization of biota and land-use modification)

The functionality and PES of each of the delineated wetlands are discussed in more detail below.

HGM 1

HGM 1 did not fall within the study area and were therefore not fully assessed. However, from some limited observations HGM 1 was perceived to be important from a functional perspective, especially in terms of water supply (draining west) as well as providing habitat for species of conservation concern. The hillslope seepage was considered to be largely intact and natural with a few modifications and limited loss of natural habitats.

HGM 2

This relatively small hillsope seepage system highest scoring eco-services attributes were maintenance of biodiversity and streamflow regulation (Figure 6). It is likely that this hydro-geomorphic unit occurs on underlying geology with strong surface-groundwater linkages as water percolates through crevices on cliff faces situated directly below this HGM unit. These cliff faces contained various species of conservation concern that utilises groundwater discharges which are probably linked to HGM 2. The shallow soils and relatively small size of the hillslope seep reduced the opportunity for other ecosystem services to attain high scores.

HGM 2 was determined to be moderately modified with some loss of natural habitats (PES Category C; Table 7). Modifications to this system include possible changes to the hydrology of the system as a result of the existing parking lot and ablution facilities directly below the parking lot. The parking lot would have likely increased peakflows that the wetland would receive during and shortly after precipitation events which could potentially had an impact on the geomorphology of the wetland through a loss of soil. This was supported by the presence of an invasive *Rubus* sp. as well as the dominance of *Pteridium* sp. (Bracken fern) within this unit indicating species composition changes that has taken place in the past. The ablution facilities septic tanks which is located in close proximity to HGM 2 could potentially have a negative impact on the water quality of the wetland.

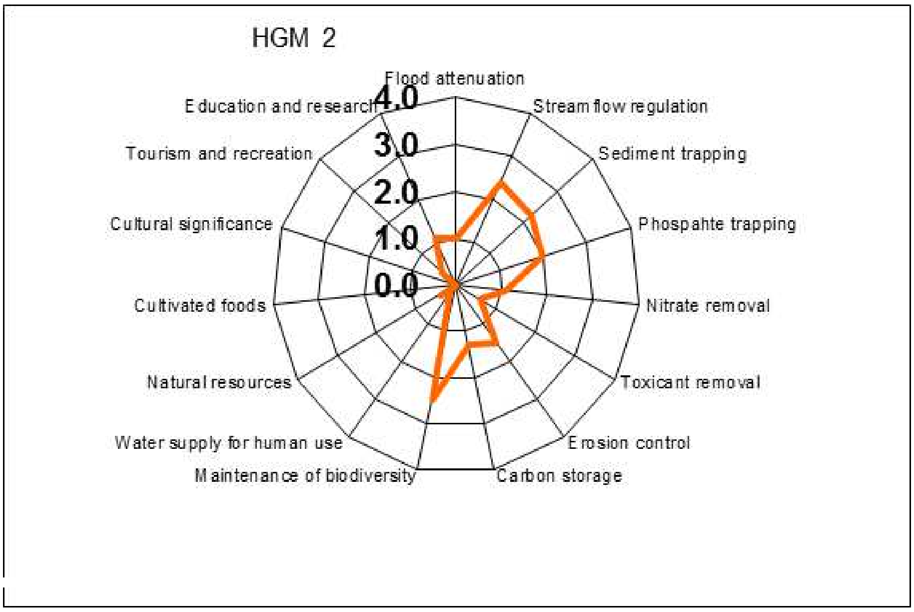


Figure 6: Spiderweb diagram depicting results for Wet-EcoServices assessment for HGM 2

Table 7: Wet-Health scores for HGM 2

Hydrology	Geomorphology	Vegetation	PES Category
2.4	2.3	3.8	C (2.7)

HGM 3

From a functional perspective HGM 3 scored well for several ecosystem services such as maintenance of biodiversity, carbon storage, water supply and tourism (Figure 7). The habitat provided by the associated mistbelt forest contain a multitude species of conservation concern and the lush multilayered growth structure with near permanent wet conditions increases the carbon storage potential. The very high surface roughness of the forest floor increases the systems'propensity for flood attenuation and allow water to recharge the underlying geology which helps to facilitate streamflow regulation. Water supply to the local tourism industry is from a fountain derived just below HGM 3 and supplies water throughout the year. The uniqueness of this understudied system combined with the location affords tourism potential and various education opportunities.

HGM 3 was determined to be largely unmodified (PES Category A; Table 8). The only modifications to this system include the existing tourism walkway, most of which is elevated boardwalks and a viewpoint which resulted in some limited vegetation clearing.

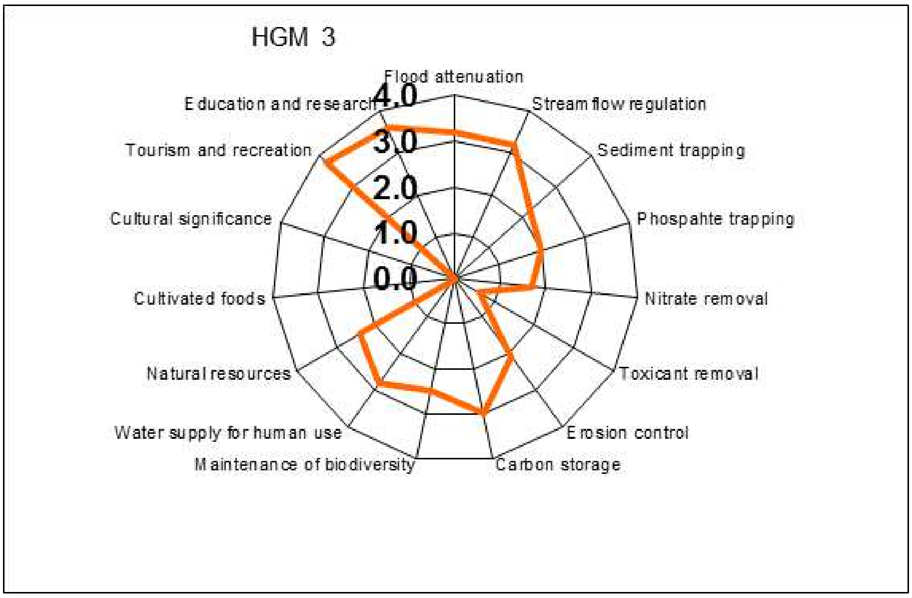


Figure 7: Spiderweb diagram depicting results for Wet-EcoServices assessment for HGM 3

Table 8: Wet-Health scores for HGM 3

Hydrology	Geomorphology	Vegetation	PES Category
0.3	0.1	0.2	A (0.2)

HGM 4

These specialised hillslope seepages that were grouped together as a single HGM unit achieved limited scores for most of the assessed ecosystem services largely as a result of the small size associated with these groundwater fed wetlands (Figure 8). The majority of the observed hillslope seepages were less than three square meters in extent which doesn't allow much reaction time for the various bio-geochemical processes commonly associated with larger and more typical wetland systems. However, these hillslope seepages did provide habitat for several species of conservation concern and are therefore considered to be important for maintenance of biodiversity and provides opportunities for research.

HGM 4 was determined to be unmodified (PES Category A; Table 9). No modifications to these systems were observed. Although speculative, it could be possible that the hydrology of a few of these higher lying hillslope seepages could have been slightly affected by the development of the existing parking lot (as it was likely to reduce recharge).

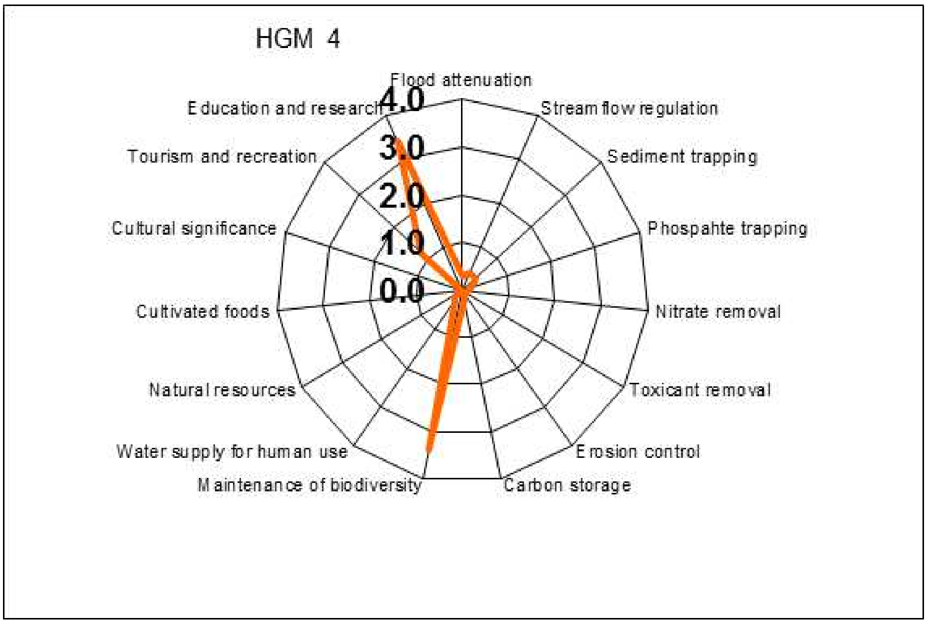


Figure 8: Spiderweb diagram depicting results for Wet-EcoServices assessment for HGM 4

Table 9: Wet-Health scores for HGM 4

Hydrology	Geomorphology	Vegetation	PES Category
0.0	0.0	0.0	A (0.0)

5. ECOLOGICAL IMPORTANCE AND SENSITIVITY

All wetlands, rivers, their flood zones and their riparian areas are protected by law and no development is allowed to negatively impact on these. The vegetation in and around wetlands, rivers and drainage lines play an important role in water catchments, assimilation of phosphates, nitrates and toxins as well as flood attenuation. Quality, quantity and sustainability of water resources are fully dependent on good land management practices within the catchment. All flood lines, riparian zones and wetlands along with corresponding buffer zones must be designated as sensitive.

The Ecological Importance and Sensitivity (EIS) assessment was undertaken to rank wetlands in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

Water resources which have high values for one or more of these criteria may thus be prioritised and managed with greater care due to their ecological importance (for instance, due to biodiversity support for endangered species), hydrological functional importance (where water resources provide critical functions upon which people may be dependent, such as water quality improvement) or their role in providing direct human benefits (Rountree, 2013).

Ecological Importance and Sensitivity results for each of the HGM units identified to be associated with the study area are listed in Table 10.

Table 10: Ecological Importance and Sensitivity scores for wetland

Wetland Complex	Parameter	Rating (0 - 4)	Confidence (1 – 5)
HGM 2	**Ecological Importance & Sensitivity**	High (3.0)	3.4
	Hydrological / Functional Importance	Low (1.5)	2.5
	Direct Human Benefits	Low (0.2)	3
HGM 3	**Ecological Importance & Sensitivity**	Very High (3.8)	4.4
	Hydrological / Functional Importance	High (3.0)	3.5
	Direct Human Benefits	Medium (2.1)	3.0
HGM 4	**Ecological Importance & Sensitivity**	Very High (3.8)	4.4
	Hydrological / Functional Importance	Medium (0.4)	3.5
	Direct Human Benefits	Medium (0.3)	3.0

All three HGM units were assigned high to very high scores for ecological importance and sensitivity as a result of the high concentrations of threatened species recorded on the cliff edges, vertical cliffs and mistbelt forests (SEF, 2013). HGM 3, the mistbelt forest associated wetlands was considered to have high importance from a hydrological perspective as it is likely to be an important recharge zone which supports various ecologically sensitive areas within and surrounding the study area. Direct human benefit associated with the wetland includes tourism opportunities as well as the water supply to current tourism infrastructure derived from HGM 3.

6. IMPACT ASSESSMENT AND MITIGATION

Any developmental activities in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of this phase of the study was to identify and assess the significance of the impacts caused by the proposed activities and to provide a description of potential mitigation required so as to limit the perceived impacts on the natural environment.

6.1 Impact Assessment Methodology

The environmental impacts are assessed with mitigation measures (WMM) and without mitigation measures (WOMM) and the results presented in impact tables which summarise the assessment. Mitigation and management actions are also recommended with the aim of enhancing positive impacts and minimising negative impacts.
In order to assess these impacts, the proposed development has been divided into two project phases, namely the construction and operational phase. The criteria against which these activities were assessed are discussed below.

Nature of the Impact

This is an appraisal of the type of effect the project would have on the environment. This description includes what would be affected and how and whether the impact is expected to be positive or negative.

Extent of the Impact

A description of whether the impact will be local, limited to the study area and its immediate surroundings, regional, or on a national scale.

Duration of the Impact

This provides an indication of whether the lifespan of the impact would be short term (0-5 years), medium term (6-10 years), long term (>10 years) or permanent.

Intensity

This indicates the degree to which the impact would change the conditions or quality of the environment. This was qualified as low, medium or high.

Probability of Occurrence

This describes the probability of the impact actually occurring. This is rated as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any prevention measures).

Degree of Confidence

This describes the degree of confidence for the predicted impact based on the available information and level of knowledge and expertise. It has been divided into low, medium or high.

The following risk assessment was used to determine the significance of impacts:

Significance = (Magnitude + Duration + Scale) x Probability

The maximum potential value for significance of an impact is 100 points. Environmental impacts can thus be rated as high, medium or low significance on the following basis:

- High environmental significance 60 – 100 points
- Medium environmental significance 30 – 59 points
- Low environmental significance 0 – 29 points

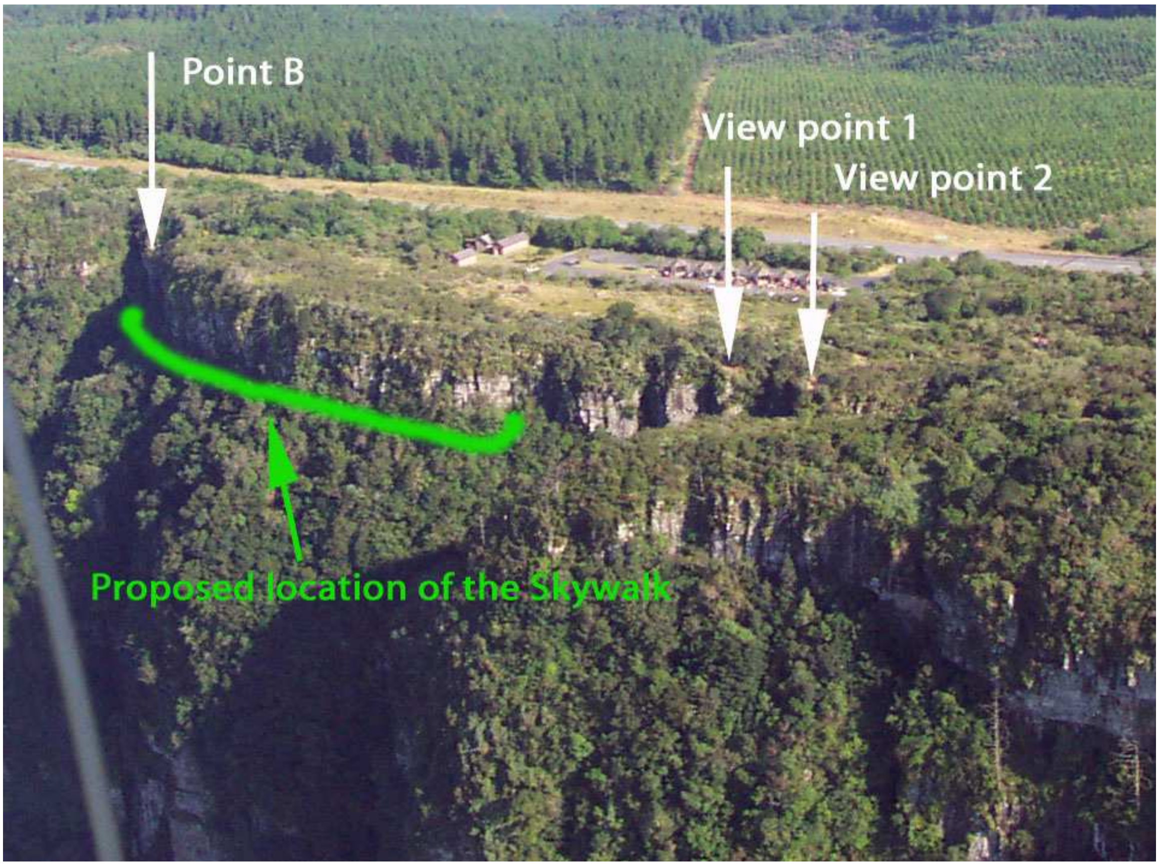
Table 11 illustrates the scale used to determine the overall ranking.

Table 11: Scale used to determine significance ranking

Magnitude (M)		Duration (D)	
Description	**Numerical value**	**Description**	**Numerical value**
Very high	10	Permanent	5
High	8	Long-term (ceases at end of operation)	4
Moderate	6	Medium-term	5-15 years
Low	4	Short-term	0 – 5 years
Minor	2	Immediate	1
Scale (S)		**Probability (P)**	
Description	**Numerical value**	**Description**	**Numerical value**
International	5	Definite (or unknown)	5
National	4	High	4
Regional	3	Medium	3
Local	2	Low	2
Site	1	Improbable	1
None	0	None	0

6.2 Impact Assessment

The current impact assessment only considers the proposed Skywalk complex which includes the Skywalk, a restaurant/venue, ablutions and a heritage museum, and does not include the Skylift, adventure centre or any other viewpoints (Photograph 11; Figure 9). The position of the proposed facilities in relation to the delineated wetlands is depicted in Figure 4.



Photograph 11: Proposed location of the Skywalk complex in relation to the existing facilities at God's Window

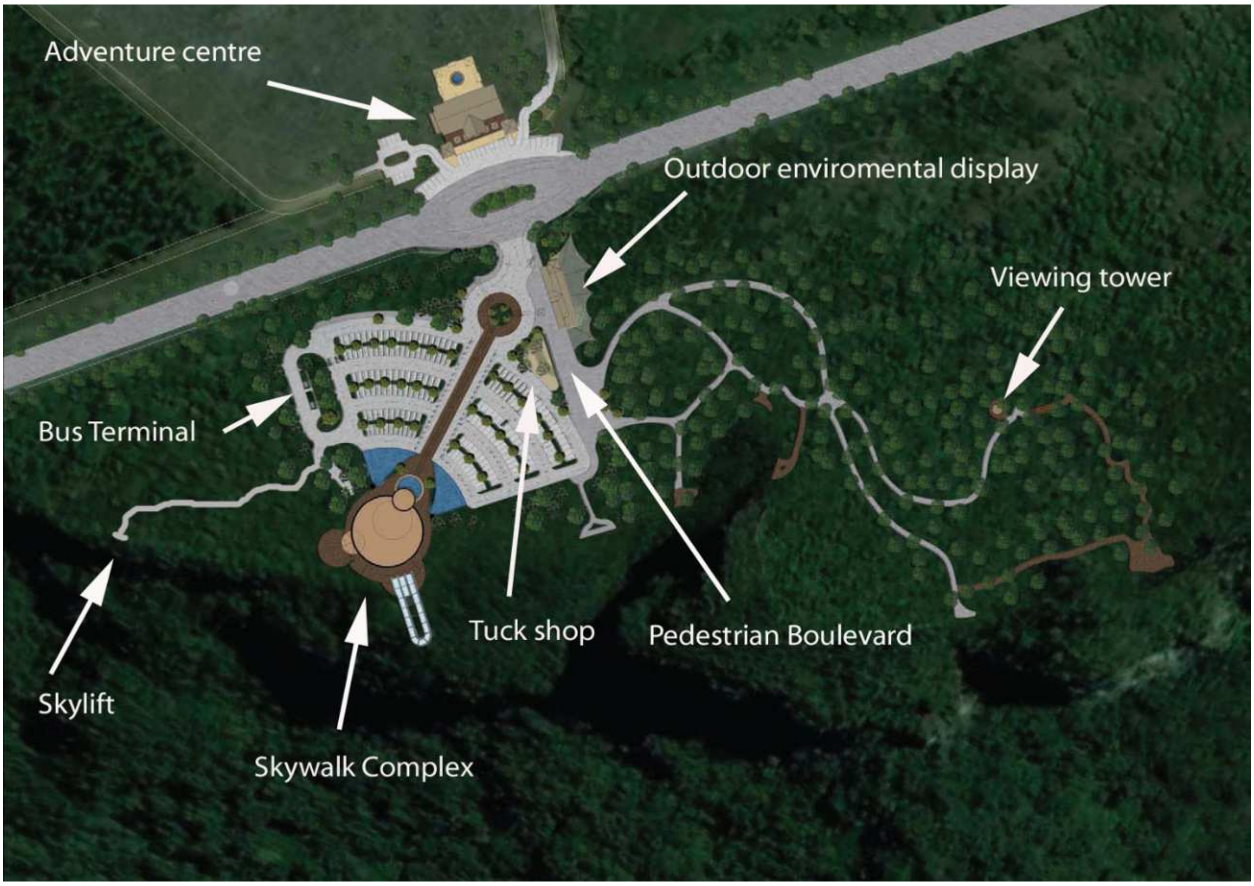


Figure 9: Preliminary proposed layout of multiple tourist facilities for the study area. Note that not all aspects depicted above are assessed in current impact assessment

Possible impacts and their sources associated with the proposed activities are provided in Table 12 (construction phase), Table 13 (operational phase). Some of the impacts are relevant during both the construction and operational phases and have therefore only been described once.

Table 12: Possible impacts arising during the construction phase

Possible impact	Source of impact
Degradation and destruction of wetlands habitat	Removal of hydric soils, hydrophytic vegetation.
Sedimentation of wetland and increased erosion	Runoff from construction activities associated with clearing of natural vegetation
Surface and groundwater pollution	Mobilisation of sediments, excavations, removal and disturbances to vegetation and soils, hydrocarbon and or other chemicals

Table 13: Possible additional impacts arising during the operational phase

Possible impact	Source of impact
Altered hydrological regime	Changes to catchment hydrology including impacts associated with hardened surfaces, decreased basal cover resulting in increased run-off and geo-hydrological impacts
Surface and groundwater pollution	Inappropriately designed or installed sewerage systems can pollute watercourses downstream

6.2.1 Construction Phase

Degradation and destruction of wetlands

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Degree of Confidence
Without mitigation measures	Local (2)	Permanent (5)	High (8)	High (4)	High (60)	Medium
With mitigation measures	Site (1)	Short term (2)	Minor (2)	Low (2)	Low (10)	Medium

Description of Impact

The footprint of proposed infrastructure and associated construction activities could infringe on or destroy wetland habitat. The removal of natural vegetation and hydric soils could lead to the degradation and ultimate destruction of wetland areas through the initiation of erosion processes and increased runoff of sediment into watercourses and or preferential flow paths particularly during times of high rainfall. The construction of access roads and changes to the basal cover within the catchment could lead to changes in the hydrology of the catchment, negatively effecting wetlands through receiving increased run-off rates (especially peak-flow) concentrated and or reduced flow paths.

Mitigation Measures

- All mitigation measures as included in the Ecological report (SEF, 2013) should be adhered to;
- The design of drainage and stormwater systems for the construction period must ensure there is no contamination, eutrophication or erosion of the wetland/riparian areas. Drainage systems should be maintained regularly in order to minimize the runoff of harmful chemical substances into the wetland areas and must be done in a manner that would protect the quality and quantity of the downstream system;
- Avoid activities in wetlands through proper planning, demarcation and appropriate environmental training. Management has the responsibility to inform members of staff of the need to be vigilant against any practice that will have a harmful effect on wetlands areas. Due to the sensitive nature of the area, the minimal construction footprint area should be fenced off for the duration of the construction phase;

- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimized, and be surrounded by bunds. It should also only be stored for the minimum amount of time necessary;
- All construction materials including fuels and oil should be stored in a demarcated area that is contained within a bunded impermeable surface to avoid spread of any contamination (outside of wetlands/riparian/buffer zones);
- Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area, in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase;
- Any proclaimed weed or alien species that germinate during the construction period shall be cleared by hand before flowering;
- Emergency plans must be in place in case of spillages to prevent contaminants reaching preferential flow paths; and
- Littering and contamination of water sources during construction must be mitigated by effective construction camp management.

Sedimentation of wetlands and increased erosion

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Degree of Confidence
Without mitigation measures	Local (2)	Permanent (5)	High (8)	High (4)	High (60)	Medium
With mitigation measures	Site (1)	Short term (2)	Low (4)	Low (2)	Low (14)	Medium

<u>Description of Impact</u>

The clearing of natural vegetation and reduction in basal cover will increase runoff of sediment from the site into wetlands associated with the study area. This is particularly so during times of high rainfall and the sandy nature of the soil profile in the study area. Water flowing down trenches and access roads, as well as movement of construction vehicles and personnel, could cause additional erosion processes and sediment to accumulate within the wetland/riparian areas. The potential siltation of the wetland systems could alter geomorphic functioning, the movement of water through the system (hydrological functioning) as well as having an impact on water quality and associated biota within the resource. In addition, compacted surfaces and bare areas are likely to increase surface run off velocities and peak flows received by wetland/riparian areas.

<u>Mitigation Measures</u>

- Stormwater generated in catchment must be diffused and not reach the wetland as concentrated flows where it will have serious negative impacts on the wetlands soils. Swales, soils screens and other sediment barriers should be applied wherever necessary;
- Erosion must not be allowed to develop on a large scale before effecting repairs;
- A wetland/riparian monitoring program should be initiated before the onset of the construction phase. The Environmental Control Officer should be briefed by a wetland / aquatic specialist on specific monitoring issues. An inspection of cleared and disturbed areas

as well as any stormwater infrastructure needs to take place after each large rain event. Appropriate mitigation needs to be implemented after consultation with relevant specialist if any problems are detected;

- Make use of existing roads and tracks where feasible, rather than creating new routes through vegetated areas;
- Runoff from roads must be managed to avoid erosion and pollution problems;
- All areas susceptible to erosion must be protected and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas;
- Natural trees, shrubbery and grass species must be retained wherever possible;
- Areas exposed to erosion due to construction should be vegetated with species naturally occurring in the area; and
- Surface water or storm water must not be allowed to concentrate, or flow down cut or fill slopes without erosion protection measures being in place.

Surface water and groundwater pollution

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Degree of Confidence
Without mitigation measures	Local (2)	Long term (4)	High (6)	High (4)	Medium (48)	Medium
With mitigation measures	Site (1)	Short term (2)	Low (4)	Low (2)	Low (14)	Medium

Description of Impact

Hydrocarbon-based fuels or lubricants spilled from construction vehicles, construction materials and litter deposited by construction workers may be washed into drainage lines and wetlands. The mobilisation of sediments, excavations, removal and disturbances to vegetation, mobilisation of hydrocarbon and other compounds could have various negative impacts on wetland/riparian areas and their associated functionality. Should appropriate toilet facilities not be provided for construction workers at the construction crew camps, the potential exists for surface water resources and surroundings to be contaminated by raw sewage.

Mitigation Measures

- Construction vehicles are to be maintained in good working order so as to reduce the probability of leakage of fuels and lubricants;
- A walled concrete platform, dedicated store with adequate flooring or bermed area should be used to accommodate chemicals such as fuel, oil, paint, as appropriate, in well-ventilated areas;
- No herbicides or pesticides should be allowed on site;
- Storage of potentially hazardous materials should be above any 100-year flood line, outside wetland areas, preferably at high elevations as far as possible from drainage features. These materials include fuel, oil, cement, bitumen etc.;
- Concrete is to be mixed on mixing trays only, not on exposed soil;
- Concrete and tar shall be mixed only in areas which have been specially demarcated for this purpose;

- All construction materials liable to spillage are to be stored in appropriate structures with impermeable flooring;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- Under no circumstances may ablutions occur outside of the provided facilities;
- No uncontrolled discharges from the construction crew camps to any surface water resources shall be permitted. Any discharge points need to be approved by the relevant authority;
- Store all litter carefully so it cannot be washed or blown into any of the water courses within the study area;
- Provide bins for construction workers and staff at appropriate locations, particularly where food is consumed;
- The construction site should be cleaned daily and litter removed; and
- Conduct on-going staff awareness programs so as to reinforce the need to avoid littering.

6.2.2 Operational Phase

Altered hydrological regime

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Degree of Confidence
Without mitigation measures	Local (2)	Permanent (5)	Very High (10)	High (4)	High (68)	Medium
With mitigation measures	Site (1)	Short term (2)	Low (4)	Low (2)	Low (14)	Medium

<u>Description of impact</u>

The clearing of natural vegetation with high basal cover and subsequent replacement with hardened surfaces and other infrastructure including an increase of access roads and other compacted areas as well as roofs are likely to result in increased run-off, especially peak flow velocities received by wetland and potential recharge areas. The hydrology of the area seems interconnected and important in terms of regulating different moisture regimes in different areas, many areas serving as habitat harbouring a multitude of species of conservation concern. Lateral water movement seems likely to be an important component of the geohydrology of the area with groundwater-fed seeps occurring in several locations within and surrounding the study area. The construction of foundations for the new tourist facility could potentially intercept surface water flows, a perched aquifer and or other water-bearing geological features leading to desiccation of wetland and other sensitive habitats, especially HGM 2 and HGM 4.

<u>Mitigation Measures</u>

- Detailed geohydrological investigations should accompany core drilling exercises planned for further geotechechnical studies (investigating suitability of the geology for the envisaged tourism infrastructure). The geo-hydrology studies need to ascertain how much water bearing features underlies the proposed footprint of the tourism infrastructure and how one can avoid impacts on these water bearing features;

- As a result of the sensitivities on site, a conservative approach is highly recommended where the design of the infrastructure reduces the chances of negative impacts on surface and groundwater. This could likely be achieved through using a pilon design with a raised floor/foundation, allowing free flow of surface water and minimum disturbance to groundwater. The roof of the structure can be vegetated within indigenous flora and simulate natural run-off conditions while reducing the visual impact;
- A sensitive stormwater management plan must be developed in conjunction with a wetland specialist on completion of the detailed geohydrological studies; and
- Design of a monitoring plan must be incorporated during the infrastructure design phase and be implemented well ahead of construction activities in order to build up adequate baseline data. As a minimum, HGM 2 and seepages associated with HGM 4 (below the construction footprint area) should be monitored. This would entail at least three fixed transects to be adopted on the cliff face below the construction footprint to monitor population containing species of conservation concern as well as groundwater supported hillslope seepages.

Surface and groundwater pollution

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Degree of Confidence
Without mitigation measures	Local (2)	Long term (4)	High (8)	High (4)	Medium (56)	Medium
With mitigation measures	Site (1)	Short term (2)	Low (4)	Low (2)	Low (14)	Medium

<u>Description of Impact</u>

Sewerage systems that are inadequately designed or / and installed could potentially lead to pollution of water resources. This aspect is especially relevant as a result of the close proximity of water resources to tourism infrastructure.

<u>Mitigation Measures</u>

- A package plant as recommended by Aurecon (2013) should be installed on site;
- Appropriate design of sewerage infrastructure in conjunction with an aquatic/ wetland specialist. The design must be robust with adequate back-up systems in case of failure;
- Proper installation of sewerage infrastructure to take place under supervision of briefed ECO;
- Monitoring program to be designed by aquatic / wetland specialist (during the sewerage infrastructure design phase) and implemented; and
- The old septic sewage system on site should be appropriately cleaned and removed from site (without any spillages).

7. CONCLUSION

One hydro-geomorphic type, a hillslope seepage wetland connected to a watercourse was recognised within the study area. However, not all wetlands within the study area conformed to typical hydro-geomorphic types as a result of their unique landscape setting and attributes. Four hydro-geomorphic units were delineated and classified within and in the direct vicinity of the study area.

The ecosystem services performed by the identified wetlands were assessed through applying a Level 2 Wet-EcoServices assessment. Functions receiving the highest scores include streamflow regulation and the maintenance of biodiversity as the study area contained several areas with large populations of species of conservation concern. The wetlands' ability to contribute to ecosystem services within the study area is further dependent on the particular wetland's Present Ecological State in relation to a benchmark or reference condition. A Wet-Health Level 2 assessment of the wetlands within the study area assigned a Present Ecological State score for the particular hydro-geomorphic units. Combined area weighted Wet-Health results considered the majority of the identified wetlands to be largely unmodified (Present Ecological State Category A), while one wetland was considered to be moderately modified (Present Ecological State Category C).

The Ecological Importance and Sensitivity assessment was undertaken to rank wetlands in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- Biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

All of the HGM units in the study area were assigned high to very high scores for ecological importance and sensitivity as a result of the high concentrations of threatened species recorded on the cliff edges, vertical cliffs and mistbelt forests. HGM 3, the mistbelt forest associated wetlands was considered to have high importance from a hydrological perspective as it is likely to be an important recharge zone which support various ecologically sensitive areas within and surrounding the study area. Direct human benefit associated with the wetland includes tourism opportunities as well as the water supply to current tourism infrastructure derived from HGM 3.

The impact assessment identified a potential altered hydrological regime as the most significant impacts associated with the development of tourism infrastructure. Some of the mitigation measures discussed in the report included:

- Detailed geo-hydrological investigations should accompany core drilling exercises planned for further geotechechnical studies (investigating suitability of the geology for the envisaged tourism infrastructure). The geo-hydrology studies need to ascertain how much water-bearing features underlies the proposed footprint of the tourism infrastructure and how one can avoid impacts on these water-bearing features.
- As a result of the sensitivities on site, a conservative approach is highly recommended where the design of the infrastructure reduces the chances of negative impacts on surface and groundwater. This could likely be achieved through using a pilon design with a raised floor/foundation, allowing free flow of surface water and minimum disturbance to groundwater. The roof of the structure can be vegetated within indigenous flora and simulate natural run-off conditions while reducing the visual impact.

- A sensitive stormwater management plan must be developed in conjunction with a wetland specialist on completion of the detailed geo-hydrological studies.
- Design of a monitoring plan must be incorporated during the infrastructure design phase and be implemented well ahead of construction activities in order to build up adequate baseline data. As a minimum, HGM 2 and seepages associated with HGM 4 (below the construction footprint area) should be monitored. This would entail at least three fixed transects to be adopted on the cliff face below the construction footprint to monitor population containing species of conservation concern as well as groundwater supported hillsope seepages.

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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.
Buffer zone	A collar of land that filters edge effects.
Conservation	The management of the biosphere so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations. The wise use of natural resources to prevent loss of ecosystems function and integrity.
Critically Endangered	A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Ecosystem	Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.
Ecological Corridors	Corridors are roadways of natural habitat providing connectivity of various patches of native habitats along or through which faunal species may travel without any obstructions where other solutions are not feasible.
Edge effect	Inappropriate influences from surrounding activities, which physically degrade habitat, endanger resident biota and reduce the functional size of remnant fragments including, for example, the effects of invasive plant and animal species, physical damage and soil compaction caused through trampling and harvesting, abiotic habitat alterations and pollution.
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.
Exotic species	Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity
Fauna	The animal life of a region.
Flora	The plant life of a region.
Forb	A herbaceous plant other than grasses.

Habitat Type of environment in which plants and animals live.

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.

Outlier An observation that is numerically distant from the rest of the data

Primary vegetation Vegetation state before any disturbances such as cultivation, overgrazing or soil removal

Threatened Species that have naturally small populations and species which have been reduced to small (often unsustainable) population by man's activities.

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

Species diversity A measure of the number and relative abundance of species.

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

Vulnerable A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

APPENDIX A

Wetland delineation methodology

The report incorporated a desktop study, as well as field surveys, with site visits conducted during June 2014. Additional data sources that were incorporated into the investigation for further reliability included:

- Google Earth images;
- 1:50 000 cadastral maps; and
- ortho-rectified aerial photographs.

A pre survey wetland delineation was performed in order to assist the field survey. Identified wetland areas during the field survey were marked digitally using GIS (changes in vegetation composition within wetlands as compared to surrounding non-wetland vegetation show up as a different hue on the orthophotos, thus allowing the identification of wetland areas). These potential wetland areas were confirmed or dismissed and delineation lines and boundaries were imposed accordingly after the field surveys.

Field surveys were undertaken on the 19th of June 2014. The wetland delineation was based on the legislatively required methodology as described by DWAF (2005. The DWAF delineation guide (DWAF, 2005) uses four field indicators to confirm the presence of wetlands, namely:

- terrain unit indicator (i.e. an area in the landscape where water is likely to collect and a wetland to be present),
- soil form indicator (i.e. the soils of South Africa have been grouped into classes / forms according to characteristic diagnostic soil horizons and soil structure), See Figure 6 for auger sample points
- soil wetness indicator (i.e. characteristics such as gleying or mottles resulting from prolonged saturation), and
- vegetation indicator (i.e. presence of plants adapted to or tolerant of saturated soils).

The Department of Water affairs and Forestry (DWAF) wetland delineation guide makes use of indirect indicators of prolonged saturation by water, namely wetland plants (hydrophytes) and (hydromorphic) soils. The presence of these two indicators is indicative of an area that has sufficient saturation to classify the area as a wetland. Hydrophytes were recorded during the site visit and hydromorphic soils in the top 0.5 m of the profile were identified by taking cored soil samples with a bucket soil auger and Dutch clay auger (photographs of the soils were taken). Each auger point was marked with a handheld Global Positioning System (GPS) device. All cored samples were analysed for signs of wetness that indicate wetland associated conditions.

The methodology "*Wet-EcoServices"* (Kotze *et al.,* 2005) was adapted and used to assess the different benefit values of the wetland units. A level two assessment, including a desktop study and a field assessment were preformed to determine the wetland functional benefits between the different hydro-geomorphological types within the study area. Other documents and guidelines used are referenced accordingly. During the field survey, all possible wetlands and drainage lines identified from maps and aerial photos were visited on foot. Where feasible, cross sections were taken to determine the state and boundaries of the wetlands.

Following the field survey, the data was submitted to a GIS program for compilation of the map sets. Subsequently the field survey and desktop survey data were combined within a project report.

In order to gauge the Present Ecological State of various wetlands within the study area, a level 2 Wet-Health assessments were applied in order to assign PES categories to certain wetlands. Wet-Health (Macfarlane *et al., 2*009) is a tool which guides the rapid assessment of a wetland's environmental condition based on a site visit. This involves scoring a number of attributes connected to the geomorphology, hydrology and vegetation, and devising an overall score which gives a rating of environmental condition.

Wet-Health is useful when making decisions regarding wetland rehabilitation, as it identifies whether the wetland is beyond repair, whether rehabilitation would be beneficial, or whether intervention is unnecessary, as the wetland's functionality is still intact. Through this method, the cause of any wetland degradation is also identified, and this facilitates effective remediation of wetland damage. There is wide scope for the application of Wet-Health as it can also be used in assessing the Present Ecological State of wetlands and thereby assist in determining the Ecological Reserve as laid out under the National Water Act. Wet-Health offers two levels of assessment, one more rapid than the other.

For the assessments, an impact and indicator system is used. The wetland is first categorized into the different hydrogeomorphic (HGM) units and their associated catchments, and these are then assessed individually in terms of their hydrological, geomorphologic and vegetation health by examining the extent, intensity and magnitude of impacts, of activities such as grazing or draining. The extent of the impact is measured by estimating the proportion the wetland that is affected. The intensity of the impact is determined by looking at the amount of alteration that occurs in the wetland due to various activities. The magnitude is then calculated as the combination of the intensity and the extent of the impact and is translated into an impact score. This is rated on a scale of 1 to 10, which can be translated into six health classes (A to F – compatible with the Ecostatus categories used by DWAF,) (Table 14). Threats to the wetland and its overall vulnerability can also be assessed and expressed as a likely Trajectory of Change.

Table 14: Interpretation of scores for determining Present Ecological State (Kleynhans 1999)

Rating of Present Ecological State Category (PES Category)
CATEGORY A
Score: 0-0.9; Unmodified, or approximates natural condition.
CATEGORY B
natural with few modifications, but with some loss of natural habitats.
CATEGORY C
Score: 2 – 3.9; Moderately modified, but with some loss of natural habitats.
CATEGORY D
Score: 4 – 5.9; Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E
Score: 6 -7.9; Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F
Score: 8 - 10; Critically modified. Modifications have reached a critical level and the system has been

modified completely with an almost complete loss of natural habitat.

* If any of the attributes are rated <2, then the lowest rating for the attribute should be taken as indicative of the PES category and not the mean

Determination of Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2010). An example of the scoring sheet is attached as Table 15. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 16.

Table 15: Example of scoring sheet for Ecological Importance and sensitivity

ECOLOGICAL IMPORTANCE AND SENSITIVITY:			
Ecological Importance	Score (0-4)	*Confidence (1-5)*	**Motivation**
Biodiversity support			
Presence of Red Data species			
Populations of unique species			
Migration/breeding/feeding sites			
Landscape scale			
Protection status of the wetland			
Protection status of the vegetation type			
Regional context of the ecological integrity			
Size and rareity of the wetland type/s present			
Diversity of habitat types			
Sensitivity of the wetland			
Sensitivity to changes in floods			
Sensitivity to changes in low flows/dry season			
Sensitivity to changes in water quality			
ECOLOGICAL IMPORTANCE & SENSITIVITY			

	Direct Human Benefits		Score (0-4)	*Confidence (1-5)*
Subsistence benefits	***Water for human use***	*The provision of water extracted directly from the wetland for domestic, agriculture or other purposes*		
	Harvestable resources	*The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.*		
	Cultivated foods	*Areas in the wetland used for the cultivation of foods*		
Cultural benefits	***Cultural heritage***	*Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants*		
	Tourism and recreation	*Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife*		
	Education and research	*Sites of value in the wetland for education or research*		
		TOTAL OVERALL SCORE AND CONFIDENCE:		

Table 16: Category of score for the Ecological Importance and Sensitivity

Rating	Explanation
Very low (0-1)	Rarely sensitive to changes in water quality/hydrological regime.
Low (1-2)	One or a few elements sensitive to changes in water quality/hydrological regime.
Moderate (2-3)	Some elements sensitive to changes in water quality/hydrological regime.
High (3-3.5)	Many elements sensitive to changes in water quality/ hydrological regime.
Very high (+3.5)	Very many elements sensitive to changes in water quality/ hydrological regime.