FLORAL, FAUNAL AND WETLAND ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL AUTHORISATION PROCESS FOR THE PROPOSED THARISA NORTH EASTERN WASTE ROCK DUMP (WRD), NORTH WEST PROVINCE

Prepared for

SLR Consulting (Africa) (Pty) Ltd.

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal and wetland ecological assessment as part of the environmental assessment and authorisation process for the proposed Tharisa north eastern Waste Rock Dump (WRD) as part of the Tharisa Mine expansion project, hereafter referred to as the "study area". The study area is situated within the Northwest Province to the northeast of the Tharisa Mining Rights Area (MRA) and approximately 2km to the north of the N4 roadway, with the Lonmin Road bordering the study area in the north.

The Tharisa MRA was assessed by SAS in the report entitled 'Faunal, Floral, Wetland and Aquatic Assessment as Part of the Environmental Assessment and Authorisation Process for the Proposed Tharisa Mine Expansion Project, North West Province', dated November 2013. The current report forms an addendum to this report and references it where required.

The study area is surrounded by properties in which agricultural and mining activities, as well as rural development dominate, leaving the surrounding areas largely transformed. The ecological assessment was therefore confined to the study area and its immediate surrounds and did not include an ecological assessment of surrounding properties. The surrounding area was however considered as part of the desktop assessment of the area as well as the searches undertaken on national and provincial databases.

FLORAL ASSESSMENT

The following points summarise the key findings of the floral assessment:

- The study area falls within the Savanna Biome, the Central Bushveld Bioregion and within the Marikana Thornveld vegetation type (Mucina & Rutherford, 2006). It is furthermore situated within the 2527DA Quarter Degree Square (QDS);
- Three habitat units were identified during the assessment namely the Transformed Habitat Unit, the Scattered Bushveld Habitat Unit and the Wetland Habitat Unit;
- The Transformed Habitat Unit covers the majority of the study area and includes areas where vegetation structure and composition has been significantly modified by historical agricultural activities, quarries/ borrow pits, as well as local access roads and areas of significant soil disturbance within the east of the study area;
- The Scattered Bushveld Habitat Unit includes limited areas of less transformed bushveld throughout the study area which has been less impacted by development activities, but has been affected by edge effects. These areas have not previously been cultivated and have not been significantly impacted by quarrying activities;
- The Wetland Habitat Unit is located in the west and central portions of the study area, and is associated with two non-perennial drainage lines;
- The various habitat units obtained the following Vegetation Index Scores (VIS) which define the integrity of the vegetation in each habitat unit:

Habitat unit	Score	Class	Motivation
Transformed Bushveld Habitat Unit	5	**E – The loss of natural habitat extensive**	These areas have been disturbed extensively due to agricultural and quarrying activities as well as due to soil disturbance. A high abundance of alien floral species are present.
Wetland Habitat Unit	15	**C – Moderately modified**	This habitat is of importance in terms of habitat provision for a number of floral and faunal species. Moderate to low levels of alien species encroachment was noted.
Scattered Bushveld Habitat Unit	18	**C – Moderately modified**	Vegetation structure is intact and increased species diversity is present, however this habitat unit is fragmented due to agricultural activities. A low abundance of alien species were noted.

- Of the three habitat units identified, the Wetland Habitat Unit is considered to be of to be of increased ecological sensitivity due to the contribution of the drainage line features to faunal

migratory connectivity, wetland eco-services provision and the niche habitat provided for faunal and floral species, specifically within the areas with surface water;

- *Crinum* sp. was encountered on site, but it was not possible to accurately identify the exact species due to the plants having no flowers and the leaves turning brown at the time of assessment. Floral species protected under the Transvaal Nature Conservation Ordinance (No 12 of 1983) therefore include *Crinum* sp and also *Gladiolus* spp., both which occur throughout the study area, mainly within the Wetland Habitat Unit;
- One individual of a tree species protected under the National Forests Act (Act 84 of 1998), namely *Sclerocarya birrea* subsp *caffra* (Marula) was encountered within the Scattered Bushveld Habitat Unit;
- Four Red Data Listed (RDL) floral species are known to occur in the QDS 2527DA. None of these RDL floral species were observed during the site assessment and it is considered unlikely that these species will occur within the study area. Although not listed for the QDS, three floral species, listed by the South African National Biodiversity Institute (SANBI) as 'Declining' namely *Boophane disticha*, *Hypoxis hemerocallidae* and *Crinum macowanii*, may however occur in the study area;
- A moderate diversity of alien species occurs within the study area, with a number of these species falling within Category 1. The majority of alien plant species was identified within the Transformed Habitat Unit and to a lesser degree within the Wetland Habitat Unit;
- Apart from *Crinum* sp. and *Sclerocarya birrea* subsp. *caffra*, which are protected species the medicinal species encountered within the study area are all commonly occurring species and are not confined to the study area.

Impact assessment:

Three possible impacts on the floral ecology within the study area may occur during the construction and operational phases of the development. The table below summarises the findings indicating the significance of the impact before management takes place and the likely impact if management and mitigation takes place during the construction and operational phases of the development. From the table it is evident that if effective management takes place, all potential impacts on floral species may be reduced to low and medium-low significance level.

Summary of potential floral impacts

Construction phase

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-High	Medium-Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on important (RDL, protected, medicinal) species	Medium-High	Medium-Low

Operational phase

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-Low	Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on important (RDL, protected, medicinal) species	Medium-Low	Low

FAUNAL ASSESSMENT

The following points summarise the key findings of the faunal assessment:

Faunal habitat:

- High levels of anthropogenic activity including agricultural and quarrying activity within the study area and surrounding area have led to high levels of transformation of natural faunal habitat throughout the majority of the study area;
- The Wetland Habitat Unit (as well as the Rocky Outcrop Habitat Unit to the south of the study area) provides improved faunal habitat and food resources for a variety of faunal species.

RDL Faunal assessment:

- No RDL mammals were observed during the site survey. In terms of conservation, the likelihood that any threatened RDL mammal species will be encountered within the study area is considered low;

- No threatened RDL avifaunal species were identified during the site survey. However, threatened species with a greater than 60% Probability of Occurrence (POC) of utilising the study area, predominantly for foraging purposes, are *Tyto capensis* (African Grass Owl), *Falco peregrinus* (Peregrine Falcon), *Polemaetus bellicosus* (Martial Eagle), *Sagittarius serpentarius* (Secretary bird) and *Gyps coprotheres* (Cape Vulture);
- No RDL amphibian species were identified during the site survey and the probability of such species occurring is low due to lack of suitable habitat;
- No RDL listed reptiles species were identified during the site assessment and the likelihood of such species being present within the study area is low due to lack of suitable rocky habitat;
- No RDL invertebrate species were encountered on the study area. The likelihood of such species being present within the study area is low due to high levels of disturbance within the study area;
- No threatened spider or scorpion species were identified within the study area.

RDSIS assessment:

- Five RDL species calculated a POC greater than 60% namely *Gyps coprotheres* (Cape Vulture), *Tyto capensis* (African Grass Owl), *Falco peregrinus* (Peregrine Falcon), *Polemaetus bellicosus* (Martial Eagle) and *Sagittarius serpentarius* (Secretary bird);
- The greater than 60% POC likelihood of these RDL faunal species is largely due to them utilising the study area for foraging purposes;
- The RDSIS assessment of the study area calculated a low score of 34%, indicating a low importance to RDL faunal species conservation within the study area in terms of conservation.

Impact assessment:

Based on the faunal impact assessment it is evident that there are three possible impacts on the faunal ecology within the study area. The tables below summarise the findings, indicating the significance of each impact before management takes place and the likely significance of the impacts if management and mitigation takes place, for both the construction and operational phases of the development. From the table it is evident that if effective management takes place, all potential impacts on faunal species may be reduced, mostly to low significance levels.

Summary of potential faunal impacts:

Construction phase

Impact	Unmanaged	Managed
1: Impact on faunal habitat	Medium-High	Medium-Low
2: Impact on faunal diversity	Medium-Low	Low
3: Impact on potential RDL faunal species	Medium-Low	Low

Operational phase

Impact	Unmanaged	Managed
1: Impact on faunal habitat	Medium-Low	Low
2: Impact on faunal diversity	Medium-Low	Low
3: Impact on potential RDL faunal species	Low	Low

WETLAND ASSESSMENT

The following points summarise the key findings of the wetland assessment:

Wetland ecology:

- The study area falls within the Bushveld Basin Aquatic Ecoregion and within quaternary catchment A21K;
- The NFEPA database indicates no wetlands or watercourses within or in the immediate vicinity of the study area, however two non-perennial drainage line features were identified within the study area;
- Drainage Line A, comprising an unchannelled valley bottom wetland feature, is located within the centre of the study area, while Drainage line B, comprising a channelled valley bottom wetland feature borders the study area in the west;
- Drainage Line A is indicated on topographic maps to continue flowing northwards; however historic impacts on this feature, such as the road traversing the study area to the south and the artificial dam currently located in the middle of the study area, are considered to have altered

the hydrology of this feature such that it is no longer considered to function as a wetland. In addition it is deemed likely that the system has not functioned as a wetland for an extended period of time;

- In terms of wetland service provision, Drainage Line A obtained an ecological service provision score of 1.2 (moderately low), and Drainage line B obtained an overall ecological service provision score of 1.1, which also places this wetland in a moderately low class.
- The overall WET-Health score for Drainage Line A was calculated as 2.5, indicating this wetland to fall within Category C (A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact), while the WET-Health score for Drainage line B was 1.3, which places the PES category of this feature in Category B (A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place);
- In terms of Ecological Importance and Sensitivity (EIS), both features have been determined to fall in an EIS Category C. This implies that the features are ecologically important on a localised scale, but not necessarily within the greater catchment area, and are not considered to be very sensitive to changes.

Wetland delineation:

- Wetlands were delineated using the wetland indicators as defined by the DWA guideline leading to the production a map depicting the extent of wetland resources in the vicinity of the proposed development.
- After consideration of findings during the wetland assessment, a suitable buffer zone was considered for the proposed WRD. One buffer zone is applicable to this study area, i.e. a 100m buffer in terms of GN704 of the National Water Act (NWA) (1998).

Impact assessment:

Based on the wetland impact assessment it was found that there are three possible impacts on the wetland ecology within the study area and surrounds. The tables below summarise the findings, indicating the significance of each impact before management takes place and the likely significance of the impacts if management and mitigation takes place, for both the construction and operational phases of the development. From the table it is evident that if effective management takes place, all potential impacts on wetland species may be reduced.

Summary of potential wetland impacts:

Construction phase

Impact	Drainage Line	Unmanaged	Managed
1: Loss of wetland habitat and ecological structure	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low
2: Changes to wetland ecological and socio-cultural service provision	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low
3: Impacts on wetland hydrological function and sediment balance	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low

Operational phase

Impact	Management Unit	Unmanaged	Managed
1: Loss of wetland habitat and ecological structure	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low
2: Changes to wetland ecological and socio-cultural service provision	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low
3: Impacts on wetland hydrological function and sediment balance	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low

SENSITIVITY MAPPING:

Areas of increased ecological sensitivity are limited to the drainage line areas and buffer zones as indicated in Figure A below. All other areas within the study area are considered to be of low ecological sensitivity.

From the assessment, it is evident that the Transformed Habitat Unit has low ecological sensitivity as a result of current and historic anthropogenic activity in the form of mining and agricultural activities having impacted on the ecological integrity of these areas. The Scattered Bushveld Habitat Unit has been exposed to fewer disturbances than the surrounding Transformed Habitat Unit and still hosts a reasonably high biodiversity and suitable habitat for a number of faunal and floral species, including the protected tree species, *Sclerocarya birrea* subsp *caffra*. These areas are however fragmented and have been impacted by edge effects from agricultural activities, with the habitat type also being locally common. It is however important to note that the entire study area falls within a terrestrial Critical Biodiversity Area (CBA) which is considered important for retaining biodiversity and supporting continued ecosystem functioning and services.

All drainage line areas as included within the Wetland Habitat Unit, are regarded as being of increased ecological importance and sensitivity due to the contribution of the features to faunal migratory connectivity, wetland eco-services provision and the niche habitat provided for faunal and floral species. Taking into account the findings from the wetland assessment and considering the results obtained in calculating the function and ecoservices assessment, WET-Health, and EIS, it was determined that both drainage line features are considered to be of medium EIS.

A 100m buffer zone is indicated around both drainage line (wetland) features as advocated by Regulation GN 704 of the National Water Act, 1998 and as far as possible activities in these areas should be avoided.

Figure A: Sensitivity Map for the study area.

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1. INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a faunal, floral and wetland ecological assessment as part of the environmental assessment and authorisation process for the proposed Tharisa northeastern Waste Rock Dump (WRD) as part of the Tharisa Mine expansion project, hereafter referred to as the "study area" (Figures 1 & 2). The study area is situated within the Northwest Province to the northeast of the Tharisa Mining Rights Area (MRA) and approximately 2km to the north of the N4 roadway, with the Lonmin Road bordering the study area in the north.

The Tharisa MRA was assessed by SAS in the report entitled 'Faunal, Floral, Wetland and Aquatic Assessment as Part of the Environmental Assessment and Authorisation Process for the Proposed Tharisa Mine Expansion Project, North West Province', dated November 2013. The current report forms an addendum to this report and references it where required. The project scope in terms of terrestrial and wetland assessment outcomes, assumptions and limitations and assessment approach, including the impact assessment methodology remains unchanged.

The study area is surrounded by properties in which agricultural and mining activities, as well as rural development dominate, leaving the surrounding areas largely transformed. The ecological assessment was therefore confined to the study area and its immediate surrounds and did not include an ecological assessment of surrounding properties. The surrounding area was however considered as part of the desktop assessment of the area as well as the searches undertaken on national and provincial databases.

This report, after consideration and the description of the ecological integrity of the study area, must guide the Environmental Assessment Practitioner (EAP), regulatory authorities and mining proponent, by means of the presentation of results and recommendations, as to the ecological viability of the proposed development activities.

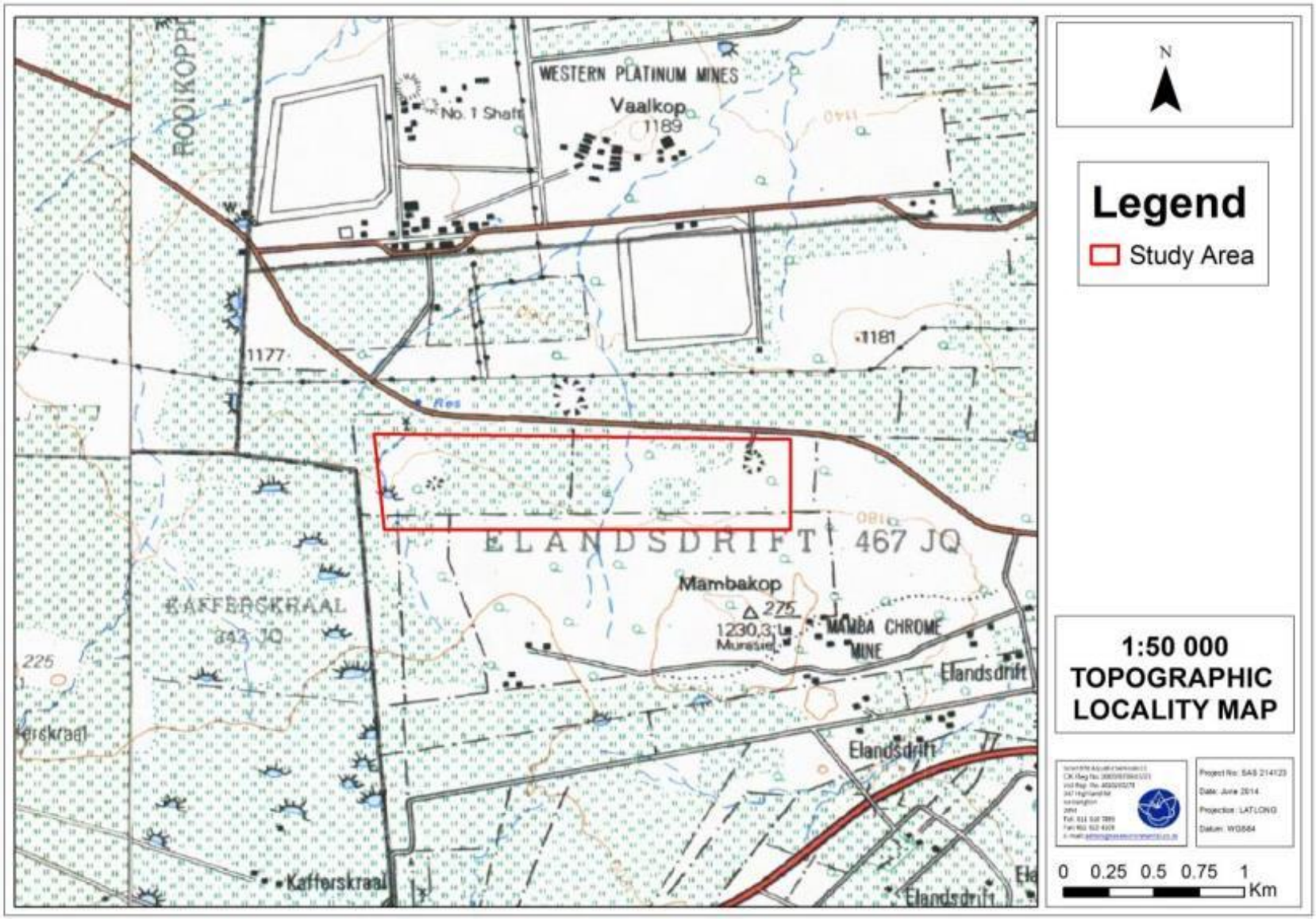

Figure 1: The study area depicted on a 1:50 000 topographical map in relation to its surrounding area.

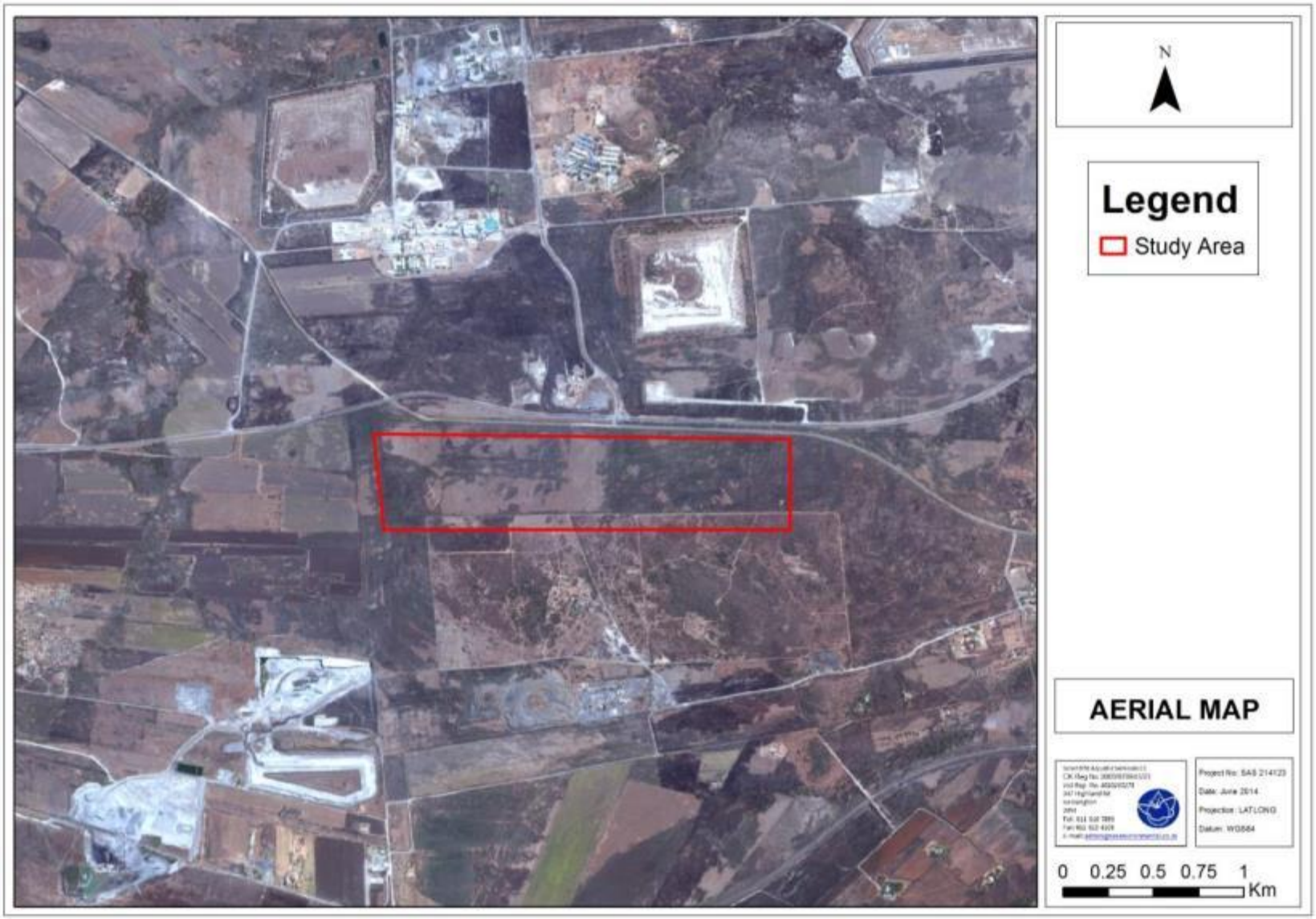

Figure 2: Digital satellite image depicting the location of the study area in relation to surrounding areas.

2. LAND USE AND CONSERVATION CHARACTERISTICS OF THE STUDY AREA

The following sections contain data accessed as part of the desktop assessment. It is important to note, that although all data sources used provide useful and often verifiable high quality data, the various databases used do not always provide an entirely accurate indication of the study area's actual site characteristics. This information is however considered to be useful as background information to the study. Thus, this data was used as a guideline to inform the assessment and areas where increased conservation importance is indicated were paid attention to.

2.1 Importance According to the Mining and Biodiversity Guideline (2013)

The Mining Biodiversity Guideline (2013) provides explicit direction in terms of where mining-related impacts are legally prohibited, where biodiversity priority areas may present high risks for mining projects, and where biodiversity may limit the potential for mining. The Guideline distinguishes between four categories of biodiversity priority areas in relation to their importance from a biodiversity and ecosystem service point of view as well as the implications for mining. These categories include: Legally Protected Areas, Highest Biodiversity Importance, High Biodiversity Importance and Moderate Biodiversity Importance.

According to the Mining Biodiversity Guidelines the study area falls within areas considered to be of High Biodiversity Importance (Figure 3). High Biodiversity Importance Areas are important for conserving biodiversity, for supporting or buffering other biodiversity priority areas, for maintaining important ecosystem services for particular communities or the country as a whole. An environmental impact assessment should include an assessment of optimum, sustainable land use for a particular area and will determine the significance of the impact on biodiversity. Mining options may be limited in these areas, and red flags for mining projects are possible.

It must be noted that although areas of High Biodiversity Importance are indicated within the study area, habitat transformation has occurred due to current and historical agricultural activities within the study area. Thus the site assessment focused on identifying areas within the study area which may still be considered representative of the above category.

2.2 National List of Threatened Terrestrial Ecosystems for South Africa (2011)

The National Environmental Management: Biodiversity Act (NEMBA) (Act 10 of 2004) provides for listing of threatened or protected ecosystems, in one of four categories: critically endangered, endangered, vulnerable or protected. Threatened ecosystems are listed in order to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to conserve sites of exceptionally high conservation value (South African National Biodiversity Institute (SANBI), Biodiversity Geographic Information Systems (BGIS)).

According to the National List of Threatened Terrestrial Ecosystems (2011) the study area does not fall within an area indicated as remaining extent of a threatened ecosystem.

2.3 National Biodiversity Assessment (NBA), 2011

The latest NBA (2011) provides an assessment of South Africa's biodiversity and ecosystems, including headline indicators and national maps for the terrestrial, freshwater, estuarine and marine environments. The NBA (2011) was led by SANBI in partnership with a range of organisations. It follows on from the National Spatial Biodiversity Assessment (2004), broadening the scope of the assessment to include key thematic issues as well as a spatial assessment. The NBA (2011) includes a summary of spatial biodiversity priority areas that have been identified through systematic biodiversity plans at national, provincial and local levels (SANBI, BGIS).

According to the NBA (2011), the study area is not located within a formally or informally protected area, with the entire study area falling within an area that is currently not protected (Figure 4).

2.4 Importance According to the North West Province Biodiversity Conservation Assessment (2009)

Critical Biodiversity Areas (CBA's) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services. According to the North West Province Biodiversity Conservation Assessment

(2009), the study area is located within a terrestrial CBA (Figure 5) and an aquatic CBA is situated approximately 6km to the southwest thereof.

2.5 National Protected Area Expansion Strategy (NPAES; 2008)

The goal of the NPAES (2008) is to achieve cost effective protected area expansion for ecological sustainability and adaptation to climate change. The NPAES sets targets for protected area expansion, provides maps of the most important areas for protected area expansion, and makes recommendations on mechanisms for protected area expansion. It deals with land-based and marine protected areas across all of South Africa's territory (SANBI, BGIS).

According to the NPAES database, the study area does not fall within an area earmarked as an NPAES area.

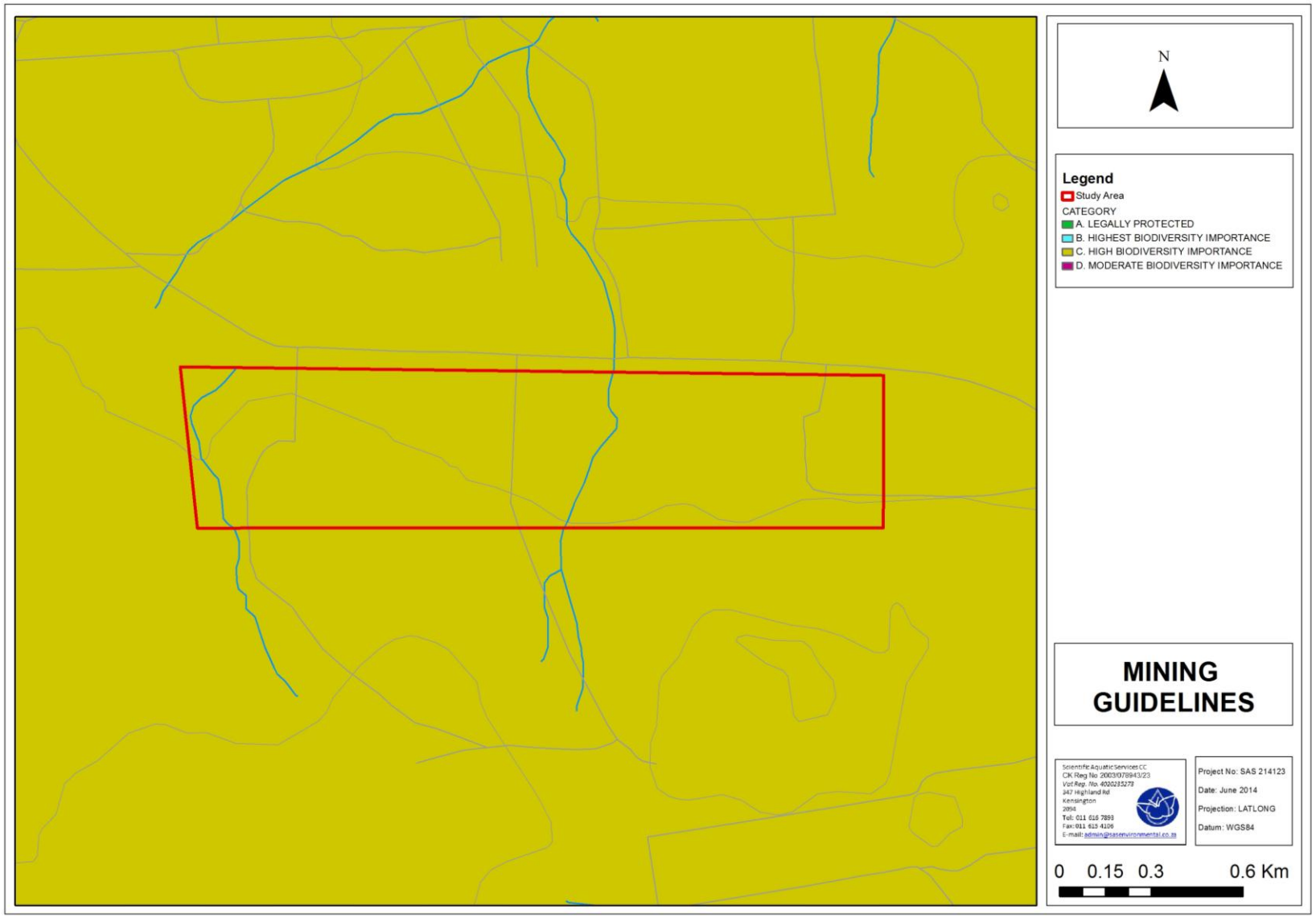

Figure 3: Importance according to the Mining and Biodiversity Guidelines (2013).

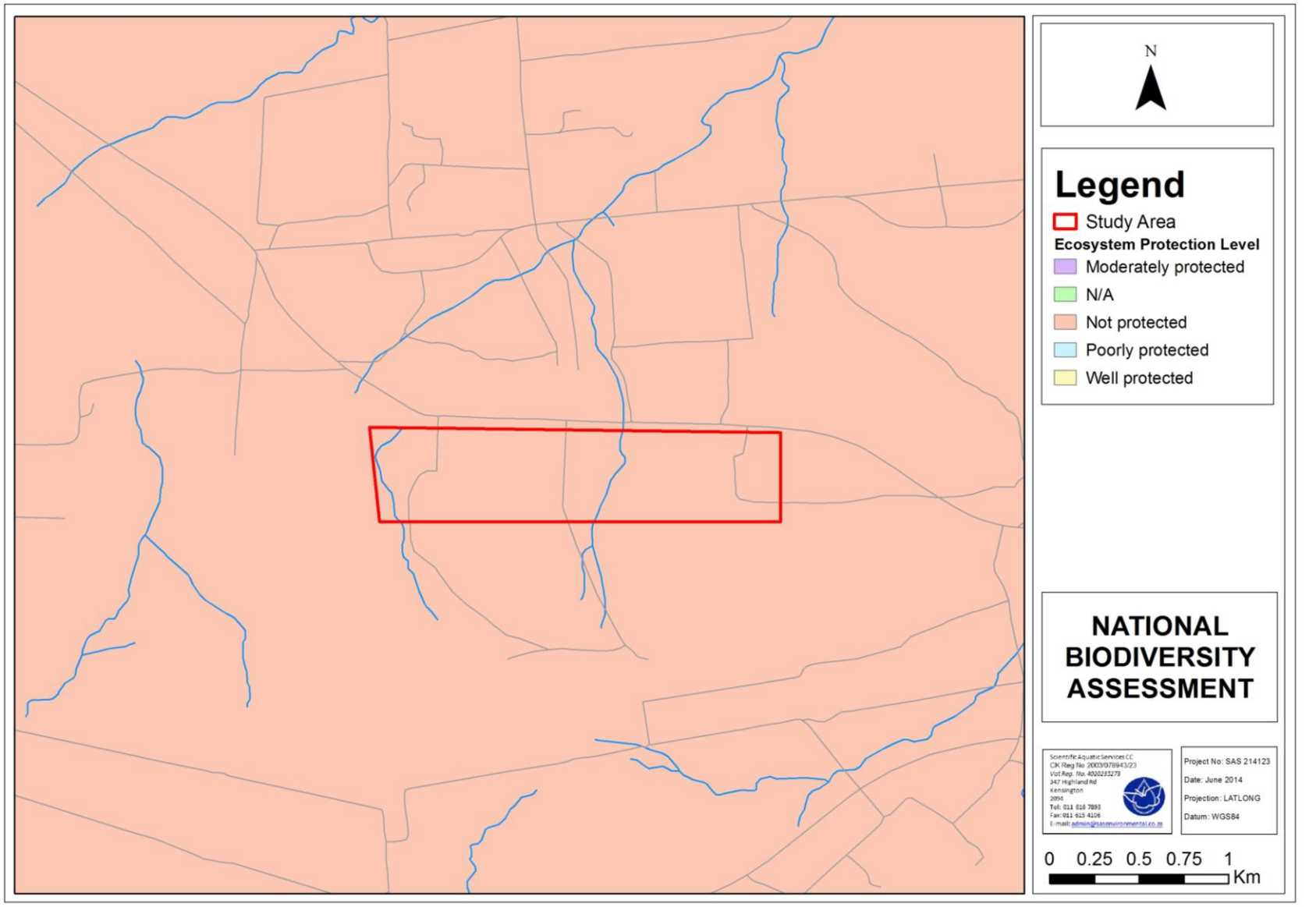

Figure 4: Level of ecosystem protection according to the National Biodiversity Assessment (2011).

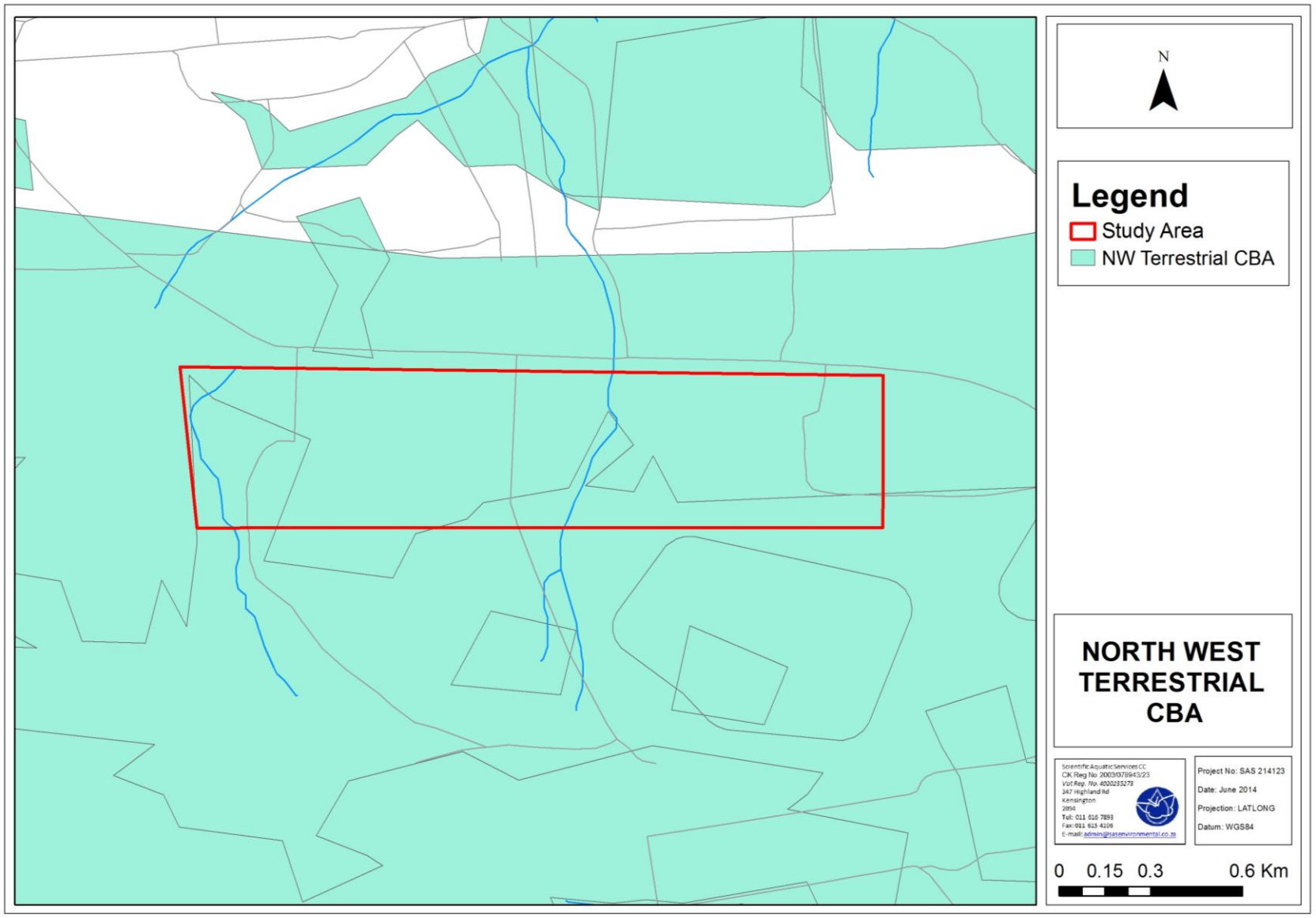

Figure 5: The location of North West Province Terrestrial CBAs in relation to the study area.

3. FLORAL DESCRIPTION

3.1 Biome and Bioregion

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford, 1997). The study area falls within the Savanna biome (Rutherford & Westfall, 1994). Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. The study area is situated within the Central Bushveld Bioregion (Mucina & Rutherford, 2006) (Figure 6).

3.2 Vegetation Type and Landscape Characteristics

While biomes and bioregions are valuable as they describe broad ecological patterns, they provide limited information on the actual species that are expected to be found in an area. Knowing which vegetation type an area belongs to provides an indication of the floral composition that would be found if the assessment site was in a pristine condition, which can then be compared to the observed floral list and so give an accurate and timely description of the ecological integrity of the assessment site. When the boundary of the assessment site is superimposed on the vegetation types of the surrounding area (Figure 7), it is evident that the study area falls within the Marikana Thornveld vegetation type (Mucina & Rutherford, 2006). The characteristics of this vegetation type are outlined in the SAS (2013) report.

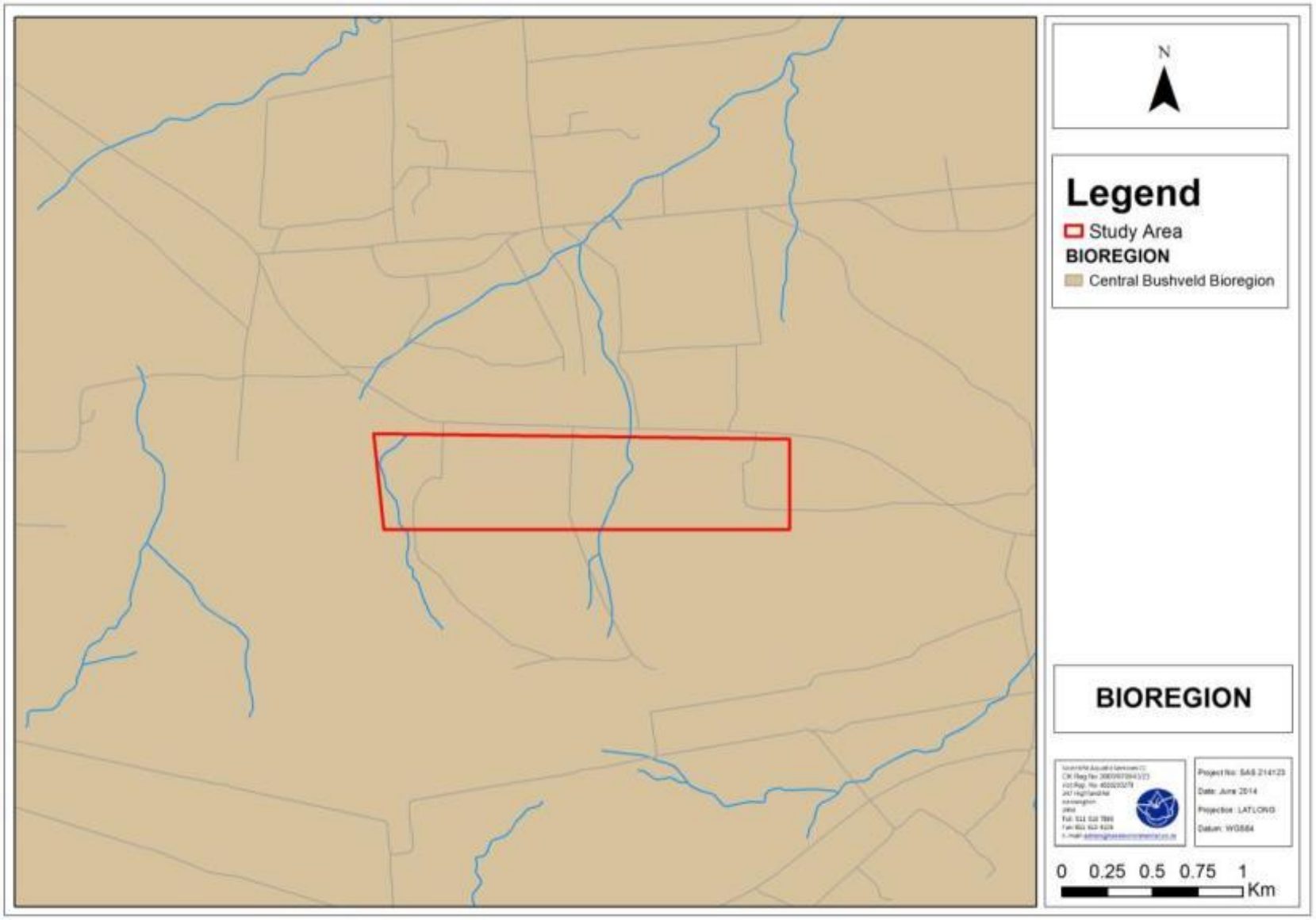

Figure 6: Bioregion associated with the study area (Mucina & Rutherford, 2006).

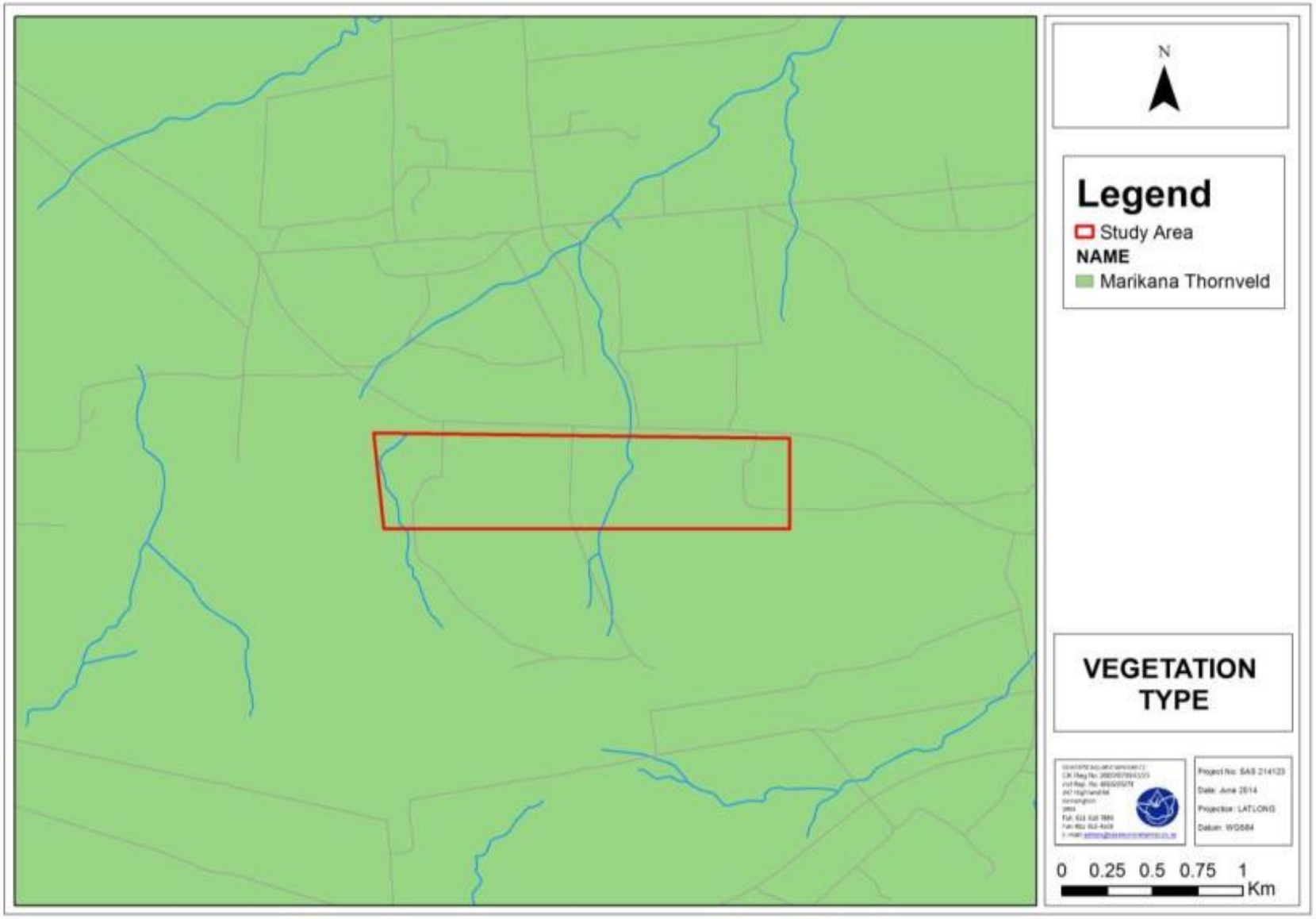

Figure 7: Vegetation type associated with the study area (Mucina & Rutherford, 2006).

4. RESULTS OF THE FLORAL INVESTIGATION

The vegetation associated with the study area comprises three habitat units, namely the Transformed Habitat Unit, the Scattered Bushveld Habitat Unit and the Wetland Habitat Unit, as illustrated in Figure 8 and discussed in the sections below.

The Transformed Habitat Unit covers the majority of the study area and includes areas where vegetation structure and composition has been significantly modified by historical agricultural activities and infrastructure development, which include quarries/ borrow pits, as well as local access roads and areas of significant soil disturbance within the east of the study area.

The Scattered Bushveld Habitat Unit includes areas of less impacted bushveld habitat containing an increased abundance of indigenous woody species. This habitat unit occurs throughout the study area, mainly in the vicinity of the Wetland Habitat Unit and to the south of the study area, where vegetation clearing is less prominent. These areas have not previously been cultivated and have not been significantly impacted by quarrying activities and soil disturbances. One floral species, which is protected under the National Forests Act (Act 84 of 1998), namely *Sclerocarya birrea* subsp. *caffra* (Marula) was noted within the study area while more specimens are likely to occur within this habitat unit particularly towards the south of the study area. In terms of this act, protected tree species may not be cut, disturbed, damaged or destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold - except under licence granted by the Department of Water Affairs (DWA). Applications for such activities should be made to the responsible official in each province.

The Wetland Habitat Unit is located in the west and central portions of the study area, and is associated with non-perennial drainage lines.

The Rocky Outcrop Habitat Unit, identified within the Tharisa MRA (SAS, 2013) is not present within the study area, but large rocky outcrops are located approximately 200m to the south of the study area. The proposed WRD development activities are not expected to impact these ecologically sensitive rocky areas due to the distance thereof from the study area. These areas were therefore not discussed in detail.

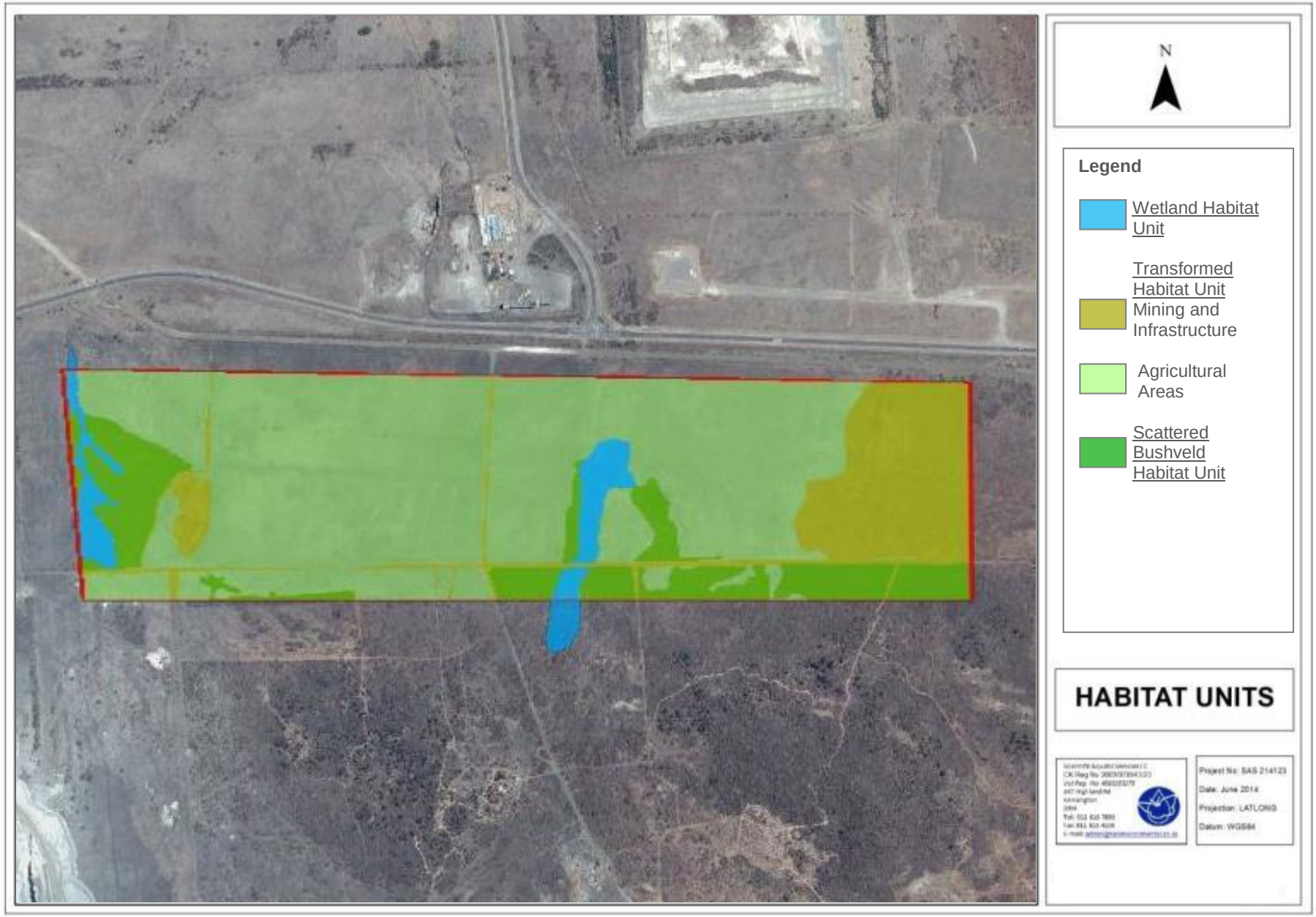

Figure 8: Habitat units identified within the study area.

4.1 Habitat Unit 1: Transformed Habitat Unit

Figure 9: The Transformed Habitat Unit is representative of the majority of the vegetation within the study area.

The Transformed Habitat Unit (Figure 9) is associated with the majority of the study area and includes areas impacted by historical agricultural and quarrying activities as well as areas towards the east where soil disturbance has led to localised bush encroachment. These impacts have resulted in a change in vegetation composition and structure, with the woody component being largely absent within the historical agricultural areas. Floral diversity within the Transformed Habitat Unit has also been impacted, with the grass layer being dominated by *Ischaemum afrum* as well as species typical of disturbed environments, such as *Botriochloa insculpta*, *Aristida bipartita, Eragrostis chloromelas* and *Cynodon dactylon*. The impacted areas in the east of the study area and in the vicinity of the various quarries within the study area are dominated by dense stands of *Dischrostacys cinerea*.

A number of the common alien and invasive floral species, often associated with agricultural activities and disturbance occur within this habitat unit, including *Tagetes minuta*, *Bidens pilosa* and *Zinnia peruviana*. The dominant floral species encountered within this habitat unit during the field assessment are listed below.

Table 1: Dominant floral species encountered in the Transformed Habitat Unit. Alien species are indicated with an asterisk (*).

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Aristida bipartita	**Bidens pilosa*	*Acacia karroo*
Aristida congesta subsp. *barbicollis*	**Datura stramonium*	*Acacia nilotica*
Aristida congesta subsp. *congesta*	**Gomphrena celosioides*	*Dichrostachys cinerea*
Bothriochloa insculpta	**Hibiscus trionum*	*Searsia lancea*
Cynodon dactylon	**Physalis angulata*	*Searsia pyroides*
Dicanthium annulatum	**Schkuhria pinnata*	*Grewia flava*
Digitaria eriantha	**Sesbania bispinosa*	*Peltophorum africanum*
Enneapogon cenchroides	**Tagetes minuta*	*Pappea capensis*
Eragrostis lehmanniana	**Verbena bonariensis*	
Eragrostis chloromelas	**Xanthium strumarium*	
Eragrostis curvula	**Zinnia peruviana*	
Heteropogon contortus	*Aloe greatheadii* var *davyana*	
Hyparrhenia hirta	*Asclepias fruticosa*	
Hyparrhenia tamba	*Asparagus laricinus*	
Ischaemum afrum	*Chamaecrista mimosoides*	
Melinis repens	*Cratotheca triloba*	
Panicum schinzii	*Felicia muricta*	
Paspalum dilatatum	*Gladiolus* sp.	
Pogonarthria squarrosa	*Leonotis leonurus*	
Urochloa mosambicensis	*Monsonia angustifolia*	
Themeda triandra	*Nidorella resedifolia*	
	Ocimum angustifolium	
	Rhynchosia nitens	
	Solanum panduriforme	
	Vernonia oligocephala	

In terms of conservation value, this habitat unit provides limited suitable habitat for a high diversity of floral and faunal species and has impaired functionality, which lowers the ecological sensitivity of these areas. Therefore, vegetation within the Transformed Habitat Unit has a low ecological sensitivity and conservation value.

4.2 Habitat Unit 2: Scattered Open Bushveld Habitat Unit

Figure 10: The Scattered Bushveld Habitat Unit.

The Scattered Bushveld Habitat Unit (Figure 10) includes areas of less disturbed bushveld habitat that have not previously been directly impacted by agricultural activities and mining activities through vegetation clearing, but has however been affected by edge effects such as bush encroachment and loss of vegetation structure. This habitat unit occurs mainly in the vicinity of the Wetland Habitat Unit in the west and centre of the study area. Rocky bushveld areas providing habitat for trees such as *Sclerocarya birrea* subsp. *caffra* and *Erythrina lysistemon* are also present within this habitat unit and overall floral biodiversity is considered moderate with a high abundance of indigenous forbs and grass species present. The presence of alien floral species is also considerably lower than within the surrounding Transformed Habitat Unit.

The table below lists the dominant floral species found within this habitat unit during the field assessment.

Table 2: Dominant species encountered in the Scattered Bushveld Habitat Unit. Alien species are indicated with an asterisk (*).

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Aristida bipartita	**Aruaujia sericifera*	**Opuntia ficus-indica*
Aristida congesta subsp.	**Bidens pilosa*	*Acacia caffra*
Aristida congesta subsp. *barbicollis*	**Hibiscus trionum*	*Acacia karroo*
Aristida congesta subsp. *congesta*	**Tagetes minuta*	*Acacia nilotica*
barbicollis	**Zinnia peruviana*	*Acacia robusta*
Bothriochloa insculpta	*Aloe greatheadii* var *davyana*	*Acacia tortilis*
Cynodon dactylon	*Asclepias fruticosa*	*Berchemia zeyheri*
Dicanthium annulatum	*Asparagus laricinus*	*Celtis africana*
Digitaria eriantha	*Ceratothea triloba*	*Dichrostachys cinerea*
Eragrostis chloromelas	*Chamaecrista mimosoides*	*Ehretia rigida*
Eragrostis curvula	*Clematis brachiata*	*Erythrina lysistemon*
Eragrostis lehmanniana	*Commelina africana*	*Grewia flava*
Fingerhuthia africana	*Convolvulus sagittatus*	*Pappea capensis*
Heteropogon contortus	*Crabbea hirsuta*	*Peltophorum africanum*
Hyparrhenia hirta	*Cratotheca triloba*	*Sclerocarya birrea* subsp *caffra*
Hyperthelia dissoluta	*Cucumis zeyherii*	*Searsia lancea*
Ischaemum afrum	*Cyphostemma sandersonii*	*Searsia leptodictya*
Melinis repens	*Dipcadi viride*	*Searsia pyroides*
Panicum maximum	*Felicia muricta*	*Tarchonanthus camphoratus*
Panicum schinzii	*Gladiolus* sp.	*Ziziphus mucronata*
Paspalum dilatatum	*Hypoxis rigidula*	
Pogonarthria squarrosa	*Kohautia virgata*	
Setaria nigrirostris	*Ledebouria revoluta*	
Sorghum bicolor	*Leonotis leonurus*	
Themeda triandra	*Monsonia angustifolia*	
Urochloa mosambicensis	*Monsonia angustifolia*	
	Nidorella resedifolia	
	Ocimum angustifolium	
	Rhynchosia nitens	
	Rhynchosia nitens	
	Sida rhombifolia	
	Solanum panduriforme	
	Tephrosia capensis	
	Vernonia oligocephala	
	Viscum rotundifolium	

This habitat unit provides improved habitat conditions for a number of faunal and floral species. However, due to its limited extent within the study area and large areas of similar habitat located to the south, loss of this habitat unit is unlikely to result in a significant loss of floral diversity in the region. The Scattered Bushveld Habitat Unit is therefore not considered to be of high importance in terms of conservation nor is it considered to be of high ecological sensitivity. It is however important to note that the study area fall within a terrestrial CBA and the remaining bushveld area may therefore be considered important in order to reach provicial conservation targets.

4.3 Habitat Unit 3: Wetland Habitat Unit

Figure 11: The Wetland Habitat Unit occurring within the west and centre of the study area.

Two wetland features associated with non-perennial drainage lines and comprising the Wetland Habitat Unit, were identified in the western and central portions of the study area. The vegetation present within the Wetland Habitat Unit (Figure 11) includes a variety of facultative and obligate wetland species within the artificial dam areas, including *Schoenoplectus corymbosus*, *Cyperus* spp and *Typha capensis*, while the vegetation associated with the non-perennial drainage lines comprises a grass and forb species composition similar to the surrounding terrestrial areas, and includes species such as *Eragrostis curvula*, *Bothriochloa inscultpa* and *Hyparrhenia hirta*, while species often associated with moist conditions such as *Imperata cylindrica* and *Eragrostis plana,* and the woody species *Combretum eryhtrophyllum* were also encountered.

The table below lists the dominant floral species encountered within the Wetland Habitat Unit.

Table 3: Dominant species encountered in the Wetland Habitat Unit. Alien species are indicated with an asterisk (*).

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Andropogon schirensis	**Lantana camara*	*Acacia karroo*
Bothriochloa insculpta	**Persicaria laphathifolia*	*Asparagus laricunus*
Cynodon dactylon	**Schkuhria pinnata*	*Combretum erythrophyllum*
Cyperus esculentis	**Sesbania bispinosa*	*Diospyros lycioides*
Cyperus longus	**Tagetes minuta*	*Pappea capensis*
Cyperus ruprestis	**Verbena bonariensis*	*Searsia lancea*
Dicanthium annulatum	**Zinnia peruviana*	*Searsia pyroides*
Eragrotis curvula	*Asparagus laricunus*	*Tarchonanthus camphoratus*
Eragrotis lehmanniana	*Commelina africana*	*Ziziphus mucronata*
Eragrostis plana	*Crinum* sp.	
Heteropogon contortus	*Gladiolus* sp.	
Hyparrhenia hirta	*Hypoxis rigidula*	
Hyperthelia dissoluta	*Jamesbrittenia aurantiaca*	
Imperata cylindrica	*Ledebouria cooperi*	
Ledebouria revoluta	*Polygala hottentotta*	

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Mariscus congestus	*Psiadia punctulata*	
Panicum maximum	*Scabiosa columbaria*	
Panicum schinzii	*Waltheria indica*	
Phragmites australis		
Schoenoplectus corymbosus		
Setaria nigrirostris		
Setaria sphacelata		
Sporobolus africanus		
Themeda triandra		
Typha capensis		

The Wetland Habitat Unit is considered to be of increased ecological sensitivity due to the contribution of the drainage line features to faunal migratory connectivity, wetland eco-services provision and the niche habitat provided for faunal and floral species, specifically within the areas with surface water.

4.4 RDL Floral and Protected Tree Species Assessments

An assessment considering the presence of all floral species of concern as outlined in SAS (2013), as well as suitable habitat to support any such species, was undertaken. The complete PRECIS RDL floral lists for the QDS references (2527DA) were obtained from SANBI (SAS, 2013) and the Probability of Occurrence (POC) for each of the species listed for the QDS was calculated (Table 4 below) with reference to habitat suitability within the study area.

Table 4: POC for floral species of concern.

Species	Literature	Habitat	Disturbance	POC	Motivation
Frithia pulchra	2	0	0	13%	No suitable habitat, particularly coarse quartzitic soils is available for this species.
Ilex mitis	3	0	0	33%	No suitable habitat is available for this species.
Stenostelma umbelluliferum	2	1	1	26%	If present, this species will be located within the Wetland Habitat Unit.
Prunus africana	3	0	0	20%	No suitable habitat is available for this species.

From the above assessment, it is clear that none of the RDL floral species listed for the QDS has a high probability of occurring within the study area, due to the high levels of historical anthropogenic activities in the region, which include cultivation, quarrying and grazing and due to lack of suitable habitat for these species. If present, these species will occur within the less disturbed portions of the Wetland Habitat Unit.

Crinum sp. was encountered on site, but it was not possible to accurately identify the exact species due to the plants having no flowers and the leaves turning brown at the time of assessment. This species may however be *Crinum macowanii*. Together with *Hypoxis hemerocallidea* and *Boophane disticha*, this species have a high POC throughout the study area, within less impacted areas. Although these species have not been recorded for the QDSs, they are listed by SANBI as being 'Declining'. Should these species be encountered within the study area, such specimens should be relocated to similar suitable habitat within or in the vicinity of the Tharisa Mine, within areas earmarked for conservation such as wetland buffer areas.

The tree species *Sclerocarya birrea* subsp. *caffra* (Marula) is present on the study area within Scattered Bushveld Habitat Unit. This tree species is protected under the National Forests Act of 1998 (Act 84 of 1998). In terms of this act, protected tree species may not be cut, disturbed, damaged or destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold - except under licence granted by the Department of Water Affairs (DWA) (or a delegated authority). Applications for such activities should be made to the responsible official in each province. Each application is evaluated on merit (including site visits) before a decision is taken whether or not to issue a licence (with or without conditions). Such decisions must be in line with national policy and guidelines.

Sclerocarya birrea subsp. *caffra* trees are difficult to transplant once mature, due to the risk of damaging the relatively shallow root system. Should transplanting prove unsuccessful, additional *Sclerocarya birrea* subsp. *caffra* trees are to be planted to offset potential loss of marula trees due to infrastructure development. It is recommended that for each Marula tree destroyed, two additional trees of the same species are to be planted, preferably within an area earmarked for conservation in the vicinity of Tharisa Mine.

Two floral genera, protected under the Transvaal Nature Conservation Ordinance (TNCO) (No 83 of 1983), namely *Crinum* sp. and *Gladiolus* spp. were encountered within the study area. In addition to these species, although not noted on site, a high probability exists that *Boohane disticha*, also listed as protected in terms of the TNCO, will also be present within the study area. It is unclear whether the TNCO act is still applicable. The North West Province Biodiversity Conservation Bill, which was published for comment under Notice Nr. 394, Provincial Gazette 6719, dated 23 December 2009, incorporates the old TNCO of 1983, but the status of this Bill is also currently unclear. It is therefore recommended that the relevant competent authorities provide clarity on this issue in the Record of Decision (ROD).

4.5 Vegetation Index Score

The information gathered during the assessment of the study area was used to determine the Vegetation Index Score (VIS) - see Appendix A for calculations. Due to variation between the different habitat units, the habitat units were assessed separately. The table below lists the results of each habitat unit. The scoring categories are outlined in SAS (2013).

Table 5: Vegetation Index Score

Habitat unit	Score	Class	Motivation
Transformed Bushveld Habitat Unit	5	**E – The loss of natural habitat extensive**	These areas have been disturbed extensively due to agricultural and quarrying activities as well as due to soil disturbance. A high abundance of alien floral species are present.
Wetland Habitat Unit	15	**C – Moderately modified**	This habitat is of importance in terms of habitat provision for a number of floral and faunal species. Moderate to low levels of alien species encroachment was noted.
Scattered Bushveld Habitat Unit	18	**C – Moderately modified**	Vegetation structure is intact and increased species diversity is present, however this habitat unit is fragmented due to agricultural activities. A low abundance of alien species were noted.

4.6 Alien and Invasive Floral Species

Alien invasive plants are plants that are of exotic origin and are invading previously pristine areas or ecological niches (Bromilow, 2001). Not all weeds are exotic in origin but, as these exotic plant species have very limited natural “check” mechanisms within the natural environment, they are often the most opportunistic and aggressively growing species within the ecosystem. Therefore, they are often the most dominant and noticeable within an area. Disturbances of the ground through trampling, excavations or landscaping often leads to the dominance of exotic pioneer species that rapidly dominate the area. Under natural conditions, these pioneer species are overtaken by sub-climax and climax species through natural veld succession. This process, however, takes many years to occur, with the natural vegetation never reaching the balanced, pristine species composition prior to the disturbance. There are many species of indigenous pioneer plants, but very few indigenous species can out-compete their more aggressively growing exotic counterparts.

Alien vegetation invasion causes degradation of the ecological integrity of an area, causing (Bromilow, 2001):

- A decline in species diversity;
- Local extinction of indigenous species;

- Ecological imbalance;
- Decreased productivity of grazing pastures; and
- Increased agricultural input costs.

During the floral assessment, all alien and weed species were identified and are listed in the table below.

Table 6: Dominant alien vegetation species identified during the general area assessment.

Species	English name	Origin	Category*
Trees/ shrubs			
Opuntia ficus-indica	Prickly pear	Mexico	1
Forbs/ Grasses			
Araujia sericifera	Moth catcher	South America	1
Bidens pilosa	Common blackjack	South America	N/A
Datura stramonium	Common thorn-apple	North America	1
Gomphrena celosioides	Prostrate globe amaranth	South America	N/A
Hibiscus trionum	Bladder hibiscus	Meidterranean	N/A
Lantana camara	Common lantana	Tropical America	1
Persicaria lapathifolia	Spotted knotweed	Europe	N/A
Physalis angulata	Wild gooseberry	America	N/A
Schkuhria pinnata	Dwarf marigold	South America	N/A
Sesbania bispinosa	Spiny sesbania	Asia, North Africa	N/A
Tagetes minuta	Tall khakiweed	South America	N/A
Verbena bonariensis	Purple top	South America	1
Xanthium strumarium	Large cocklebur	South America	1
Zinnia peruviana	Redstar zinnia	South America	N/A

Category 1 – Declared weeds. Prohibited plants, which must be controlled or eradicated.
Category 2 – Declared invader plants with a value. “Invaders” with certain useful qualities (i.e. commercial). Only allowed in controlled, demarcated areas.
Category 3 – Mostly ornamental plants. Alien plants presently growing in, or having escaped from, areas such as gardens, but are proven invaders. No further planting or trade in propagative material is allowed (Bromilow, 2001).

From the table above it is clear that a moderate diversity of alien species occurs within the study area, with a number of these species falling within Category 1. The majority of alien plant species was identified within the Transformed Habitat Unit and to a lesser degree within the Wetland Habitat Unit.

4.7 Medicinal Plant Species

Medicinal plant species are not necessarily indigenous species, with many of them regarded as alien invasive weeds.

The table below presents a list of plant species with traditional medicinal value, plant parts traditionally used and their main applications, which were identified during the field assessment. Apart from *Crinum* spp. which is a protected species (SANBI, TNCO), these medicinal species are all commonly occurring species and are not confined to the study area.

Table 7: Traditional medicinal plants identified during the field assessment. Medicinal applications and application methods are also presented (van Wyk, et al., 1997; van Wyk and Gericke, 2000; van Wyk and Wink, 2004; van Wyk, Oudtshoorn, Gericke, 2009).

Species	Name	Plant parts used	Medicinal uses
Acacia karroo	Sweet thorn	Bark, leaves and gum	Remedy for diarrhoea and dysentery.
Aloe greatheadii var *davyana*	Aloe	Stems and leaves	Decoction of powdered stems and leaf bases is taken orally twice a day after delivery to cleanse the system.
Asclepias fruticosa	Milkweed	Leaves, sometimes roots	Used as snuff to treat headaches and tuberculosis.
Asparagus laricinus	Wild asparagus	Rhizomes and fleshy roots	Traditionally used as treatment for tuberculosis, kidney ailments and rheumatism.
Crinum sp.	Crinum	Bulbs and leaves	Remedy for scrofula, micturition and rheumatic fever. Also used for blood cleansing, kidney and bladder diseases, glandular swelling, fever and skin problems.
Datura stramonium	Thornapple	Leaves and green fruit	Mainly used to relieve asthma and to reduce pain. Weak infusions are used as hypnotics by the elderly and as aphrodisiacs by adults.
Dichrostachys cinerea	Sickle bush	Root and often stems bark, leaves and pods	Root infusions have been used to treat body pain, backache, toothache, elephantiasis, syphilis, leprosy and as a styptic, diuretic, purgative and aphrodisiac.
Erythrina lysistemon	Common coral tree	Bark, sometimes leaves and roots	The main use of the bark is to treat sores, wounds, abscesses and arthritis.
Leonotis leonurus	Wild dagga	Mainly the leaves and stems, but also the roots	Widely used as a remedy for snake bite and also to treat other bites and stings. Externally, decoctions have also been applied to treat boils, eczema, skin diseases, itching and muscular cramps. Internally, decoctions are also used for coughs, colds and influenza, and also for bronchitis, high blood pressure and headaches.
Scabiosa columbaria	Wild scabious	Leaves and fleshy roots	Remedy for colic and heartburn, dried roots are made into a wound-healing ointment and powered roots are also used as a pleasant-smelling baby powder.
Sclerocarya birrea subsp. *caffra*	Marula	Bark, roots and leaves	Diarrhoea, dysentery and unspecific stomach problems are treated with the bark. Also used as a general tonic, in combatting fever and in the treatment of malaria.

Species	Name	Plant parts used	Medicinal uses
Tagetes minuta	Tall khaki bush	Leaves, flowers	The repellent properties of essential oil have been known for a long time and were found to be effective in preventing sheep from becoming infected with blow-fly larvae. Many gardeners use warm water extracts of the fresh plant to keep roses and other garden plants free from insects and fungal diseases. The essential oil is used in perfumery and as a flavourant in food, beverages and tobacco.
Tarchonanthus camphoratus	Wild camphor bush	Leaves and twigs	Used to treat stomach trouble, abdominal pain, headache, toothache, asthma, bronchitis and inflammation.
Typha capensis	Bulrush	Rhizomes	Used for venereal diseases during pregnancy to ensure an easy delivery, and for dysmenorrhoea, diarrhoea, dysentery and to enhance male potency and libido.
Vernonia oligocephala	Groenamara	Leaves and twigs	Infusions are taken as stomach bitters to treat abdominal pain and colic
Ziziphus mucronata	Buffalo thorn	Roots, bark or leaves used separately or in combination.	Warm bark infusions (sometimes together with roots or leaves added) are used as expectorants (also as emetics) in cough and chest problems, while root infusions are a popular remedy for diarrhoea and dysentery. Decoctions of roots and leaves (or chewed leaves) are applied externally to boils, sores and glandular swellings, to promote healing and as an analgesic.

5. RESULTS OF THE FAUNAL INVESTIGATION

All appendices referred to in the following sections can be found in the 'Faunal, Floral, Wetland and Aquatic Assessment as Part of the Environmental Assessment and Authorisation Process for the Proposed Tharisa Mine Expansion Project, North West Province' report, dated November 2013.

5.1 Mammals

During the field assessment, no mammal species were directly observed; however identification of scat indicated the presence of *Lepus saxatalis* (Scrub Hare) within the study area (Figure 12). Based on SAS (2013) and personal communications with Tharisa Mine personnel, other mammals which may be present in the study area include *Sylvicapra grimmia* (Common Duiker), *Raphicerus campestris* (Steenbok) and *Canis mesomelas* (Black-backed jackal). The rocky areas and bushveld to the south of the study area provides more suitable habitat for an increased diversity of mammals species to occur compared to the study area, however any of the species listed in Table 8 has a high likelihood of occasionally occurring within the study area (SAS, 2013).

Table 8: Mammal species likely to occur within the study area.

Scientific Name	Common Name	NW Status	IUCN Status
Lepus saxatilis	Scrub hare	LC	LC
Cynictis penicillata	Yellow mongoose	LC	LC
Crocidura mariquensis	Swamp musk shrew	LC	LC
Raphicerus campestris	Steenbok	LC	LC
Ichneumia albicauda	White tailed mongoose	LC	LC
Lemniscomys rosalia	Single-stripped mouse	LC	LC
Helogale parvula	Dwarf mongoose	LC	LC
Hystrix africaeaustralis	Porcupine	LC	LC
Galerella sanguinea	Slender mongoose	LC	LC
Cynictis penicillata	Yellow mongoose	LC	LC
Caracal caracal	Caracal	LC	LC
Leptailurus serval	Serval	LC	LC
Sylvicapra grimmia	Common duiker	LC	LC

LC = Least Concern

According to the North West Province State of the Environment Report (NW SoER) (2002) and the International Union for the Conservation of Nature (IUCN) (2014), the above mentioned species are all considered to be non-threatened mammal species. A list of threatened mammal species for the North West Province is included in Appendix A (SAS, 2013).

In terms of conservation, no RDL or threatened mammal species were encountered during the field assessment. Furthermore, the likelihood of any threatened mammal species as listed in Appendix A (SAS, 2013) being encountered within the study area is considered to be low due to the high levels of anthropogenic activity such as agricultural activity within the study area. The proposed WRD is therefore considered unlikely to pose a threat to mammal species conservation in the region provided that the sensitivity map and buffer zones as provided in this report are adhered to. In addition it is also considered important to ensure that the rocky outcrop to the south of the study area remain conserved, as available habitat for mammal species within the area is becoming severely limited.

Figure 12: *Lepus saxatalis* (Scrub Hare) droppings noted within the study area.

5.2 Avifauna

Avifaunal surveys were conducted across the entire study area and all avifaunal species seen or heard during the field assessment were recorded. Table 9 lists all the avifaunal species identified during the assessment as well as their current IUCN status. The complete list of RDL avifaunal species occurring within the region according to the NW SoER (2002) is included in Appendix B (SAS, 2013) and the reference for finding complete lists of avifaunal species expected for the QDSs 2527DA (SABAP2) are included in Appendix G (SAS, 2013).

From Table 9 below it can be seen that all avifaunal species identified within the study area are common species known to reside within or utilise the bushveld and wetland habitat in the region and may be either permanently or occasionally present within the study area. All species observed during the SAS (2013) survey may also be present within the study area.

Table 9: Avifaunal species recorded during the survey.

Scientific Name	Common Name	IUCN status
Stigmatopelia senegalensis	Laughing dove	LC
Euplected orix	Red bishop	LC
Anhinga rufa	African darter	LC
Fulica cristata	Red knobbed coot	LC
Ardea cinerea	Grey heron	LC
Ardea melanocephala	Black headed heron	LC
Acridotheres tristis	Indian myna	LC
Streptopelia capicola	Cape turtle dove	LC
Vanellus coronatus	Blacksmith plover	LC
Numida meleagris	Helmeted guineafowl	LC
Lanius collaris	Common fiscal shrike	LC
Quelea quelea	Red billed quelea	LC

Scientific Name	Common Name	IUCN status
Bubulcus ibis	Cattle egret	LC
Bostrychia hagedash	Hadeda ibis	LC
Ploceus velatus	Southern masked weaver	LC

LC = Least Concern

The study area is situated within the Magaliesberg/Witwatersberg Important Bird Area (IBA SA025) as described in SAS (2013).

No threatened RDL avifaunal species were identified during the site survey. However, there is a likelihood of RDL avifaunal species utilising the study area for foraging purposes or as a migratory corridor, with specific reference to raptor species. Threatened avifaunal species known to occur in the region are listed in Appendix B (SAS, 2013). Threatened species with a greater than 60% POC of utilising the study area, predominantly for foraging purposes, are *Falco peregrinus* (Peregrine Falcon), *Polemaetus bellicosus* (Martial Eagle), *Sagittarius serpentarius* (Secretary bird) and *Gyps coprotheres* (Cape Vulture) (Table 10).

Table 10: North West Province RDL avifaunal species with a POC of more than 60% (Appendix B, SAS (2013)).

Scientific Name	Common Name	NW status	IUCN status	POC %
Tyto capensis	*African Grass Owl*	VU	LC	60
Falco peregrinus	*Peregrine Falcon*	R	LC	65
Polemaetus bellicosus	*Martial Eagle*	VU	NT	60
Sagittarius serpentarius	*Secretary bird*	NT	VU	64
Gyps coprotheres	*Cape Vulture*	VU	VU	62

VU = Vulnerable, NT = Near threatened, R = Rare.

Sufficient suitable habitat for avifaunal species is present in the areas surrounding the study area, particularly to the south within the Magaliesberg region and it is therefore considered unlikely that the proposed WRD project will have a significant impact on avifaunal species' diversity and abundance. Most of the threatened avifauna species (Appendix B, SAS 2013) known to occur in the region are considered to be highly mobile species and if present, will only utilise the study area for foraging purposes or as a migration corridor. Due to their high mobility, such avifaunal species will be able to move to areas of improved favourability should the habitat within the study area be further disturbed. The proposed WRD development activities are thus unlikely to pose a significant conservation threat to RDL avifauna species within the study area, provided that mitigation measures as provided are adhered to.

5.3 Reptiles

No reptile species were observed during the field assessment, however this was expected as reptiles are notoriously difficult to detect, are well camouflaged and have well-developed senses to avoid detection by predators, thus often making on-site observations of reptiles difficult. The study area offers limited favourable habitat for reptile species, however due to the presence of rocky areas to the south of the study area it is expected that reptile species may utilise the study area for foraging purposes.

Common non threatened reptile species expected to occur within the vicinity of the study area are *Hemachatus haemachatus* (Rinkhals), *Naja nivea* (Cape Cobra), *Bitis arietans* (Puff Adder) and *Agama atra* (Southern Rock Agama) (Table 11). None of the abovementioned reptile species are considered to be threatened (IUCN, 2013; NW SoER, 2002). The complete list of RDL reptile species occurring within the North West Province is included in Appendix D (SAS, 2013).

Table 11: Reptile species expected to occur within the study area.

Scientific Name	Common Name	NW Status	IUCN Status
Hemachatus haemachatus	Rinkhals	LC	LC
Chamaeleo dilepis	Flap necked chameleon	LC	LC
Naja nivea	Cape cobra	LC	LC
Bitis arietans	Puff adder	LC	LC
Agama atra	Southern rock agama	LC	LC
Pachydactylis affinis	Transvaal gecko	LC	LC
Meroles squamulosus	Common rough-scaled lizard	LC	LC

LC = Least Concern.

One RDL reptile species, namely *Python sebae natalensis* (African Rock Python) is known to occur within the North West Province. This species is however not considered likely to permanently occur within the study area.

Due to the high levels of historical anthropogenic activities within the study area and surrounding region, the proposed mining activities are deemed unlikely to pose a significant conservation threat to *P. natalensis* or other reptile species in the region, provided that mitigation measures as provided are adhered to. If *P. natalensis* is found within the proposed development footprint areas, this species should be safely relocated to an appropriate and safe area by an accredited snake handler.

5.4 Amphibians

No amphibian species were encountered during the field assessment, partially due to the non-perennial nature of the drainage lines traversing the study area and due to the survey having been done late in the rainy reason. It is expected that the majority of amphibian species likely to occur on the study area will be present within the artificial dam area associated with the central drainage line, which contain water for a prolonged period of time throughout the year.

Common species with the potential to occur within the Wetland Habitat Unit include *Ptychadena anchietae* (Plain Grass Frog), *Afrana angolensis* (Common River frog), *Xenopus laevis* (Platanna), *Cacosternum boettgeri* (Common Caco), *Schismaderma carens* (Red toad), *Tomopterna cryptotis* (Tremolo sand frog), *Kassina senegalensis* (Bubbling kassina), *Phrynomantis bifasciatus* (Banded Rubber Frog) *Amietophrynus gutturalis* (Guttural toad), *Tomopterna natalensis* (Natal sand frog), and *Ptychadena mossambica* (Striped grass frog), none of which are considered to be threatened (NW SoER, 2002, IUCN 2014) (Table 12). These common species may occur within the Wetland Habitat Unit under favourable conditions during the rainy seasons.

Table 12: Amphibian species which may potentially occur within the study area.

Scientific Name	Common Name	NW Status	IUCN Status
Kassina senegalensis	Bubbling Kassina	LC	LC
Phrynomantis bifasciatus	Banded Rubber Frog	LC	LC
Afrana angolensis	Common River Frog	LC	LC
Schismaderma carens	Red Toad	LC	LC
Poyntonophrynus fenoulheti	Fenoulhet's Toad	LC	LC
Amietophrynus garmani	Eastern Olive Toad	LC	LC
Amietophrynus gutturalis	Gutteral Toad	LC	LC
Amietophrynus poweri	Lowveld Toad	LC	LC
Cacosternum boettgeri	Common Caco	LC	LC
Phrynobatrachus natalensis	Natal Dwarf Puddle Frog	LC	LC
Ptychadena anchietae	Plain Grass Frog	LC	LC
Ptychadena mossambica	Broad-banded Grass Frog	LC	LC
Strongylopus fasciatus	Striped Stream Frog	LC	LC
Tomopterna cryptotis	Common sand Frog	LC	LC
Tomopterna natalensis	Natal Sand Frog	LC	LC
Xenopus laevis	Platanna	LC	LC

LC = Least Concern.

A list of RDL amphibian species known to occur within the region is included in Appendix E (SAS, 2013). The only amphibian species listed as being of concern within the North West

Province is *Pyxicephalus adspersus* (African Bullfrog). This species is considered by the NW SoER (2002) to be Near Threatened. *P. adspersus* is however listed by the IUCN (2014) as being of Least Concern. The high level of anthropogenic activities within the study area, particularly historical agricultural activities, combined with the extent of mining activities in the vicinity of the study area, decreases the possibility that this species will occur within the study area. Furthermore, very little suitable habitat was found within the study area and it is deemed unlikely that the Wetland Habitat Unit, with specific reference to the centrally located drainage line, is large enough to support a significant population of *P. adspersus*.

In terms of conservation, there is a low possibility of encountering RDL or threatened amphibian species within the study area and associated wetland habitat. The proposed WRD development activities are therefore deemed unlikely to pose a significant conservation threat to *P. adspersus* and other amphibian species within the study area, provided that mitigation measures as provided are adhered to, with specific reference to conservation of the Wetland Habitat Unit and associated buffer zones.

5.5 Invertebrates

The invertebrate assessment conducted was a general assessment with the purpose of identifying common species and taxa in the study area. As such, the invertebrate assessment is not an indication of the complete invertebrate diversity potential of the study area and surrounding area. A representation of commonly encountered families in the Insecta class that were observed during the assessment is listed in Table 13 below, with some of these species illustrated in Figure 13. A list of RDL invertebrate species known to occur within the region, of which none were recorded during the assessment, is included in Appendix E (SAS, 2013).

Table 13: General results from the invertebrate collection and observation during the field assessment.

Insects	Comments
Order: Lepidoptera (Butterflies & Moths)	These are all commonly occurring species typical of the locality and habitat
Family: Nymphalidae	
Subfamily: Danainae	Visual observations (Figure 13)
Danaus chrysippus aegyptius (African monarch)	
Subfamily: Nimphalinae	
Junonia hierta (Yellow pansy)	Visual observations
Byblia ilythia (Spotted joker)	
Family: Pieridae	
Eurema hecabe (Common grass Yellow)	Visual observations
Beleonis creona (African Common White)	
Beleonis aurota aurota (Brown-veined White)	

Order: Orthoptera (Grasshoppers, Crickets & Locusts)	These are all commonly occurring species typical of the locality and habitat
Family: Anostostomatidae *Onosandrus* sp	Visual observations
Family: Gryllidae *Gryllus bimaculatus* (Common garden cricket)	Visual observations
Family: Tettigoniidae *Conocephalus caudalis* (Meadow Katydid)	Visual observations
Family: Acrididae *Cannula gracilis* (Grass mimicking Grasshopper)	Visual observations
Order: Hymenoptera & Isoptera (Ants, Bees, Termites & Wasps)	These are all commonly occurring species typical of the locality and habitat
Family: Apidae *Apis mellifera scutellata* (African honey bee)	Visual observations
Order: Coleoptera (Beetles)	These are all commonly occurring species typical of the locality and habitat
Family: Lycidae *Lycus melanurus* (Hook winged Net winged beetle)	Visual observations
Family: Geotruidae *Geotrupes egeriei* (Earth-boring dung beetles)	Visual observations
Family: Scarabaeidae *Cyrtothyrea marginalis* (Common dotted fruit chafer)	Visual observations (Figure 13)
Order: Mantodea (Mantids)	These are all commonly occurring species typical of the locality and habitat
Family: Mantidae *Sphodromantis lineola* (African Praying mantis)	Visual observations

Figure 13: *Danaus chrysippus aegyptius* (African Monarch) on the left and *Cyrtothyrea marginalis* (Common dotted fruit chafer) to the right.

The results from the invertebrate survey comprise invertebrate species that are common to the area. Due to anthropogenic impacts, such as mining and agricultural activities having already occurred within the study area, loss of natural invertebrate habitat has taken place, which reduces invertebrate presence and abundance as well as the probability of RDL

species being present. Therefore, the proposed development is unlikely to contribute to a loss of invertebrate diversity in the region.

5.6 Spiders and Scorpions

No threatened spider or scorpion species are listed in the North West Province SoER (2002). Therefore, a record of threatened spiders and scorpions was acquired from the most recent RDL spider and scorpion data available for South Africa using the South African National Biodiversity Institute (SANBI) threatened species database (http://www.speciesstatus.sanbi.org) as presented in Appendix F (SAS, 2013). It was determined through this database that trapdoor and Baboon spiders are listed as threatened throughout South Africa (Dippenaar-Schoeman, 2002).

Table 14 lists the only spider species identified during the site visit, namely *Olurunia ocellata* (Grass funnel-web spider). No evidence was encountered of SANBI endangered or threatened Mygalomorphae arachnids which includes both Baboon and Trapdoor spiders.
No scorpion species were encountered, due to the limited suitable rocky habitat available for such species within the study area.

Table 14: Araneae species recorded during the survey.

Common Name	Scientific Name	NW status	IUCN status
Olurunia ocellata	Grass funnel-web spider	LC	LC

LC = Least Concern

6. FAUNAL RED DATA SPECIES ASSESSMENT

No RDL faunal species were identified during the site survey, and due to the high level of anthropogenic impacts within the study area, it is considered unlikely that any RDL faunal species would occur here. All faunal species that were assessed during the calculation of the RDSIS for the site are included in Appendix H (SAS, 2013), which lists faunal species known to occur within the North West Province. Five RDL or threatened species, presented in Table 15, were found to have a 60% or greater POC within the study area and its immediate vicinity.

Table 15: Threatened faunal species with a 60% or greater Probability of Occurrence (POC) within or in the vicinity of the study area.

Scientific Name	Common Name	NW status	IUCN status	POC %
Tyto capensis	*African Grass Owl*	VU	LC	60
Falco peregrinus	*Peregrine Falcon*	R	LC	65
Polemaetus bellicosus	*Martial Eagle*	VU	NT	60
Sagittarius serpentarius	*Secretary bird*	NT	VU	64
Gyps coprotheres	*Cape Vulture*	VU	VU	62

VU = Vulnerable, NT = Near threatened, R = Rare, LC = Least Concern

The species listed in the table above were then used to calculate the RDSIS for the study area, the results of which are presented in Table 16.

Table 16: Red Data Sensitivity Index Score calculated for the study area.

Red Data Sensitivity Index Score	
Average Total Species Score	**64**
Average Threatened Taxa Score	**70**
Average (Ave TSS + Ave TT/2)	**67**
% Species greater than 60% POC	**5%**
RDSIS of Site	**34%**

The RDSIS assessment for the study area yielded a low score of 34%, indicating a low importance with regards to RDL faunal species conservation within the region. All potential RDL species are avifaunal species, with the ability to migrate away from unfavourable conditions. The proposed WRD development activities will thus have a low impact on RDL faunal conservation within the study area and in the surrounding region provided that the sensitivity map developed for the study area is adhered to.

7. RESULTS OF THE WETLAND INVESTIGATION

7.1 Aquatic Ecoregions

The study area falls within the Bushveld Basin Aquatic Ecoregion and within quaternary catchment A21K (Figure 14). The properties of this Aquatic Ecoregion and quaternary catchment are discussed in detail in the report entitled ‘Faunal, Floral, Wetland and Aquatic

Assessment as Part of the Environmental Assessment and Authorisation Process for the Proposed Tharisa Mine Expansion Project, North West Province' (SAS, 2013).

7.2 General Importance of the Study Area with Regards to Watercourse Conservation

7.2.1 Importance according to the National Freshwater Ecosystems Priority Areas database (2011)

The NFEPA (2011) database was consulted to define the aquatic ecology of the wetlands and river systems close to and within the study area that may be of ecological importance. From the assessment it was found that the NFEPA database indicate no wetlands or watercourses within or in the immediate vicinity of the study area.

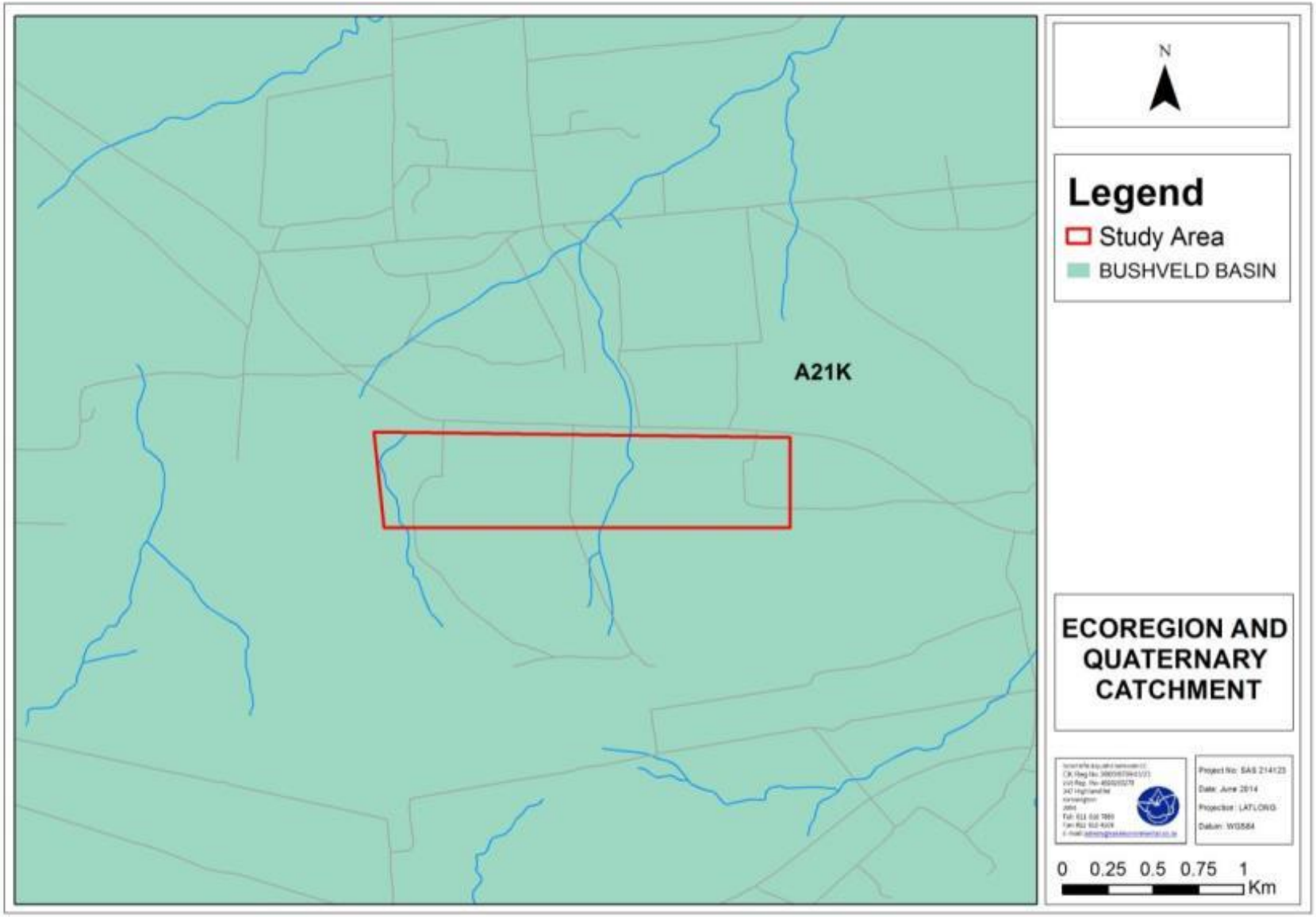

Figure 14: **The Aquatic Ecoregion and Quaternary Catchment associated with the study area.**

7.3 Wetland System Characterisation

Two wetland features in the form of drainage lines were identified within the study area, and were classified according to the Classification System compiled by Ollis *et al.* (2013), hereinafter referred to as the "Classification System". Both wetland features are considered to be poorly developed drainage lines, and comprise two broad HGM Units according to the Classification System, namely:

- Channelled valley bottom; and
- Unchannelled valley bottom (Table 17).

Although no wetlands were indicated by the NFEPA database, one WetVeg Group applies to the study area, namely Central Bushveld Group 2. Channelled valley bottom wetlands occurring within this WetVeg Group are considered to be "Critically Endangered" ecosystems, whilst unchannelled valley bottom wetlands in this group are considered to be 'Vulnerable' ecosystems.

Drainage Line A refers to the drainage line identified within the centre of the study area, while Drainage Line B refers to the drainage line feature within the west of the study area. Historically, Drainage Line A is indicated on topographic maps to continue flowing north; however close inspection of this area on site did not reveal indicators of wetland conditions. It is likely that the road traversing the south of the study area along with the artificial dam located at the north end of this drainage line has altered the hydrology of the feature, such that the portion of the drainage line between the artificial dam and the Lonmin haul Road no longer functions as a wetland. Therefore, the proposed development will not have an impact on this non-functional portion of the wetland.

The location of these two drainage lines is indicated in Figure 17 below.

Table 17: Classification system for the drainage lines.

Wetland feature location	Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit HGM Type
Drainage line A	**Inland:** An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	**Bushveld Basin Ecoregion:** The study area falls within the Bushveld Basin Ecoregion **WetVeg:** Central Bushveld Group 2	**Valley floor:** The typically gently sloping, lowest surface of a valley	**Unhannelled valley-bottom wetland:** A mostly flat wetland area on a valley floor that is characterised by an absence of distinct channel banks, and the prevalence of diffuse flows. Water inputs are typically from an upstream channel that becomes dominated by diffuse (surface and subsurface) flow as it enters the wetland and seepage from adjacent slopes. There may also be groundwater input.
Drainage line B	**Inland:** An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	**Bushveld Basin Ecoregion:** The study area falls within the Bushveld Basin Ecoregion **WetVeg:** Central Bushveld Group 2	**Valley floor:** The typically gently sloping, lowest surface of a valley	**Channelled valley-bottom wetland:** A mostly flat wetland area on a valley floor that is dissected by and typically elevated above a well-defined stream channel. Dominant water inputs to these areas are typically from the channel (when it overtops or from sub-surface discharge) and from adjacent valley-side slopes

Representative photographs of the two drainage line features are presented in the figures below.

Figure 15: Representative photographs of the northern portion of Drainage Line A, showing surface water present.

Figure 16: Representative photographs of sections of Drainage Line B.

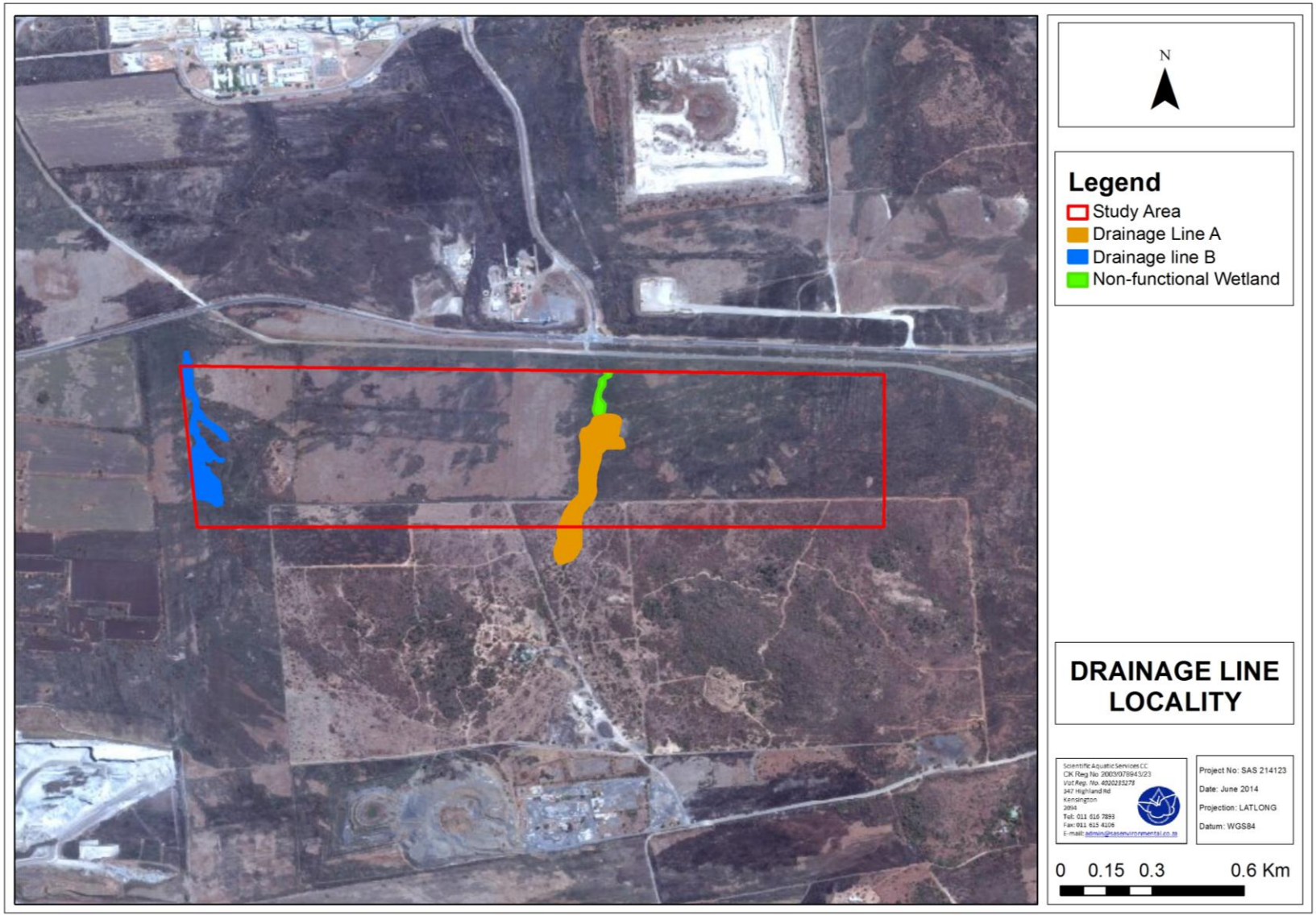

Figure 17: Location of the drainage line features in relation to the study area presented conceptually on a satellite image.

7.4 Vegetation Community Considerations

The various wetland vegetation components were identified during the assessment, with special attention being paid to both facultative and obligate wetland vegetation associated with soils that are frequently saturated. Dominant species were characterised as either wetland or terrestrial species. The wetland species were then further categorised as temporary, seasonal and permanent zone species. This characterisation is presented in the table below, including the terrestrial species identified within the wetland areas. It should be noted that this is not an exhaustive list of all floral species associated with the wetland areas the study area.

Table 18: Dominant floral species identified during wetland delineation of the wetland present on the study area (alien floral species are indicated with an asterisk).

Terrestrial species	Temporary zone species	Seasonal zone species	Permanent zone species
Andropogon schirensis	*Asparagus laricunus*	**Lantana camara*	**Persicaria laphathifolia*
Asparagus laricunus	*Berkheya radula*	**Persicaria laphathifolia*	*Cynodon dactylon*
Commelina africana	*Bothriochloa insculpta*	**Schkuhria pinnata*	*Cyperus longus*
Eragrotis curvula	*Commelina africana*	**Sesbania bispinosa*	*Dicanthium annulatum*
Eragrotis lehmanniana	*Cymbopogon pospischilii*	**Tagetes minuta*	*Schoenoplectus*
Heteropogon contortus	*Cynodon dactylon*	**Verbena bonariensis*	*corymbosus*
Panicum maximum	*Cynodon dactylon*	**Zinnia peruviana*	*Sporobolus africanus*
Acacia karroo	*Eragrotis plana*	*Andropogon schirensis*	*Typha capensis*
Pappea capensis	*Imperata cylindrica*	*Asparagus laricunus*	
Ziziphus mucronata	*Searsia pyroides*	*Combretum erythrophyllum*	
	Sporobolus africanus	*Cynodon dactylon*	
		Eragrostis curvula	
		Eragrostis lehmanniana	
		Eragrostis plana	
		Heteropogon contortus	
		Hyparrhenia hirta	
		Panicum schinzii	
		Searsia lancea	
		Setaria megaphylla	
		Themeda triandra	

7.5 Ecoservices and Function Assessment

The wetland function and service provision of the drainage line features was assessed utilising the WET-Ecoservices (Kotze *et. al*. 2009) method as previously described by SAS (2013). The results of the assessment are tabulated below and depicted in the radar plot in Figure 18 that follows.

Table 19: Wetland functions and service provision for the drainage line features in the study area.

Ecosystem service	Drainage Line A	Drainage Line B
Flood attenuation	2	2,1
Streamflow regulation	1,6	1,4
Sediment trapping	2	2
Phosphate assimilation	2,1	1,8
Nitrate assimilation	1,8	1,2
Toxicant assimilation	2,1	1,8
Erosion control	2,1	2,2
Carbon Storage	1,3	1
Biodiversity maintenance	2,1	2,1
Water Supply	0,6	0,5
Harvestable resources	0	0
Cultural value	0	0
Cultivated foods	0	0
Tourism and recreation	0	0
Education and research	0	0
SUM	**17,7**	**16,1**
Average score	**1,2**	**1,1**

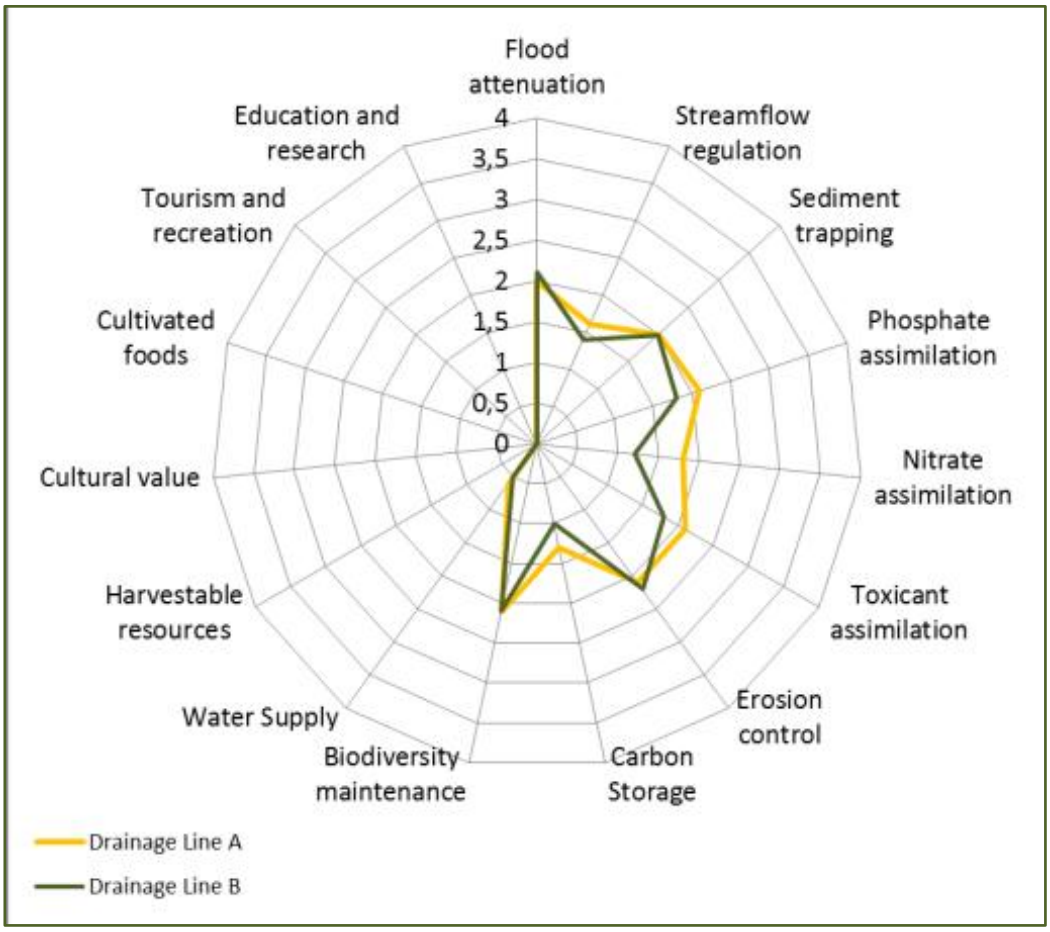

Figure 18: Radar plot of wetland services provided by the drainage line features within the study area.

The results of this assessment indicate that the two drainage line features identified has slightly different levels of importance in terms of ecological service provision and functionality, although they share many similarities (such as floral species composition and characteristics common to the greater catchment for example changing land uses).

The presence of surface water, although minimal at the time of assessment, in Drainage Line A increases it's potential for streamflow regulation, nutrient and toxicant assimilation, as well as for carbon storage. In addition, waterlogging also promotes the accumulation of organic matter by impeding its decomposition (Kotze *et al.* 2009). It should be noted that Drainage Line A has in the past undergone artificial modification as the downstream portion of the feature has been altered to create an artificial dam.

As Drainage Line B did not contain surface water at the time of the assessment, this feature is considered to be marginally less important in terms of streamflow regulation, and nutrient and toxicant assimilation. Nonetheless, the levels of service provision provided in terms of flood attenuation, erosion control and sediment trapping are deemed to be slightly higher compared to the same eco-services provided by Drainage Line A. Vegetation cover within and surrounding both features is deemed to be relatively high, particularly taking into account the historical agricultural activities which has historically taken place within the study area. Floral species composition and community structure associated with the drainage line has undergone some transformation, but the degree of alien plant invasion is not as high as could be expected in an area that has undergone disturbances. Although there is a component of alien vegetation throughout the study area, including within the drainage line features, the level of cover provided by the existing vegetation is considered to be of value in terms of slowing stormwater flows, trapping sediment, and assimilating nutrients and toxicants.

Whilst both drainage line features obtained a score of 2.1 for biodiversity maintenance, it should be noted that this was primarily due to the location of the features within a catchment which is experiencing relatively high cumulative loss of wetlands, and also due to the conservation status of the features within the context of the applicable WetVeg Group. The score for this aspect of the assessment could be considered to be lower, in the region of 1.9, if these factors are not taken into account.

Neither of the drainage line features was considered to have value in terms of general socio-cultural services such as harvestable resources, cultural value, cultivated foods, tourism and recreation or education and research.

7.6 WET-Health Assessment

A Level 1 WET-Health assessment was applied, in which three modules, namely hydrology, geomorphology and vegetation were assessed to ascertain the overall "health" of the wetland features. The results of this assessment are summarised in the table below:

Table 20: Summary of results of the WET-Health Assessment.

Drainage Line Feature	Hydrology		Geomorphology		Vegetation	
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Drainage Line A	**C**	↓	**B**	↓	**C**	↓
Drainage Line B	**B**	↓	**B**	↓	**C**	↓

The anticipated trajectory of change was assessed, taking into consideration the project footprint as well as increased mining activity in the catchment. It is deemed likely that the condition of all wetlands is likely to deteriorate over the next five years, particularly if suitable mitigatory measures are not implemented in order to prevent such deterioration.

The overall score, which aggregates the scores for the three modules in order to obtain the PES category, was calculated for the wetland features using the formula[1] as provided by the Wet-Health methodology. These scores are presented below:

Table 21: Summary of results of the overall score for each wetland obtained in the WET-Health Assessment.

Wetland system	PES score	PES category
Drainage Line A	2.5	C
Drainage Line B	1.3	B

As can be seen from these results, the PES Category of Drainage Line A was found to fall within a Category C, whilst Drainage Line B, having been subjected to fewer modifications, calculated a score that placed it in a PES Category B.

The results of the WET-Health assessment show that the module which has undergone the greatest degree of change in both drainage line features is the vegetation module. This is largely due to edge effects from historical clearing of vegetation for agricultural purposes as well as grazing by livestock, resulting in the removal of indigenous floral species, and the disturbance to the soil profile leading to alien vegetation encroachment.

[1] ((Hydrology score) x 3 + (geomorphology score) x2 + (vegetation score) x 2))/ 7 = PES

The hydrology of Drainage Line A has been modified predominantly by the impoundment of water and historical agricultural activities at the downstream of the feature. The creation of an artificial dam wall has resulted in the desiccation of the drainage line north of the wall which has been exacerbated by clearing of vegetation for agricultural activities. Therefore, the hydrology module for Drainage Line A obtained a score placing it in a Category C. Drainage Line B however has not undergone such severe levels of modifications. Alterations to the hydrology of this feature consist primarily of limited historical earthworks which may have altered the natural flow of water through this feature. Although the topography suggests that water may be impounded temporarily upstream of this feature, a channel exists which allows water to flow through the feature relatively unimpeded. Although additional water inputs resulting from increased hardening of the catchment are likely to enter the feature during the rainy season, there is ample vegetation cover to slow the velocity of water, thus reducing the possibility that the channel will overflow.

The geomorphology of both features has undergone minimal alteration, and such alterations are mainly due to erosional and depositional features as a result of historical disturbances to the soil profile, as well as increased runoff originating in the catchment, which may transport additional sediment, which is then deposited within the drainage line features. Although neither of the features have undergone stream diversions or shortening, due to the historical impacts of agricultural activities on the features, especially the downstream section of Drainage Line A, this was accounted for when assessing the geomorphological health of the drainage line features.

7.7 Ecological Importance and Sensitivity (EIS)

In order to determine relative importance and sensitivity of the two drainage line features from an ecological perspective, the EIS assessment was applied as described by SAS (2013). The results of this assessment, presented in the table below, show that both features are considered to fall in an EIS Category C. This implies that they are ecologically important on a localised scale, but not necessarily within the greater catchment area, and are not considered to be very sensitive to changes. It should be noted that the overall score for each feature could potentially be even lower, if their conservation status according to the relevant WetVeg group was not taken into consideration during scoring.

Table 22: Summary of results of the EIS Assessment.

Determinant	Score: Drainage Line A	Score: Drainage Line B	Confidence
PRIMARY DETERMINANTS			
1. Rare & Endangered Species	1	1	4
2. Populations of Unique Species	1	1	4
3. Species/taxon Richness	1	1	3
4. Diversity of Habitat Types or Features	1	1	3
5. Migration route/breeding and feeding site for wetland species	2	2	3
6. PES as determined by WET-Health assessment	1	2	4
7. Importance in terms of function and service provision	2	2	4
MODIFYING DETERMINANTS			
8. Protected Status according to NFEPA Wetveg	4	4	4
9. Ecological Integrity	2	2	4
TOTAL	15	16	
MEAN	1,67	1,78	
OVERALL EIS	**C**	**C**	

7.8 Recommended Ecological Class (REC)

After consideration of the wetland function and WET-Health assessments, as well as the outcome of the EIS assessment, a suitable REC for both drainage line features is considered to be a Category C. This is deemed sufficient to prevent further degradation to the features.

7.9 Wetland Delineation and Sensitivity Mapping

During the assessment, the following temporary zone indicators were used:

- Terrain units were used to determine in which parts of the landscape the drainage line feature is most likely to occur, as wetland features occupying the valley bottom landscape unit are generally easily distinguishable, and the extent of the associated wetland area can often be readily be determined.
- The soil form indicator was used to determine the presence of soils that are associated with prolonged and frequent saturation, as well as variation in the depth of the saturated soil zone within 50cm of the soil surface (Figure 19). This indicator was used to identify gleyed soils where the soil is a greyish/greenish/bluish colour due to the leaching out of iron. Whilst mottling was not extensive, it was present in the temporary zone. Due to the disturbances to the soil profile as a result of historical agricultural activities, as well as the dominance of the turf soils in the area, it was difficult in most instances to ascertain the natural boundaries of the drainage line features base don soil characteristics.

- The vegetation indicator was used in the identification of the drainage line boundary through the identification of the distribution of both facultative and obligate wetland vegetation associated with soils that are frequently saturated. Changes in vegetation density and levels of greening were also considered during the delineation process, particularly in instances where terrestrial species dominate the drainage line areas. This indicator was very useful in identifying the boundary of the temporary zone.
- Saturated soils were only present in a portion of Drainage Line A and thus was not utilised extensively as an indicator.

Figure 19: Representative photographs of the soil profile in Drainage Line A (left) and Drainage Line B (right) showing the presence of gleying.

After consideration of findings during the wetland assessment, a suitable buffer zone was considered for the proposed WRD. One buffer zone is applicable to this study area, i.e. a 100m buffer in terms of GN704 of the National Water Act (NWA) (1998).

This buffer zone is deemed sufficient to maintain the PES of the drainage line features, limit any further impact the proposed development could have, and to ultimately maintain the REC determined for each drainage line feature as described above. The drainage line boundaries and buffer zones are conceptually presented in Figure 20 below.

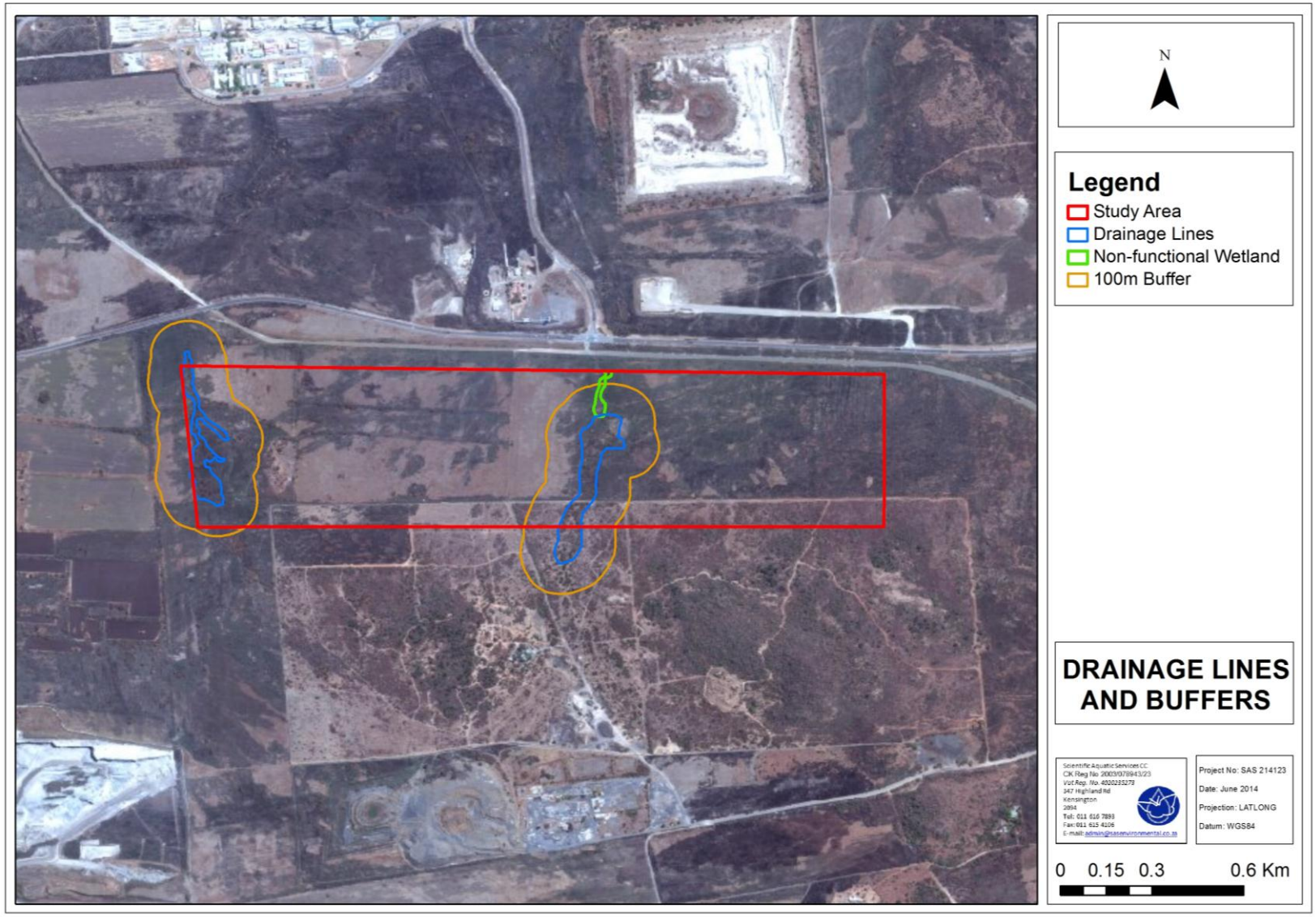

Figure 20: Conceptual representation of the drainage line features present within the study area with associated buffers.

8. SENSITIVITY MAPPING

Areas of increased ecological sensitivity are limited to the drainage line areas and buffer zones as indicated in Figure 20 above. All other areas within the study area are considered to be of low ecological sensitivity.

From the assessment, it is evident that the Transformed Habitat Unit has low ecological sensitivity as a result of current and historic anthropogenic activity in the form of mining and agricultural activities having impacted on the ecological integrity of these areas. The Scattered Bushveld Habitat Unit has been exposed to fewer disturbances than the surrounding Transformed Habitat Unit and still hosts a reasonably high biodiversity and suitable habitat for a number of faunal and floral species, including the protected tree species, *Sclerocarya birrea* subsp *caffra*. These areas are however fragmented and have been impacted by edge effects from agricultural activities, with the habitat type also being locally common. It is however important to note that the entire study area fall into a terrestrial Critical Biodiversity Area (CBA) which is considered important for retaining biodiversity and supporting continued ecosystem functioning and services.

All drainage line areas as included within the Wetland Habitat Unit, are regarded as being of increased ecological sensitivity due to the contribution of the features to faunal migratory connectivity, wetland eco-services provision and the unique habitat provided for faunal and floral species. Taking into account the findings from the wetland assessment and considering the results obtained in calculating the function and ecoservices assessment, WET-Health, and EIS, it was determined that both drainage line features are considered to be of medium EIS.

A 100m buffer zone is indicated around both drainage line (wetland) features as advocated by Regulation GN 704 of the National Water Act, 1998.

9. IMPACT ASSESSMENT

9.1 Impact Assessment Results

The impact tables below serve to summarise the significance of perceived impacts on the biodiversity of the study area. The tables present the impact assessment according to the method described in SAS (2013) and also indicate the mitigation measures required to minimise the impacts. In addition, an assessment of the significance of the perceived impacts is presented, taking into consideration the available mitigating measures assuming that they are fully implemented.

9.1.1 General management and good housekeeping practices

The following essential mitigation measures are considered to be standard best practice measures applicable to development of this nature, and must be implemented during all phases of the proposed WRD development activities, in conjunction with those stipulated in the individual tables in the following sections, which define the mitigatory measures specific to the minimisation of impacts on floral, faunal and wetland resources within the study area.

Development and operational footprint

- It is recommended that the sensitivity map (Figure 20) be considered during all phases of the development and with special mention of the planning of infrastructure to aid in the conservation of important resources within the study area where possible;
- All development footprint areas should remain as small as possible and should not encroach onto surrounding areas beyond the study area. It must be ensured that the drainage line features beyond the study area (as well as rocky outcrops to the south of the study area) are off-limits to construction and operational vehicles and personnel;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Good planning implementation and management of clean and dirty water system separation should take place throughout the life of the operation in line with the regulation of GN704 of the NWA
- Planning of temporary roads and access routes should avoid natural areas and be restricted to existing dirt roads where possible;
- Appropriate sanitary facilities must be provided for the life of the construction and all waste removed to an appropriate waste facility;
- All hazardous chemicals should be stored on bunded surfaces;
- No fires should be permitted in or near the construction area; and

- Ensuring that an adequate number of rubbish and “spill” bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Drainage line habitat

- Ensure that as far as possible all infrastructure is placed outside of drainage line areas and their respective buffer zones, with specific mention of the possibility to retain the drainage line bordering the study area in the west;

Soils

- Sheet runoff from access roads should be slowed down by the strategic placement of berms;
- As far as possible, all construction activities should occur in the low flow season, during the drier winter months; and
- Monitor all areas ouside of the development footprint for erosion and incision.

Rehabilitation

- Rehabilitate all surrounding bushveld habitat areas impacted by the proposed development activities to ensure that the ecology of these areas is re-instated during all phases. This should take place during and upon completion of the construction phase of the development;
- As much vegetation growth as possible should be promoted around the proposed development area in order to protect soils; and
- All alien vegetation in the vicinity of the study area should be removed upon completion of construction and reseeded with indigenous grasses and the strategic placement of indigenous bushveld tree species.

9.1.2 Floral Impacts

Three aspects of floral ecology were considered when assessing the impacts of the proposed mining and related construction activities within the study area, namely impact on floral habitat, impact on floral diversity and impact on important floral species, such as

potential RDL species, protected floral species and medicinal species. The sections below rate the significance of the perceived impacts during the various development phases.

9.1.3 IMPACT 1: Impact on habitat for floral species

Loss of floral habitat within the study area is expected to take place due to the expected extent of the WRD during the construction phase. During the operational phase, this impact will be less significant due to habitat loss occurring during the constrcution phase. However, edge effects form the development may lead to continued loss of floral habitat in the area surrounding the WRD. In addition, seepage and contamination from the operational facilities may take place and continue during the decommissioning and closure phase if not suitably managed.

Aspects and Activities Register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Planning of mine infrastructure placement and design leading to overall loss of floral habitat within areas of increased ecological sensitivity	Site clearing and the removal of vegetation leading to loss of floral habitat	Ongoing disturbance of soils with general operational activities leading to altered floral habitat	Ineffective rehabilitation of exposed and impacted areas and failure to implement an alien floral control plan may lead to ongoing loss of floral habitat
Inadequate design of infrastructure leading to pollution of soils and ground water	Encroachment of construction activities into more sensitive areas within the study area and surrounds could lead to loss of indigenous floral habitat	Increased introduction and proliferation of alien plant species and further transformation of natural habitat due to disturbance during operations	Disturbance of soils as part of demolition activities may alter floral habitat
	Site clearing and the disturbance of soils leading to increased erosion	Discharge and contamination from operational facilities may pollute receiving environment	Ongoing seepage and runoff may affect the groundwater regime beyond closure
	Movement of construction vehicles and access road construction impacting on floral habitat	Seepage affecting soils and the groundwater regime	Ongoing risk of discharge from mining facilities beyond closure
	Dumping of material leading to loss of floral habitat and alien plant species proliferation	Runoff and seepage from operational facilities may lead to habitat loss	Potential contamination from decommissioning of the WRD
	Compaction of soils due to construction activities affecting floral habitat	Ongoing disturbance may lead to erosion and sedimentation	Ineffective rehabilitation of exposed and impacted areas and failure to control alien floral species may lead to ongoing loss of floral habitat

			Insufficient aftercare and maintenance leading to post closure impacts on floral habitat due to poor management

Construction phase	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		5	3	4	2	5	8	11	88 (Medium-High)
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		3	3	3	2	4	6	9	54 (Medium-Low)

Essential mitigation measures for the construction phase:

- Where possible, connectivity between rocky outcrops to the south and drainage line areas should be maintained to allow for faunal and floral species migration and genetic exchange.
- Edge effects of all construction and operational activities, such as erosion and alien plant species proliferation, which may affect floral habitat, need to be strictly managed along the development boundaries.
- It is recommended that the drainage line area in the west of the study area (Drainage line B) and its associated buffer zone be excluded from the development activities.
- All drainage line (wetland) areas beyond the development footprint should be designated as No-Go areas and be off limits to all construction vehicles and personnel. Vehicles should be restricted to travelling only on designated, prefferably existing, roadways to limit the ecological footprint of the proposed development activities.
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration. If possible, such roads should be constructed a distance from the more sensitive drainage line areas and not directly adjacent thereto.
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and stormwater diversion away from areas susceptible to erosion. It must be ensured that topsoil stockpiles are located outside of any drainage lines and areas susceptible to erosion. Stockpiles should be placed away from areas known to contain hazardous substances such as fuel and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site.

Essential mitigation measures for the operational phase:

- All soils compacted as a result of construction activities falling outside of development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas.
- It must be ensured that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones, beyond the development footprint.
- It must be ensured that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- Proliferation of alien and invasive species is expected within any disturbed areas, particularly bordering the development area. These species should be eradicated and controlled to prevent their spread beyond the mine expansion and development footprint areas.
- All disturbed habitat areas must be rehabilitated and planted with indigenous floral species as soon as possible to ensure that floral ecology is re-instated.

Recommended mitigation measures for the construction and operational phases:

- During the construction and operational phases of the proposed mining expansion, erosion berms may be installed to prevent gully formation and siltation of the drainage line resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has a slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10% and 15%, berms every 20m should be installed.
  - Where the track has a slope greater than 15%, berms every 10m should be installed.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		5	3	3	1	5	8	9	72 (Medium-Low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		2	3	2	1	3	5	6	30 (Low)

Probable latent impacts:

- Loss of floral habitat may lead to altered floral biodiversity.
- Permanent loss of floral habitat may take place.
- Long term presence of alien floral species may occur and extend beyond the development footprint area.

9.1.4 IMPACT 2: Impact on floral diversity

The proposed WRD development may lead to a loss of floral diversity within the area during the construction phase through clearing of the study area and vegetation removal. During the operational phase, this potential impact will have a lowered siginificance level, although loss of species diversity may continue in the surrounding area due to edge effects taking place.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning of mine infrastructure placement and design leading to overall loss of floral species	Site clearance and removal of vegetation leading to a loss of species diversity	An increase in alien plant species leading to altered plant community structure and composition	New disturbances during decommissioning and closure
Inadequate design of infrastructure leading to pollution of soils and ground water which may lead to a decrease in plant species diversity	Construction of infrastructure and access roads through more sensitive drainage line areas leading to a loss of plant species diversity	Erosion and sedimentation as a result of operational activities leading to a loss of floral species diversity	Ineffective rehabilitation of exposed and impacted areas and failure to implement alien floral control leading to ongoing loss of floral biodiversity
	Proliferation of alien species may alter plant community structure and lead to a loss of floral species diversity.	Ongoing edge effects such as alien species proliferation and erosion from mining operations impacting on plant species diversity	Erosion and sedimentation as a result of closure and decommissioning activities leading to a loss of species diversity
	Soil compaction as a result of construction activities may alter plant community structure and composition	Increased vehicular and pedestrian movement may lead to loss of floral species	Failure to monitor rehabilitation efforts and implement an alien floral control plan
	Heavy vehicle movement through more sensitive drainage line areas impacting on floral biodiversity		Increased fire frequency and intensity, as well as uncontrolled fires during closure and decommissioning impacting on floral communities

	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact on plant communities		
	Potential blasting and drilling during the construction phase will lead to an increase in dust, which may alter floral community structure and composition		

Construction phase	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		5	3	3	1	5	8	9	72 (Medium-Low)
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		3	3	3	2	4	6	9	54 (Medium-Low)

Essential mitigation measures for the construction phase:

- Removal of the alien and weed species encountered within the study area must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout all development phases.
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used.
  - Footprint areas should be kept as small as possible when removing alien plant species.
  - No vehicles should be allowed to drive through designated sensitive drainage line areas during the eradication of alien and weed species.
  - Informal fires in the vicinity of mining areas should be prohibited during all development phases.

Essential mitigation measures in the operational phase:

- All soils compacted as a result of construction activities falling outside of development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all development including decommissioning phases to prevent loss of floral habitat.
- All disturbed habitat areas must be rehabilitated and planted with indigenous floral species as soon as possible to ensure that floral ecology is re-instated.

Recommended mitigation measures for the construction and operational phases:

- It must be ensured that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss into waterways and drainage lines in the vicinity of the study area.
- The local communities residing within and in the vicinity of the study area, as well as mining and construction personnel, should be informed about fire control and prevention measures to reduce the frequency of uncontrolled veld fires in areas surrounding the study area.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		4	3	2	1	3	7	6	42 (Low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		2	3	2	1	3	5	6	30 (Low)

Probable latent impacts:

- Loss of floral habitat may lead to altered floral biodiversity.
- A decrease in floral species diversity may occur in the vicinity of the study area due to habitat transformation as a result of development activities.
- Ineffective rehabilitation may lead to permanent loss of floral biodiversity.

9.1.5 IMPACT 3: Impact on important (RDL, protected and medicinal) floral species

A number of floral species occurring within the study area are protected under various national and provincial acts. Development of the proposed WRD will lead to direct loss of these species, if not mitigated. During the operational phase, the significance of this impact will be lower, provided that edge effects from the proposed development are lowered.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Planning of infrastructure placement and design leading to overall loss of important (medicinal, protected and potential RDL) floral species	Site clearance and removal of vegetation leading to a loss of medicinal, protected and potential RDL floral species	An increase in alien plant species leading to loss of medicinal, protected and potential RDL floral species by outcompeting these species	Ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien floral control plan leading to ongoing loss of medicinal, protected and potential RDL floral
Inadequate design of infrastructure leading to pollution of soils and ground water which may lead to a loss of important plant species	Construction of infrastructure and access roads through drainage lines, rocky outcrops and other more natural areas leading to a loss of important plant species	Erosion and sedimentation as a result of operational activities leading to a loss of important plant species	Continued erosion and sedimentation during closure and decommissioning leading to a loss of important plant species
	Vehicles accessing site through natural veld and more sensitive drainage line and rocky outcrop areas to the south	Ongoing edge effects from developed areas on surrounding more natural areas leading to impacts on important species that have been left *in situ*	

	Poor control of vehicular movement and management of edge effects leading to impacts on protected floral species left *in situ*		

Construction phase	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		5	3	4	3	5	8	12	96 (Medium-High)
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		3	3	3	2	5	6	10	60 (Medium-Low)

Essential mitigation measures for the construction phase:

- RDL and protected floral species, if discovered, are to be handled with care and the relocation of such plant species is to be overseen by a botanist.
- Prior to development, the study area should be searched for *Crinum* sp., *Hypoxis hemerocallidea*, *Boophane disticha* and *Gladiolus* sp. This search and resue operation must take place during the summer months. Such specimens should be relocated to similar suitable habitat within or in the vicinity of the Tharisa Mine, within areas earmarked for conservation such as wetland buffer areas.
- Should any RDL or other protected plant species be encountered within the proposed development footprint areas, the following should be ensured:
  - If any threatened species, or nationally or provincially protected floral will be disturbed, ensure effective relocation of individuals to suitable similar habitat.
  - All rescue and relocation plans should be overseen by a suitably qualified specialist.
  - In the case of *Sclerocarya birrea* subsp. *caffra*, two new Marula trees are to be planted in suitable habitat within areas earmarked for conservation in the vicnity of Tharisa Mine, for each tree destroyed should relocation be unsuccessful. Where these trees fall within the development footprint or will be affected by closure and decommissioning activities, special authorisation is to be obtained from relevant authorities for such trees to be cut, disturbed, damaged or destroyed. Applications for such activities should be made to the responsible official within the North-West Province.

Essential mitigation measures in the operational phase:

- It must be ensured that no RDL or protected floral species present beyond the development footprint are impacted by edge effects from the development. In this regard the development footprint must be kept as small as possible.

Recommended mitigation measures in the construction phase:

- Any specimens of the protected tree species, *Sclerocarya birrea* subsp. *caffra*, known to occur within areas in close proximity and potentially impacted by the proposed mine expansion activities, such species are to be fenced for the duration of the activities.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		3	3	3	2	5	6	10	60 (Medium-Low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		1	3	3	1	5	4	9	36 (Low)

Probable latent impacts:

- A decrease in potential RDL/ protected floral species diversity may lead to a loss of species richness over time within the region.

9.1.6 Faunal Impacts

Three aspects of faunal ecology were considered when assessing the impacts of the proposed mining and related construction activities within the study area, namely impact on faunal habitat, impact on faunal diversity and impact on important faunal species, such as potential RDL species. The sections below rate the significance of the perceived impacts during the various development phases.

9.1.7 IMPACT 4: Impact on faunal habitat

Loss of faunal habitat within the study area is expected to take place during the construction phase. During the operational phase, this impact will however be less significant and have a lower probability due to habitat loss occurring during the construction phase. However, edge effects form the development may lead to continued loss of faunal habitat in the area surrounding the WRD.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Poor planning leading to the placement of new mining infrastructure within sensitive faunal habitat areas with special mention of drainage line areas which have a higher biodiversity capacity	Site clearing, the removal of vegetation and blasting of rocky areas leading to faunal habitat loss	On-going disturbance of faunal habitat due to general mining operational activities	Disturbance of faunal habitat as part of demolition and closure activities
Inadequate design of infrastructure leading to faunal food source decline	Construction of infrastructure within potential migratory corridors which changes faunal behavioural patterns and leads to loss of faunal habitat	Increased introduction of alien floral species due to disturbance and further transformation of natural faunal habitat	On-going risk of seepage into the groundwater system beyond closure
Inadequate design of infrastructure leading to changes in faunal habitat	Construction of access and haul roads within areas of increased ecological sensitivity	Risk of discharge and spillages from all operational facilities which may pollute the receiving environment	On-going risk of discharge and spillages beyond closure
	Fire hazards leading to a loss of faunal habitat	Runoff from the WRD may pollute natural faunal water supplies	Insufficient aftercare and maintenance leading to post closure impacts on faunal habitat due to poor management
		Fire hazards leading to a loss of faunal habitat	Ineffective and insufficient rehabilitation of disturbed faunal habitat areas leading to a permanent loss of faunal habitat

		Erosion and sedimentation as a result of infrastructure development affecting faunal habitat	Permanent presence of alien plant species leading to further transformation of natural faunal habitat

Construction phase	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		5	3	4	2	5	8	11	88 (Medium-High)
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		3	3	3	2	4	6	9	54 (Medium-Low)

Essential mitigation measures for the construction phase:

- In order to ensure continued faunal migration, it is recommended that Drainage line B in the west of hte study area be excluded from the proposed development activities.
- All areas of increased ecological sensitivity beyond the development footprint area should be designated as No-Go areas and be off limits to all constrcution vehicles and personnel. Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.

Essential mitigation measures in the operational phase:

- Edge effects of all construction and operational activities, such as erosion and alien plant species proliferation, which may affect faunal habitat, need to be strictly managed in all areas of increased ecological sensitivity.
- It must be ensured that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones.
- It must be ensured that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- All soils compacted as a result of construction activities falling outside development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout the all phases of the development and during closure/decommissioning.
- All disturbed habitat areas must be rehabilitated and planted with indigenous floral species as soon as possible to ensure that faunal ecology is re-instated.

Recommended mitigation measures for the construction phase:

- Demarcation of sensitive habitats to the south of the study area in particular, may be considered.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		5	3	3	1	5	8	9	72 (Medium-Low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		2	3	2	1	3	5	6	30 (Low)

Probable latent impacts:

- Permanent loss of faunal habitat within areas where mine residue deposits will remain.

9.1.8 IMPACT 5: Impact on faunal diversity

The proposed WRD development may lead to a loss of faunal diversity within the area during the construction phase due to loss of faunal habitat. During the operational phase, this

potential impact will have a lowered siginificance level, although loss of species diversity may continue in the surrounding area due to continued edge effects and continues loss of faunal habitat taking place.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Design and placement of infrastructure leading to a decline in faunal diversity	Disturbance within the study area leading to a decline in faunal diversity	On-going operations and construction of infrastructure leading to migratory corridor alterations which alter faunal behavioural patterns and over all biodiversity	Insufficient aftercare and maintenance leading to post closure impacts on faunal diversity due to poor management and rehabilitation of faunal habitat
Loss of suitable faunal habitat and migratory areas leading to a decrease in faunal biodiversity	Collision of construction vehicles with faunal species	A decline in faunal diversity due to operational activities	Disturbance of faunal habitat as part of demolition and closure activities
	Vehicles accessing site through sensitive faunal habitat areas, with special mention of drainage line areas	Collision of operational vehicles with faunal species	Ineffective monitoring of rehabilitation due to poor management
	Poaching of faunal species due to increased human activity on site	Vehicles accessing site through sensitive faunal habitat areas, with special mention of drainage line areas	Ineffective and insufficient rehabilitation of disturbed faunal habitat areas leading to loss of faunal diversity
	Construction of infrastructure leading to migratory corridor alterations which alter faunal behavioural patterns and overall biodiversity	Poaching of faunal species due to increased human activity on site	

Construction phase	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		5	3	3	1	5	8	9	72 (Medium-Low)
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		3	3	3	2	4	6	9	54 (Medium-Low)

Essential mitigation measures for the construction phase:

- All informal fires in the vicinity of the proposed WRD development should be prohibited.
- No trapping or hunting of fauna is to take place and access control into sensitive areas beyond the study area must be implemented to ensure that no illegal trapping or poaching takes place.
- It is recommended that a speed limit of 40km/h is implemented on all roads in the vicnity of the study area in order to minimise risk to RDL and other fauna from vehicles. Speed humps should be constructed to help slow vehicles and help mitigate collision with faunal species.

Essential mitigation measures in the operational phase:

- No trapping or hunting of fauna may take place.

- It must be ensured that migratory connectivity between drainage line (wetland) areas and rocky outcrops is maintained where possible.
- All faunal habitat areas, where disturbed, are to be rehabilitated to ensure that faunal ecology is re-instated upon completion of construction works.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		3	3	3	1	4	6	8	48 (Low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		2	3	2	1	3	5	6	30 (Low)

Probable latent impacts:

- A decrease in faunal species diversity may lead to loss of species richness over time.

9.1.9 IMPACT 6: Impact on important faunal species

A number of potential RDL avifaunal species may occasionally utilise the study area for foraging purposes. Development of the proposed WRD is unlikely to lead to the direct loss of these species, due to it being considered improbable that such species will utilise the study area for breeding habitat. In addition, due to the high mobility of avifaunal species, such species are expected to move away from a disturbance. During the operational phase, high noise and dust levels are expected to further prevent such species from utilising the study area.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Removal of indigenous vegetation leading to loss of potential RDL faunal species	Site clearing and the removal of vegetation leading to the loss of potential RDL faunal species	Continuous disturbance and transformation of habitat for potential RDL faunal species during the operational phase of the proposed development	Ineffective rehabilitation and monitoring leading to latent impacts
Loss of suitable RDL faunal habitat and migratory areas due to poor planning leading to a decrease in potential RDL faunal biodiversity and occurrence	Increased poaching risk of potential RDL faunal species and fire hazards due to increased human activity on site impacting on such species	Increased poaching risk of potential RDL faunal species and fire hazards due to increased human activity on site impacting on such species	Disturbance of faunal habitat as part of decommissioning and closure activities leading to loss of potential RDL faunal species
	Vehicles accessing site through sensitive habitat areas, with specific reference to drainage line areas	A decline in potential RDL faunal diversity due to operational activities extending into areas of increased ecological importance	Loss of faunal habitat and RDL faunal biodiversity due to poor rehabilitation planning

Pre-Construction	Construction	Operational	Decommissioning and Closure
	Direct impact on potential RDL faunal species as a result of construction activities	Operational vehicles accessing site through sensitive faunal habitat which may potentially host RDL faunal species, including more mobile avifaunal species	Ineffective and insufficient rehabilitation of disturbed faunal habitat areas leading to permanent loss of potential RDL faunal species and habitat
	Loss of potential RDL faunal biodiversity due to habitat loss and a decrease in food supply	Vehicles accessing site through sensitive potential RDL faunal habitat areas	
	Collision of construction vehicles with potential RDL faunal species		

Construction phase	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		3	3	4	3	4	6	11	66 (Medium-low)
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		2	3	3	3	3	5	9	45 (Low)

Essential mitigation measures for the construction phase:

- No trapping or hunting of fauna is to take place.
- All areas of increased ecological sensitivity in the vicinity of the study area should be off limits to all construction vehicles and personnel.
- Should any RDL species be noted within the study area, these species should be relocated to similar habitat within or in the vicinity of the study area with the assistance of a suitably qualified specialist.
- It must be ensured that migratory connectivity between drainage line (wetland) areas and rocky outcrops is maintained where possible.

Essential mitigation measures in the operational phase:

- All faunal habitat areas, where disturbed, are to be rehabilitated to ensure that faunal ecology is re-instated upon completion of construction works.

Recommended mitigation measures for the construction phase:

- Education and awareness campaigns on faunal species and their habitat are recommended to help increase awareness, respect and responsibility towards the environment for all staff and contractors.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
		2	3	3	2	3	5	8	40 (Low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
		2	3	3	2	2	5	7	35 (Low)

Probable latent impacts:

- A decrease in potential RDL faunal species diversity may lead to loss of species richness over time.

9.1.10 Wetland Impacts

Three aspects of wetland ecology were considered when assessing the impacts of the proposed mining and related construction activities, namely loss of wetland habitat and ecological structure, changes to wetland ecological and sociocultural service provision, and wetland hydrological function and sediment balance.

9.1.11 IMPACT 7: Loss of wetland habitat and ecological structure

The proposed development of a WRD within the study area has significant potential to lead to loss of niche habitat and/or alteration of the drainage line (wetland) resources on the study area. Due to the nature of the proposed use of the study area, it is likely that it would be difficult to rehabilitate the drainage line habitats to resemble those presently within the study area. It is therefore important to ensure that mitigation takes place in order to limit the impact of perceived habitat loss resulting from the activity and also to ensure that wetland beyind the study area are not affected by the development activities. Since the construction of a WRD will result in the total loss of the drainage line habitat, impacts associated with the construction and operational activities are focused on. The latter is deemed especially important in the context of mining activities, as impaired water quality due to the discharge of pollutants from runoff in stockpiles and petrochemical spills are considered to be likely impacts on the wetland ecology of the study area.

The hydrological function and sediment balance of the drainage lines, particularly beyond the development footprint are also likely to be impacted by the construction activities. In the present state of the study area, vegetation cover reduces flow velocities which in turn limit erosion and sedimentation of the drainage lines.

Aspects and Activities Register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Planning of infrastructure within drainage line areas leading to increased footprint within these areas and subsequent habitat loss	Site clearing, removal of vegetation and related disturbances to soils, leading to increased runoff and erosion	Sedimentation due to erosion from the activities associated with the development	Disturbance of soils as part of demolition activities, leading to proliferation of alien vegetation
Inadequate design of infrastructure leading to risks of pollution	Earthworks in the vicinity of drainage line areas leading to increased runoff and erosion and altered runoff patterns	Erosion and sedimentation of drainage lines leading to loss of wetland habitat	Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure

	Construction activities within drainage lines leading to desiccation of downgradient areas	Alteration of drainage line vegetation community structures	Ongoing risk of discharge from mining infrastructure beyond closure
	Dumping of construction material within drainage line areas and the compaction of these soils	Loss of stream connectivity and migratory connectivity	Potential contamination from the decommissioning of mining infrastructure
	Potential contamination of soil and water, from the fuel of construction vehicles	Ongoing disturbance as a result of operational and maintenance activities, leading to altered drainage line vegetation community structures	Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure
	Movement of construction vehicles within wetlands, leading to disturbed soil profiles and subsequent increased risk of erosion		Decommissioning activities may lead to wetland habitat transformation and alien plant species proliferation
	Dumping of hazardous and non-hazardous waste, including waste material spills into the drainage line areas		Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment

Construction phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
	DL A	**5**	**3**	**4**	**2**	**5**	**8**	**11**	**88 (Medium-high)**
	DL B	**5**	**3**	**4**	**2**	**5**	**8**	**11**	**88 (Medium-high)**
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
	DL A	**5**	**3**	**2**	**2**	**5**	**8**	**9**	**72 (Medium-low)**
	DL B	**5**	**3**	**2**	**2**	**5**	**8**	**9**	**72 (Medium-low**

Essential mitigation measures for the construction phase:

- Ensure that the design of the infrastructure prevents failure.
- Avoide placement of the WRD within wetlands and associated buffers
- Clear well designed, constructed and managed clean and dirty water separation and management systems are to be implemented as paert of the project and for the life of the project.

Recommended mitigation measures for the construction phase:

- Restrict construction to the drier months if possible to reduce levels of sedimentation entering aquatic or wetland systems in the vicinity of the study area.

Essential mitigation measures in the operational phase:

- Ensure that clean and dirty water management sysems are being maintained at all times.
- It must be ensured that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones, beyond the development footprint.
- It must be ensured that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- Implement regular monitoring programme to monitor water seepage volumes and quality.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	DL A	5	3	3	1	4	8	8	64 (Medium-low)
	DL B	5	3	3	1	4	8	8	64 (Medium-low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
	DL A	4	3	3	1	4	7	8	56 (Medium-low)
	DL B	4	3	3	1	4	7	8	56 (Medium-low)

Probable latent impacts:

- Changes in wetland resource PES.
- Sedimentation of surrounding wetland systems may lead to altered wetland habitat and vegetation structure.

9.1.12 IMPACT 8: Changes to wetland ecological and sociocultural service provision

Loss of wetland ecoservices and functionality provided by the drainage line features, such as stream flow regulation, sediment trapping, nutrient cycling and chemical assimilation abilities may result from construction related activities. Changes to ground water quality, increased sediment and alteration of natural hydrological regimes may arise as a result of the impacts of construction and operational activities, further reducing the ability of the drainage line features to support biodiversity. The direct disturbance of the drainage line features will have a negative impact on the function and service provision of the features. Due to the permanent nature of the impacts during the construction phase, the impacts associated with the operational phase are not considered as severe.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Placement of infrastructure within the drainage line areas leading to loss of habitat, affecting the eco-service provision and functions of the features	Site clearing, removal of vegetation and associated disturbances to soils leading to increased runoff and erosion	Ongoing disturbance of soils with general operational activities	Disturbance of soils as part of demolition activities
Inadequate design of infrastructure leading to increased risk of pollution of ground water	Earthworks in the vicinity of wetland areas leading to increased runoff and erosion and altered runoff patterns	Spillages and seepage of hazardous waste material into the groundwater	Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure

Pre-Construction	Construction	Operational	Decommissioning & Closure
	Dumping of hazardous and non-hazardous waste into the drainage line areas leading to contamination of ground water	Risk of dischargeand potential contamination of ground water from the mining infrastructure	Ongoing risk of discharge from mining infrastructure beyond closure
	Waste material spills and waste refuse deposits into the drainage line areas leading to contamination of	Runoff, seepage and potential discharge from the waste rock dump	Potential contamination from the decommissioning of the plant and mining infrastructure
	Loss of drainage line habitat as a result of construction activities, particularly edge effects of erosion and sedimentation		Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure
			Decommissioning activities may lead to alien plant species proliferation
			Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment

Construction phase	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	DL A	5	3	4	2	5	8	11	88 (Medium-high)
	DL B	5	3	4	2	5	8	11	88 (Medium-high)
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
	DL A	5	3	3	2	5	8	10	80 (Medium-high)
	DL B	5	3	3	2	5	8	10	80 (Medium-high)

Essential mitigation measures for the construction phase:

- Ensure that the design of the infrastructure prevents failure;
- The WRD facility should be suitably lined to prevent seepage.

Recommended mitigation measures for the construction phase:

- Restrict construction to the drier months to prevent increased sediment loads entering wetland and/or aquatic systems in the vicinity of the study area.

Essential mitigation measures in the operational phase:

- Ensure that the WRD is functioning correctly at all times.
- It must be ensured that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones, beyond the development footprint.
- It must be ensured that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- Implement regular monitoring programme to monitor water seepage volumes and quality.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	DL A	5	3	3	1	4	8	8	64 (Medium-low)
	DL B	5	3	3	1	4	8	8	64 (Medium-low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
	DL A	5	3	2	1	4	8	7	56 (Medium-low)
	DL B	5	3	2	1	4	8	7	56 (Medium-low)

Probable latent impacts

- Loss of drainage line (wetland) habitat.
- Sedimentation of the system may lead to altered wetland habitat and vegetation structure in the vicinity.
- Some changes to the hydrology of the system may occur altering instream habitats on a localised scale.

9.1.13 IMPACT 9: Impacts on wetland hydrological function

During construction site clearing the removal of vegetation will result in an increase in runoff from disturbed areas and an increase in the erosion and incision of the drainage line areas. An increase in runoff from these disturbed areas may also alter flow patterns resulting in the inundation of water systems in the vicinity of the study area. In addition, sediment deposition as a result of the disturbance of soils and increased sediment runoff during the construction of the infrastructure may result in an impact on the sediment balance of the features. Prior to mitigation, the hydrology and sediment balance of the wetland features affected by the proposed development may be significantly altered as a result of construction related activities and will continue to be significantly affected throughout the operational phase of the structure.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning & Closure
Placement of infrastructure within the drainage line areas, leading to changes in hydrological function and sediment control capacity	Site clearing, removal of vegetation and associated disturbances to the soil profile, leading to increased runoff, erosion and siltation	Ongoing disturbance of soils with general operational activities	Disturbance of soils as part of demolition activities
	Altered runoff patterns, increased runoff and erosion due to earthworks in the vicinity of the drainage line areas.	Earthworks in the vicinity of wetland areas leading to increased runoff and erosion and altered runoff patterns	Earthworks in the vicinity of drainage line areas leading to increased runoff and erosion and altered runoff patterns

Pre-Construction	Construction	Operational	Decommissioning & Closure
	Topsoil stockpiling adjacent to drainage lines and runoff form stockpiles leading to sedimentation of the system	Topsoil stockpiling adjacent to wetlands and runoff form stockpiles leading to sedimentation of the system	Movement of construction vehicles leading to altered soil profiles and proliferation of alien vegetation, resulting in increased on-site water
	Movement of construction vehicles within the drainage lines resulting in altered soil profiles and dessication of the features	Altered hydrology in the area as a result of increased runoff from waste rock dump	
	Altered hydrology and dewatering due to the removal of the drainage line features	Increased runoff volumes due to increased paved and other impervious surfaces	
	Increased runoff volumes due to increased paved and other impervious surfaces		

Construction phase	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	DL A	5	3	4	2	5	8	11	88 (Medium-high)
	DL B	5	3	4	2	5	8	11	88 (Medium-high)
Operational phase	**Unmanaged**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
	DL A	5	3	3	2	5	8	10	80 (Medium-high)
	DL B	5	3	3	2	5	8	10	80 (Medium-high)

Essential mitigation measures for the construction phase:

- Ensure that the design of the infrastructure prevents failure.
- Avoide placement of the WRD within wetlands and associated buffers, where possible.
- Clear well designed, constructed and managed clean and dirty water separation and management systems are to be implemented as part of the project and for the life of the project.

Recommended mitigation measures for the construction phase:

- Restrict construction to the drier months if possible to reduce the sedimentation load entering the catchment.

Essential mitigation measures in the operational phase:

- Ensure that the clean and dirty water separation infrastructure is functionining at all times.
- It must be ensured that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones, beyond the development footprint.
- It must be ensured that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- Implement regular monitoring programme to monitor water seepage volumes and quality.

Construction phase	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	DL A	5	3	3	1	4	8	8	64 (Medium-low)
	DL B	5	3	3	1	4	8	8	64 (Medium-low)
Operational phase	**Managed**	**Probability of Impact**	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
	DL A	5	3	2	1	4	8	7	56 (Medium-low)
	DL B	5	3	2	1	4	8	7	56 (Medium-low)

Probable latent impacts

- Loss of drainage line (wetland) habitat.
- Sedimentation of the system may lead to altered wetland habitat and vegetation structure within the catchment.
- Some changes to the hydrology of the system (catchment) may occur, altering instream habitats on a localised scale.

9.2 Impact Assessment Conclusion

Based on the above impact assessment it is evident that there area number of possible impacts on the floral, faunal and wetland ecology within the study area. The tables below summarise the findings, indicating the significance of the impacts before management takes place and the likely impact if management and mitigation takes place during both the construction and operational phases of the development. From these tables it is evident that after mitigation, all potential impact significance rating may be reduced.

Table 23: A summary of the results obtained from the impact assessment of construction related activities on floral ecological aspects.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-High	Medium-Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on important floral species	Medium-High	Medium-Low

Table 24: A summary of the results obtained from the impact assessment of operational related activities on floral ecological aspects.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-Low	Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on important floral species	Medium-Low	Low

Table 25: A summary of the results obtained from the impact assessment of construction related activities on faunal ecological aspects.

Impact	Unmanaged	Managed
1: Impact on faunal habitat and ecological structure	Medium-High	Medium-Low
2: Impact on faunal diversity and ecological integrity	Medium-Low	Low

3: Impact on potential RDL faunal species	Medium-Low	Low

Table 26: A summary of the results obtained from the impact assessment of operational related activities on faunal ecological aspects.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-Low	Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on important floral species	Low	Low

Table 27: A summary of the results obtained from the impact assessment of construction related activities on wetland ecological aspects.

Impact	Drainage Line	Unmanaged	Managed
1: Loss of wetland habitat and ecological structure	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low
2: Changes to wetland ecological and socio-cultural service provision	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low
3: Impacts on wetland hydrological function and sediment balance	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low

Table 28: A summary of the results obtained from the impact assessment of operational related activities on wetland ecological aspects.

Impact	Management Unit	Unmanaged	Managed
1: Loss of wetland habitat and ecological structure	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low
2: Changes to wetland ecological and socio-cultural service provision	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low
3: Impacts on wetland hydrological function and sediment balance	DL A	Medium-high	Medium-low
	DL B	Medium-high	Medium-low

10. CONCLUSION

The following main conclusions have been drawn upon completion of this ecological assessment:

FLORA

- Three habitat units were identified during the assessment namely the Transformed Habitat Unit, the Scattered Bushveld Habitat Unit and the Wetland Habitat Unit;
- Of the three habitat units identified, the Wetland Habitat Unit is considered to be of to be of increased ecological sensitivity due to the contribution of the drainage line features to faunal migratory connectivity, wetland eco-services provision and the niche habitat provided for faunal and floral species, specifically within the areas with surface water;

- *Crinum* sp. was encountered on site, but it was not possible to accurately identifiy the exact species due to the plants having no flowers and the leaves turning brown at the time of assessment. Floral species protected under the Transvaal Nature Conservation Ordinance (No 12 of 1983) therfore include *Crinum* sp and also *Gladiolus* spp., both which occur throughout the study area, mainly within the Wetland Habitat Unit;
- One individual of a tree species protected under the National Forests Act (Act 84 of 1998), namely *Sclerocarya birrea* subsp *caffra* (Marula) was encountered within the Scattered Bushveld Habitat Unit;
- Four Red Data Listed (RDL) floral species are known to occur in the QDS 2527DA. None of these RDL floral species were observed during the site assessment and it is considered unlikely that these species will occur within the study area. Although not listed for the QDS, three floral species, listed by the South African National Biodiversity Institue (SANBI) as 'Declining' namely *Boophane disticha*, *Hypoxis hemerocallidae* and *Crinum macowanii*, may however occur in the study area.

FAUNA

- High levels of anthropogenic activity including agricultural and quarrying activity within the study area and surrounding area have led to high levels of transformation of natural faunal habitat throughout the majority of the study area;
- The Wetland Habitat Unit (as well as the Rocky Outcrop Habitat Unit to the south of the study area) provides improved faunal habitat and food resources for a variety of faunal species;
- No RDL mammals were observed during the site survey. In terms of conservation, the likelihood that any threatened RDL mammal species will be encountered within the study area is considered low, with the RDSIS calculated at 34%. RDL species that have a POC of utilising the study area for foraging purposes, is restricted to avifaunal species.

WETLANDS

- Two non-perennial drainage line features were identified within the study area;
- Drainage Line A, comprising an unchannelled valley bottom wetland feature, is located within the centre of the study area, while Drainage line B, comprising a channelled valley bottom wetland feature borders the study area in the west;
- In terms of wetland service provision, Drainage Line A obtained an ecological service provision score of 1.2 (moderately low), and Drainage line B obtained an overall ecological service provision score of 1.1, which also places this wetland in a moderately low class;

- The overall WET-Health score for Drainage Line A was calculated as 2.5, indicating this wetland to fall within Category C (A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact), while the WET-Health score for Drainage line B was 1.3, which places the PES category of this feature in Category B (A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place);
- In terms of Ecological Importance and Sensitivity (EIS), both features have been determined to fall in an EIS Category C. This implies that the features are ecologically important on a localised scale, but not necessarily within the greater catchment area, and are not considered to be very sensitive to changes;
- Wetlands were delineated using the wetland indicators as defined by the DWA guideline leading to the production a map depicting the extent of wetland resoruces in the vicinity of the proipsoed development;
- After consideration of findings during the wetland assessment, a suitable buffer zone was considered for the proposed WRD. One buffer zone is applicable to this study area, i.e. a 100m buffer in terms of GN704 of the National Water Act (NWA) (1998).

IMPACT ASSESSMENT

- From the results of the impact assessment, it was found that if effective management and mitigation takes place, all potential impacts on the ecology of the area may be reduced during both the construction and operational phases of the development.

All essential mitigation measures as listed in Section 9 of this report must be adhered to, with emphasis on the following:

- It is recommended that Drainage Line B, within the west of the study area, together with the 100m buffer area, be excluded from the development if possible;
- Clear, well designed, constructed and managed clean and dirty water separation and management systems are to be implemented as part of the project and for the life of the project;
- Impacts from the proposed development on the drainage lines and wetland areas beyond the development footprint area as well as the rocky outcrop areas to the south of the study area (falling outside of the development area) should be prevented by managing edge effects such as erosion and alien vegetation encroachment during all development phases.

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Appendix A

Vegetation Index Score

Vegetation Index Score – Transformed Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score				X		
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score						X
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								X
Clumped		X		X	X			
Scattered	X		X			X	X	
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %				X		
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

4. *RIS*

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
	X					
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] = 5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

Vegetation Index Score - Wetland Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score					X	
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score			X			
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								
Clumped		X	X	X		X		X
Scattered	X				X		X	
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

4. *RIS*

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
				X		
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] = 15

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

Vegetation Index Score – Scattered Bushveld Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score					X	X
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score				X		
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous	X	X						
Clumped			X	X	X	X	X	X
Scattered								
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %		X				
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %		X				
PVC Score	0	1	2	3	4	5

4. *RIS*

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
						X
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] = 18

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely