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TERRESTRIAL, AQUATIC AND WETLAND ECOLOGICAL STUDIES TO INFORM THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED UNIKA WIND FARM DEVELOPMENT IN THE EASTERN PROVINCE OF ZAMBIA

Prepared for

SLR Consulting

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Section B: Floral Assessment

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ACRONYMS

CR	Critically Endangered
EIS	Ecological Importance and Sensitivity
EN	Endangered
ESHIA	Environmental Social and Health Impact Assessment
ESHMP	Environmental Social and Health Management Plan
EW	Extinct in the Wild
GIS	Geographic Information System
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature and Natural Resources
LC	Least Concern
NT	Near Threatened
PES	Present Ecological State
POC	Probability of Occurrence
RE	Regionally Extinct
SCC	Species of Conservation Concern
STS	Scientific Terrestrial Services
VU	Vulnerable

1 INTRODUCTION

1.1 Background

Scientific Terrestrial Services (STS) was appointed to conduct faunal and floral ecological assessments as part of the Environmental and Social Impact Assessment (ESIA) process for the proposed Unika Wind Farm in Eastern Zambia, henceforth referred to as the "study area". The study area is situated approximately 800m from the T4 (Great East Road) highway. The study area spans an area of approximately 35,000 ha, and encompasses the villages of Gomani, Chibela, Mbangombe and Kachingwe.

This report aims to map, consider and describe the floristic assemblages associated with the study area according to data gathered during the summer survey conducted over a four day period in February 2019. In doing so this report must guide the proponent, Environmental Assessment Practitioner (EAP) and regulating authorities, by means of the presentation of information on the baseline conditions, as to the management of the proposed project from an ecological risk management point of view as well as provide mitigation and management measures to manage potential and existing impacts.

2 ASSESSMENT APPROACH

Initially, a desktop study was undertaken to gather background information regarding the site and its surrounding areas. This involved consulting maps, aerial photographs and digital satellite images in order to determine broad habitats and sensitive sites; a literature review concerning habitats, vegetation types, floral species distributions and identifying the status of the land as well as conservation requirements and nearby conservation and protected areas. Following this, a summer field assessment was undertaken during which the data gathered during the desktop assessment phase was utilised to confirm the presence of potentially sensitive habitats and compile floral species inventories for each habitat unit. The species lists include potential floral Species of Conservation Concern (SCC), alien and invasive floral species as well as medicinal species. Detailed explanations of the floral methods of assessment are provided in Appendix A of this report.

2.1 Sensitivity Mapping

All the ecological features of the study area were considered, and sensitive areas were delineated with the use of a Global Positioning System (GPS) to augment the mapping of the

features undertaken from aerial photography. A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of proposed future activities. Due to access constraints and the extent of the study area, extrapolation for the extents of the features was undertaken by comparing “ground-truthed” data to Google Earth satellite imagery, in order to map features across the study area.

3 RESULTS OF THE FLORAL ASSESSMENTS

During the field assessment, a number of habitat units were identified. These habitat units are:

- Degraded Forest Habitat, comprising several forest tree species, where trees exceeded 8m in height with large predominantly interlinking canopies. This habitat unit was observed primarily in the upper reaches of the large inselbergs and central mountainous areas of the study area This habitat however is continually being impacted upon and decreasing due to the harvesting of timber for charcoal production, leading to the encroachment of miombo woodland species;
- Degraded Miombo Woodland Habitat, the dominant vegetation type within the study area and that of southern Zambia. The characteristics of this habitat unit were varied, with some of the more degraded areas being noted to have fewer characteristic/typical miombo floral species. The woodlands typically comprised trees varying between 4 – 8m in height but without densely interlocking canopies;
- Freshwater Habitat, comprising streams and dambos (wetlands). This habitat unit has been notably impacted upon as a result of vegetation clearance for agriculture (grazing and crop cultivation). The dambos and streams convey large amounts of water through the study area, however the large-scale removal of vegetation has resulted in increased peak water flows leading to erosion within the dambos and that of the stream banks; and
- Transformed habitat, associated with cultivated fields and areas where vegetation has been cleared in order to provide increased grazing for livestock, both in association with the areas surrounding the villages and at some distance from villages where new fields are being cleared.

These habitat units are described in the sections below. The methodology for calculating the floral habitat sensitivity of each habitat unit is presented in Appendix A.

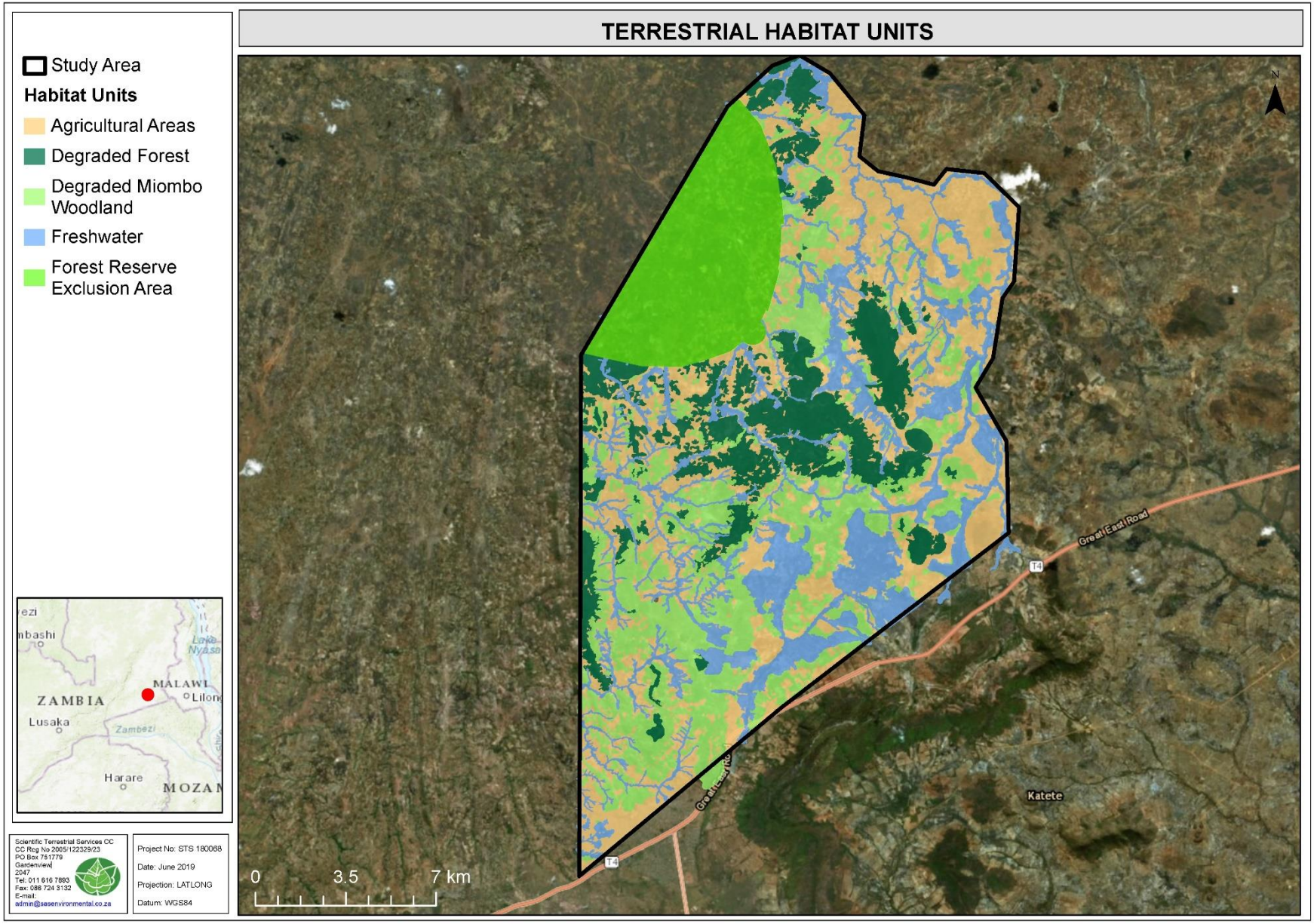


Figure 1: Conceptual illustration of the habitat units within the study area.

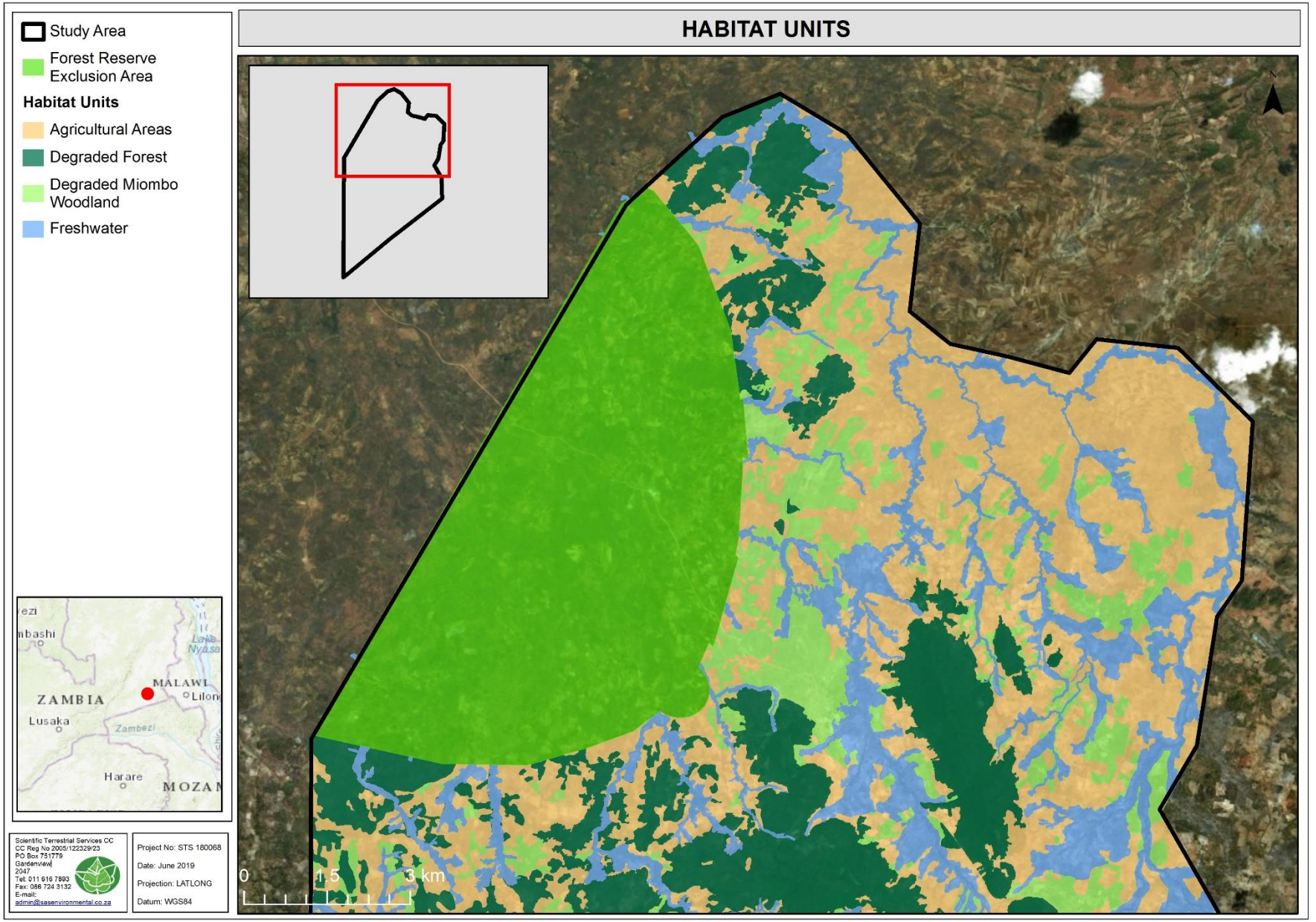


Figure 2: Conceptual illustration of the habitat units within the northern portion of the study area.

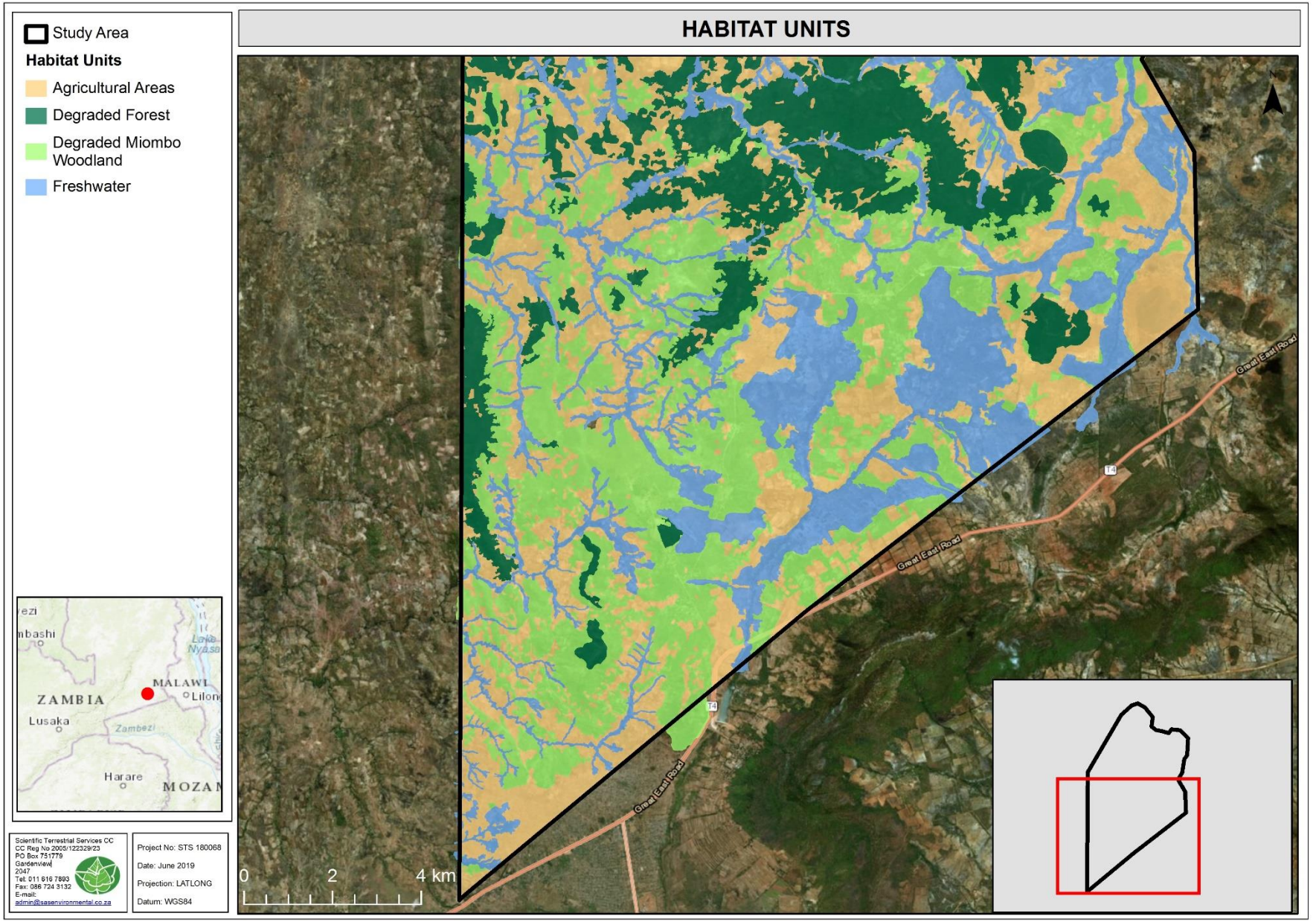


Figure 3: Conceptual illustration of the habitat units within the southern portion of the study area.

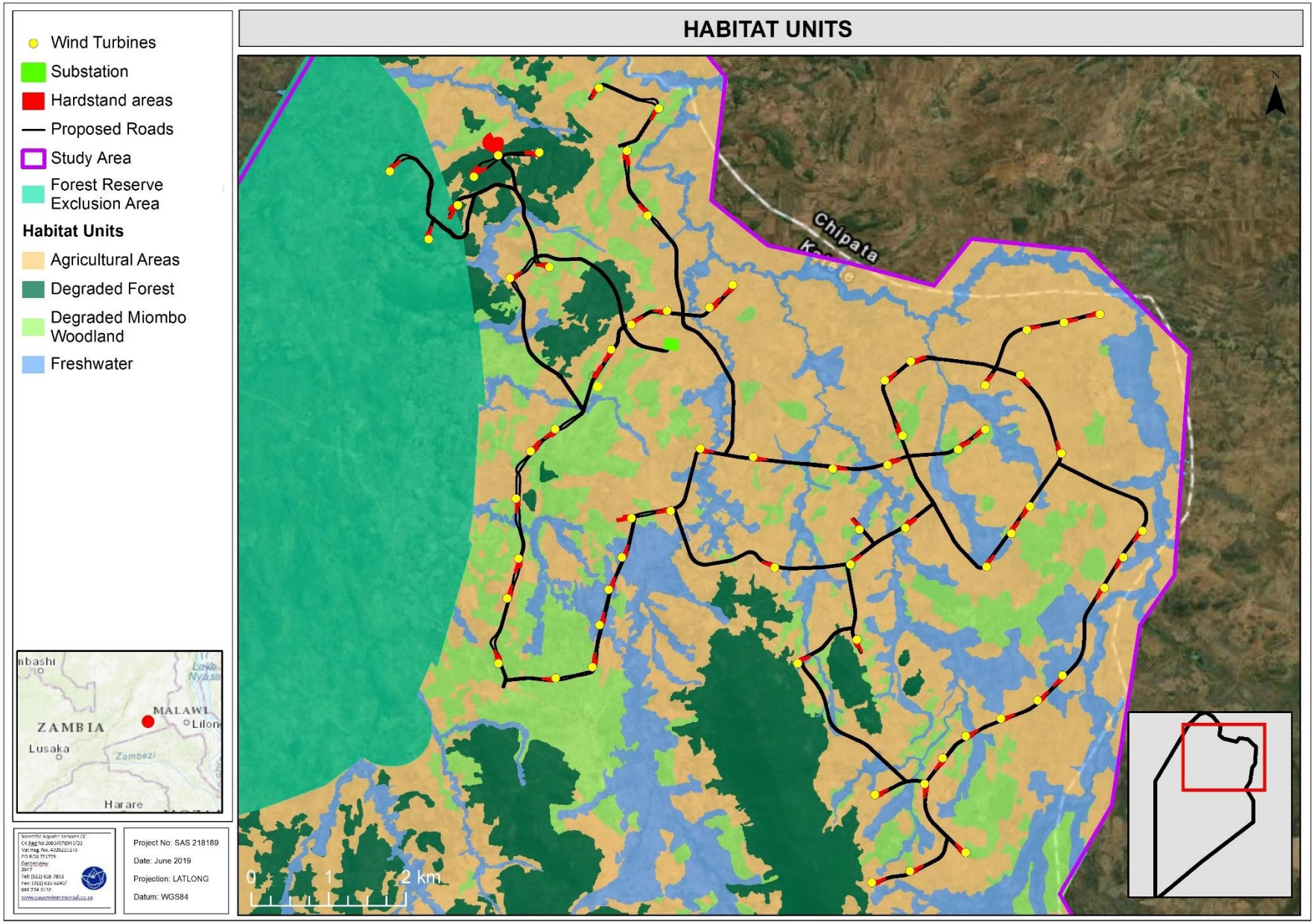


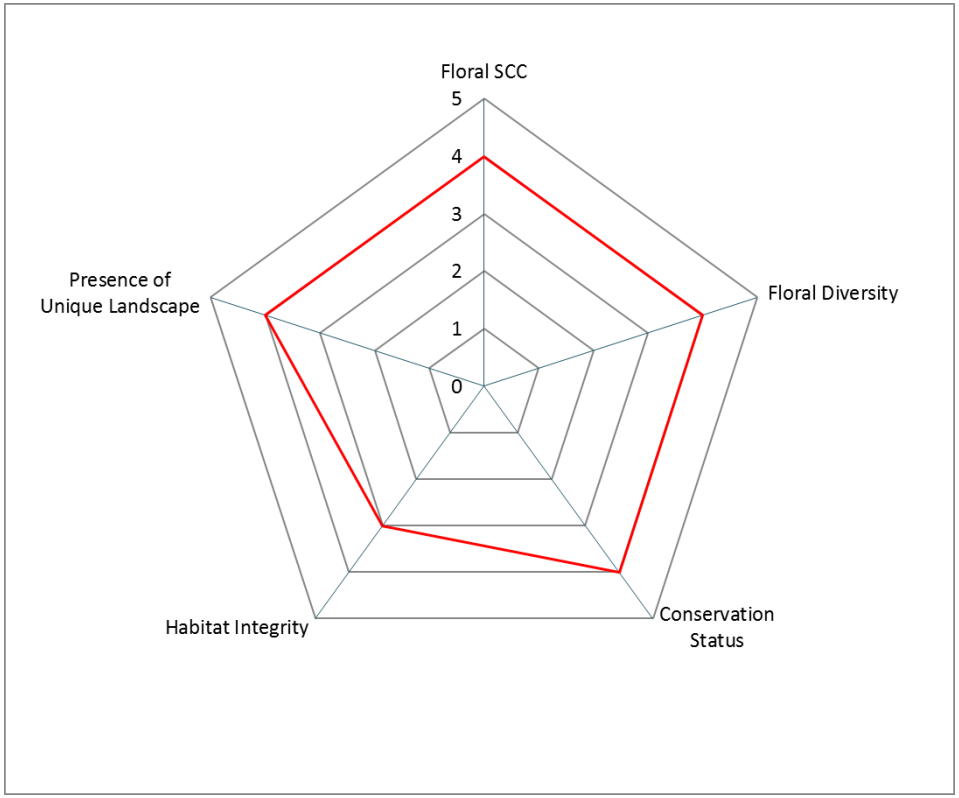
Figure 4: Conceptual illustration of the habitat units associated with the current proposed layout.

3.1 Habitat Unit 1: Degraded Forest.

Habitat Unit: Degraded Forest	Photographs: Degraded Forest areas observed in the study area with surrounding agricultural encroachment.

Habitat Sensitivity	Moderately high

Floral Habitat Sensitivity Graph:



Floral Species of Conservation Concern (SCC)

Only two floral species occur within this habitat unit which can be considered of conservation concern, not so much due to their conservation status but rather due to their continued decline due to increased harvesting. Although only listed as least concern (LC), the tree species *Pterocarpus tinctorius* (*chrysothrix*) (Makula) is highly exploited in Zambia which has resulted in the Government banning the harvesting and trading of this species. The tree species *Pterocarpus angolensis* (Mukwa / Bloodwood) is listed as least concern by the IUCN but due to continued harvesting is noted to be decreasing across its range. However, currently this species is still fairly widespread across Zambia.

General Discussion and characteristics of the habitat unit

The Degraded Forest habitat has, over the years, been subjected to continuous wide scale impacts. The habitat degradation come largely from the burgeoning charcoal trade in rural areas in order to generate an income. This has led to the extensive felling and removal of older large trees at a rapid rate. Due to the demand of wood for charcoal production, many of the younger intermediate sized trees are also being harvested, with the net result being that the forest environment is unable to recover. This continuous deforestation has led to an encroachment of miombo woodland species along the outer borders of this habitat unit, as well as the overall retraction of the forested areas. In addition to the deforestation, slash and burn activities were regularly observed in order to clear forested lands for crop production. These anthropogenic activities have led to the forest habitat becoming isolated and fragmented, occurring only in areas where the terrain is not suitable for agriculture, or where areas bear cultural significance. This has led to the overall loss of habitat integrity, driving species diversity loss and the degradation of the overall forest habitat. In addition, the continued clearing of the declared forest reserves further indicates the overall downturn of the region's conservation status.

Floral species observed in this habitat unit include, but are not limited to *Julbernardia globiflora, Brachystegia bussei, Adenia senensis, Lannea discolour, Cassia singueana, Diospyros kirkii, Pericopsis angolensis, Pterocarpus angolensis, Pterocarpus chrysothrix, , Dalbergia martini, Dichrostacys cinerea, Brachystegia utilis, Acacia nigrescens, Commiphora africana, Erythrina abbyssinica, Brachystegia boehmi, Diplorhyncus condylocarpon, Pseudolacnostylis maprouneifolia* and *Brachystegia longifolia* amongst others.

Business Case, Conclusion and Mitigation Requirements:

This habitat unit is of moderately high ecological sensitivity; however, the forest habitat unit is continually placed under pressure as a result of the harvesting of wood for charcoal production as well as slash and burn activities associated with agricultural expansion. Although the forest habitat has been subjected to varying degrees of impacts, it remains important from a floral biodiversity perspective. Additionally, it is evident from satellite imagery as well as in field assessments that these forest reserves are also being subjected to the same impacts as that of the surrounding areas. Unless a concerted effort is made from government, the current forest reserves will likely be converted into agricultural land in the years to come.

With the above in mind, provided that no wind turbines, access roads or other infrastructure associated with the proposed project are located within the forest habitat, the vegetation clearance activities associated with the project are unlikely to impact on this habitat. The construction and upgrading of the existing roads may however pose a threat to the forest habitat as such roads will provide increased access for local residents to the forest areas, notably with larger transport vehicles which is likely to accelerate wood harvesting activities. Such issues need to be taken into consideration when designing the final layout plan as well as access routes to the turbine locations.

3.2 Habitat Unit 2: Degraded Miombo Woodland

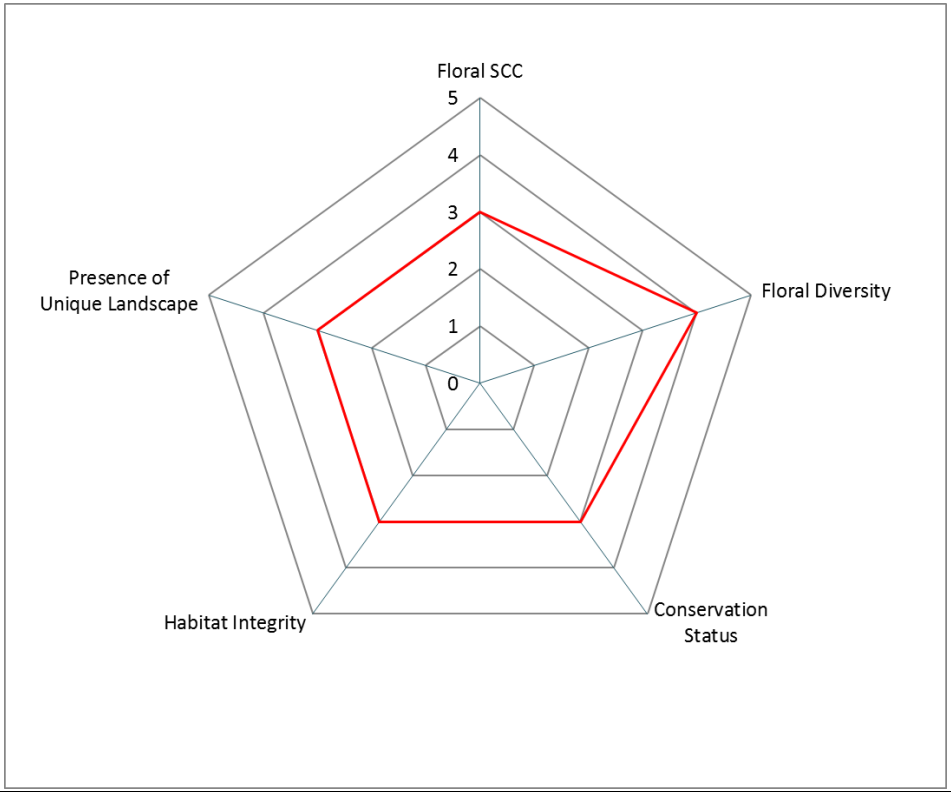
Habitat Unit: Miombo Woodland	Photographs: Miombo Woodland observed in the study area with associated disturbances (agriculture and wood harvesting).





Habitat Sensitivity	Intermediate

Floral Habitat Sensitivity Graph:



Floral Species of Conservation Concern (SCC)

The tree species *Pterocarpus angolensis* (Mukwa / Bloodwood) was observed in this habitat unit. This species is listed as least concern by the IUCN but due to continued harvesting is noted to be decreasing across its range. However, it must be noted that currently this species is still fairly widespread across Zambia.

In addition, *Boophone disticha* was observed in this habitat unit. Although not formally protected this species is often harvested for medicinal purposes or plant collections.

General Discussion and characteristics of the habitat unit

The miombo woodland habitat is the dominant habitat within the study area, however, due to this it is also the habitat that has been subjected to the highest degrees of disturbance and vegetation clearing. These impacts have resulted in the degradation of the habitat integrity, detracting from the unique landscape that this habitat unit is. The characteristics of this vegetation community varied across the study area due to varying levels of anthropogenic impacts and activities. Although numerous miombo woodland species were present, it was evident that in the more degraded areas where charcoal burning activities were higher, *Parinari curatelifolia* appeared to be more dominant. In these areas coppices and miombo saplings were evident, however larger trees had been harvested for charcoal production. In areas where less disturbance was observed the habitat unit was dominated by the miombo species *Julbernadia paniculata* and *Brachystegia boehmi*.

Floral species observed in this habitat unit include, but are not limited to *Ochna schweinfuthiana, Dyospyros kirkii, Lannea discolour, Julbernadia paniculata, Brachystegia boehmi, Pterocarpus angolensis, Dichrostachys cinerea, Terminalia sericea, Swartzia madagascariensis, Albizia harveyii, Burkea africana, Kigelia africana, Hexalobus monopetalus, Dyplorynchus condylocarpon, Cassia abbreviata, Strychnos cocculoides, Afromomum alboviolaceum, Ledebouria revoluta, Boophone disticha, Chlorophytum clarae* and *Costus spectabilis*.

Business Case, Conclusion and Mitigation Requirements:

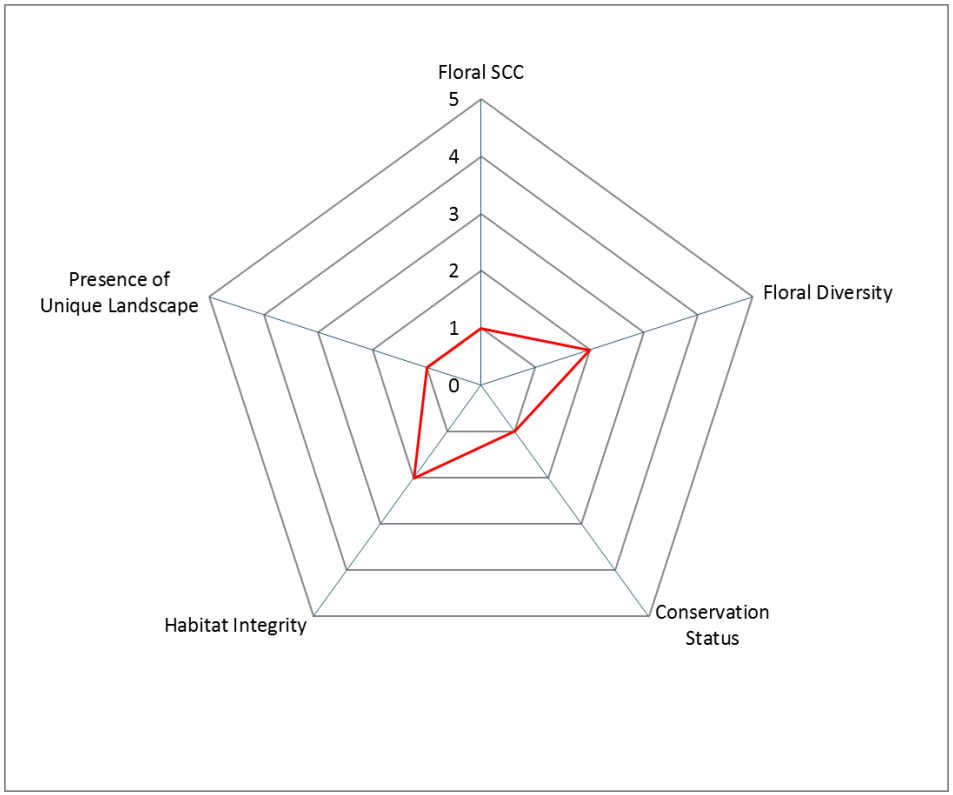
This habitat unit is of intermediate ecological sensitivity. The miombo woodland habitat has been subjected to several anthropogenically derived impacts that have led to the overall degradation of the vegetation. Prominent impacts stem from vegetation clearance activities of the communities in order to open up the land for crop planting and grazing, whilst the harvesting of miombo species for charcoal production has further resulted in an altered species composition in areas. These activities have resulted in the patchy distribution of this habitat unit throughout the study area, which are likely to be cleared in due time as the communities expand further. Within the study area there were a number of areas where no vegetation clearance or wood harvesting had occurred as these areas are either of cultural significance or are designated graveyards. It is likely that in the years to come these will be the only remaining areas where natural and intact miombo vegetation will be observed. Several of the current proposed turbines are located within this habitat unit, however, the installation of the turbines themselves is not expected to have a significant impact on the habitat unit nor lead to a loss of species diversity. However, as discussed above, the construction and upgrading of the roads may lead to an increase in the harvesting of wood and manufacturing of charcoal as areas become more readily accessible, which could accelerate the current rate of habitat loss.

3.3 Habitat Unit 3: Agricultural Areas

Habitat Unit: Agricultural Areas	Photographs: Current agricultural activities within the study area that have led to vegetation clearance and habitat loss.

Habitat Sensitivity	Moderately Low

Floral Habitat Sensitivity Graph:



Floral Species of Conservation Concern (SCC)

No floral SCC were encountered within this habitat unit. Vegetation clearance activities in these areas have left limited natural vegetation remaining.

General Discussion and characteristics of the habitat unit

The agricultural areas have been cleared to make way for agricultural crops such *Zea mays* (Maize), *Glycine max* (Soybean) and *Cucurbita* sp (pumpkin) which are grown throughout the study area. Large tracts of the low-lying lands have been cleared for cultivation, whilst in the western portions of the study area, even the uneven, steep hillsides are used for cultivation activities. It was noted that larger trees are often left along the field boundaries, presumably as a wind break but also as it would require unnecessary time and effort to remove them. Larger fruit bearing trees, notably *Mangifera indica* (Mango) are left in place and fields cultivated around them. This is attributed to their importance as a food resource in the region.

The agricultural areas have been significantly transformed and bear no similarity to the reference Miombo Woodland vegetation type of the region. Although the agricultural lands are important for food production, they are not considered important for floral species, with a moderately low floral species diversity and a notable loss of habitat integrity. The agricultural areas are furthermore not considered unique areas of habitat nor do they contribute to the overall conservation status or value of the region.

Floral species observed in this habitat unit include, but are not limited to *Uapaca siberiana, Terminalia sericea, Ficus sycamorous, Vangueria infausta, Brachystegia boehmi, Dichrostachys cinerea, Diospiros kirki* and *Mangifera indica*.

Business Case, Conclusion and Mitigation Requirements:

Continued population growth has resulted in an increased food requirement, which has in turn led to the requirement for additional grazing and crop lands. This has resulted in an increased number of areas being cleared of woody plants to create grazing lands or wholly cleared in order to plant crops. As such, this has led to significant habitat and species diversity loss. The continued growth of the local communities will only add to this in the years to come, as was observed, with large newly cleared areas being cleared and ploughed.

The majority of the turbine towers are currently placed in areas under cultivation. This will lead to the loss of current agricultural land; which local residents will have to offset through the clearing of additional areas for planting. Although the construction of the turbine towers themselves will not lead to habitat or species diversity loss in the agricultural areas, the negative spinoff impact associated with cropland loss will. As such, it is recommended that as far as possible and in accordance with best fit design, that the turbine towers be placed between the current fields or in old discarded agricultural areas that are no longer in use. Doing this should minimise the loss of current croplands and lessen the need for the local communities to substitute the lost agricultural areas with as of yet uncleared land.

3.4 Habitat Unit 4: Freshwater Habitat (Dambos and Streams)

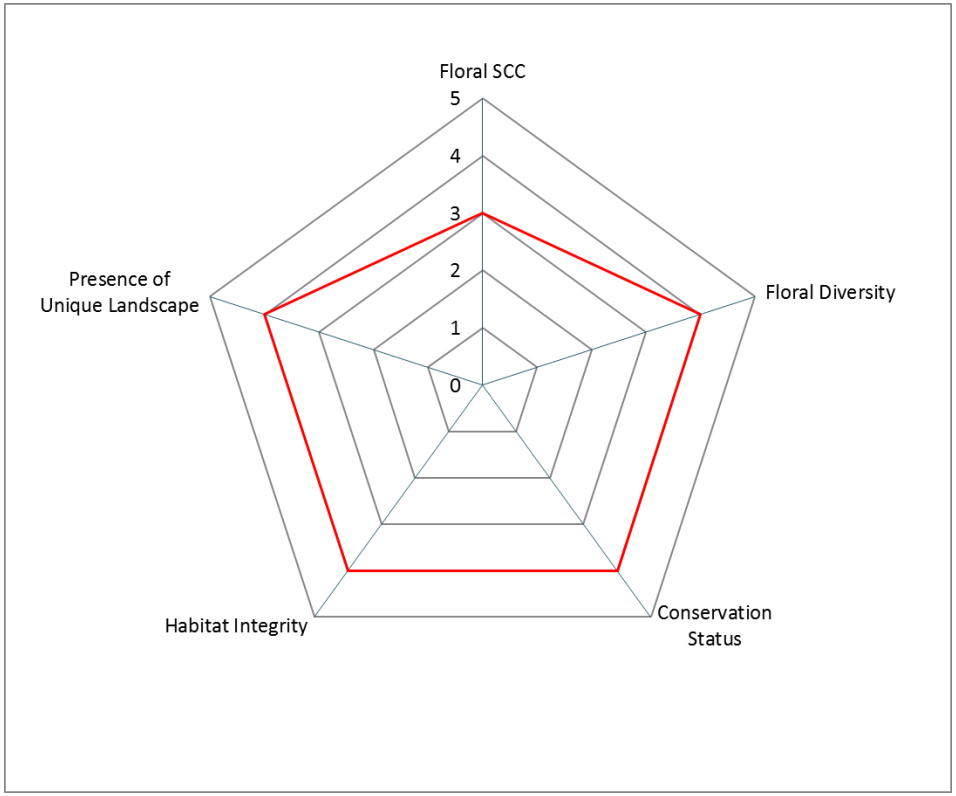
Habitat Unit: Freshwater Habitat	Photographs: Dambos and Streams observed in the study area. Increased vegetation clearance has led to erosion and stream incision.





Habitat Sensitivity	Moderately High

Floral Habitat Sensitivity Graph:



Floral Species of Conservation Concern (SCC)

Although no SCC were observed in the freshwater habitats, the dambos do provide habitat for unique floral species such as *Habenaria schimperiana* (Orchid), *Drosera sp.* (Sundew), *Boophone disticha* and *Hypoxis nyasica*, which although not formally protected are often harvested for medicinal purposes or plant collections.

General Discussion and characteristics of the habitat unit

The freshwater habitat was observed extensively throughout the study area. The dambos and riparian areas were noted to have increased floral species diversity, as is to be expected, with many of the floral species observed in these areas not occurring within the other habitat units, particularly orchid species. The riparian areas are still largely intact and of moderately high integrity, although the agricultural lands do encroach heavily upon the riparian vegetation. However, the dambos located around the villages have been significantly impacted upon as a result of vegetation clearance and crop cultivation, leading to species diversity and habitat loss in these areas. The freshwater habitat unit is considered important in terms of ongoing species conservation and habitat provision, whilst also being unique in the landscape in terms of species diversity. Although the freshwater habitat has been subjected to several anthropogenic impacts, the overall integrity and diversity of is still considered moderately high.

Species observed in the freshwater habitat include *Cyperus esculenta, Platycoryne buchanania, Cyperus* sp., *Kyllinga pumila, Habenaria schimperiana, Gnidia chrysantha, Ascolepis protea, Hypoxis nyasica, Drocera* sp., *Popowia obovata, Senegalia polyacantha, Ficus sycamorous, Mucuna coriacea, Stereospermum kunthianum, Vitex doniana, Piliostigma thonningii, Pseudolacnostylis maprouneifolia, Antidesma venosum, Grewia caffra* and *Markhamia obstifolia*.

Business Case, Conclusion and Mitigation Requirements:

This habitat unit is of moderately high ecological sensitivity. The freshwater habitat unit is considered important not only from a freshwater management perspective but also from a habitat uniqueness perspective. The niche and unique habitat provided by these areas of increased moisture lead to the formation of unique species diversity and richness, which is not found in the other habitat units within the study area. Although several of the dambos and parts of the riparian areas have been cleared for cultivation, notably where these areas are located near villages, there are still numerous dambo and riparian habitats which are still intact and considered important for continued species diversity conservation and floral habitat.

Where the wind turbines are located within the freshwater habitat, be it dambos or riparian areas, it is recommended that these structures be relocated outside of the freshwater habitat so as to ensure that further habitat degradation and species loss does not occur.

3.5 Floral Species of Conservation Concern Assessment

An assessment considering the presence of any floral species of conservation concern (SCC), as well as suitable habitat to support any such species was undertaken. Threatened species are species that are facing a high risk of extinction. Any species classified in the IUCN categories as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) is a threatened species. SCC are species that have a high conservation importance floristic diversity and include not only threatened species, but also those classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare and Declining.

There is no specific list of protected floral species for Zambia, thus all floral species observed were cross refenced with the IUCN database in order to ascertain their conservation and threat status.

None of the floral species as identified during the field assessment had a conservation status higher than that of least concern on the IUCN database. However, species such as *Pterocarpus tinctorius* (*chrysothrix*) and *Pterocarpus angolensis* are of concern as their known population numbers are declining due to overharvesting. In addition to these woody species, small bulbous species such as *Boophone disticha* and *Habenaria schimperiana*, although of least concern according to the IUCN, are also considered under pressure due to harvesting for medicinal purposes and species collections. As such, turbine locations as well as associated infrastructure, should as far as possible avoid areas where these species occur. In the case of the smaller bulbous species, should they occur in a turbine footprint, they should be carefully excavated and replanted in an area of suitable habitat close to the disturbance footprint. This should be underseen by a suitably qualified specialist.

3.6 Exotic and Invasive Species

Alien floral species in the study area were mostly associated with villages and in particular agricultural areas and livestock pens, where in some instances they were completely dominant, notably in the case of *Lantana camara*. The table below lists the exotic and invader species identified during the assessment along with their basic methods of control. It is recommended that all alien and invasive plants that are located within a wind turbine or associated infrastructure footprint are removed and destroyed, ensuring that the seed is not dispersed into the surrounding areas. The only two exceptions on the list below are that of *Mangifera indica* (Mango) and *Psidium guajava* (Guava) which have an important social and

economic use in the communities as a seasonal supply of food. Removal or destruction of these trees should be avoided where possible.

Table 1: Exotic or invasive species identified during the assessment.

Scientific name	Common name	Control
Bidens pilosa	Spanish Blackjack	Pre-emergence herbicide
Mangifera indica	Mango	None, agricultural use
Psidium guajava	Guava	None, agricultural use
Lantana camara	Lantana	Mechanical control, herbicide

3.7 Medicinal Plant Species

The table below presents a list of plant species with traditional medicinal value, plant parts traditionally used and their main applications.

The majority of the plants identified in the study area all have medicinal properties and are considered to be common to the region, especially within the degraded forest and miombo woodlands. When planning the turbine footprint locations, it is important that the local traditional healers be consulted to ensure that the turbine locations will not lead to the unnecessary removal of important medicinal plants.

Table 2: Traditional medicinal plants identified during the field assessment. Medicinal applications and application methods are also presented.

Scientific name	Medicinal use
Annona senegalensis	The bark is used medicinally to treat gastrointestinal ailments and the gum from the bark is used for sealing cuts and wounds
Pericopsis angolensis	Included in treatment for ringworm, stabbing pains, eye problems, malaria, blackwater fever, stomach problems and to increase the supply of breast milk
Stereospermum kunthianum	Pods are chewed with salt for coughs and are used in treatment of ulcers, leprosy, skin eruptions and venereal diseases; also used to cure flatulence in horses
Mangifera indica	Charred and pulverized leaves make a plaster to remove warts and also act as a styptic. Seeds are used to treat stubborn colds and coughs, obstinate diarrhoea and bleeding piles. The bark is astringent, homeostatic and antirheumatic.
Bauhinia petersiana	Wounds were successfully treated when pounded leaves boiled in a salt solution were applied
Vachellia sieberiana	In Central Africa, a bark/root decoction is used for inflammation of the urinary passages. Leaf, bark and resin are used as an astringent for colds/chest problems, diarrhoea, hemorrhage and eye inflammation. In Tanzania, bark is used to treat gonorrhoea.
Philenoptera violacea	Most parts of the plant are used to treat diarrhoea. The roots are used for gastro-intestinal problems; powdered root-bark is used to treat colds and snakebite. Root infusions are commonly used as part of a hookworm remedy.
Syzygium cordatum	The powdered bark is used as a fish poison. In central Africa the tree is known as a remedy for stomach-ache and diarrhea. It is also used to treat respiratory ailments and tuberculosis

Scientific name	Medicinal use
Parinari curatellifolia	An infusion of the roots is used to treat toothache and a leaf decoction is either drunk or used in a bath as a remedy for fevers. The crushed or pulped leaves are used in a dressing for fractures or dislocations, and for wounds, sores and cuts
Erythrophleum africanum	An infusion of the bark is drunk to treat stomach-ache or dysmenorrhea. The bark is used to make a mouth wash for relieving toothache. Steeped in water, the bark is applied externally and internally to cure cardiac diseases and epilepsy. A paste of root bark is applied to the skin to cure scabies.
Strychnos cocculoides	The fruit is mixed with honey or sugar and used to treat coughing. The fruit is used in making eardrops for treating ear complaints. The root can be chewed to alleviate stomach disorders, eczema and sores on the skin. It is also an alleged cure for gonorrhea.
Combretum adenogonium	The branches, free of fruit, are used to prepare an infusion in Liberia for washing the body to relieve pain. An infusion of the bark is taken with natron to relieve “lekki beernde” (pains in chest). The bark, together with a mistletoe which commonly parasitizes the tree, is made into an infusion for washing the body.
Diplorhynchus condylocarpon	A decoction of the root bark is used to treat indigestion, diarrhoea, fever, snakebites, infertility and venereal diseases. A decoction of the root is used to treat a variety of complaints including chronic cough, pneumonia and pulmonary tuberculosis; rectal prolapse; diabetes; testicle inflammation; and to facilitate giving birth.
Brachystegia spiciformis	An infusion provides treatment for dysentery and diarrhea. A decoction is applied as an eyewash for conjunctivitis.
Pseudolachnostylis maprouneifolia	A root decoction is taken as a purgative to treat stomach-ache and abdominal problems. The smoke of burning roots is inhaled to treat pneumonia, A root infusion is taken to treat abdominal pain, gonorrhea and female sterility. Dried, pulverized root is sniffed to treat nosebleed and headache. It is sprinkled on fresh wounds to heal them.
Rothmannia globose	In some parts of southern Africa the powdered roots are rubbed into incisions to treat leprosy.
Strychnos spinosa	It is believed that the presence of strychnine in the bark and unripe fruit, along with other alkaloids, are responsible for helping overcome the venom of certain snakes, such as Mamba. Strychnine is a powerful central nervous system stimulant that may be able to fight the respiratory depression caused by the venom of these snakes. It is also used as a purgative, for uterine problems and to treat sore eyes.
Albizia antunesiana	The roots have numerous uses in traditional medicine. An infusion or decoction is used to treat sore throat, tonsillitis, tuberculosis, gonorrhea and other sexually transmitted diseases, abdominal pains, depressed fontanelle in infants and infertility in women
Turraea nilotica	Traditionally, the roots of this species have been used to treat toothaches, pneumonia, epilepsy, abdominal pain and venereal diseases
Bobgunnia madagascariensis	A decoction of the fruits has been used to induce vomiting to remove poison from the stomach, and to treat bilharzia, leprosy and ear-ache. Roots are used to induce abortion, counteract venomous stings and bites, kill or expel intestinal worms and treat leprosy. A warm root infusion is used to treat venereal diseases and dysentery. Chopped roots are shaken in water which is then used to treat cataract of the eye.
Steganotaenia araliacea	The stem bark contains a number of dibenzocyclo-octadiene lignans. These have displayed cytotoxic (antimitotic) activity in a manner similar to colchicine on 11 human tumour cell lines. The lignans steganangin (the most abundant analogue), steganacin and steganolide A were most abundant. Saponins isolated from the leaves have shown antileukemic activity. An infusion of the plant is strongly emetic. The roots are used in treating snake bites and painful chest conditions.
Combretum zeyheri	The gum of *Combretum zeyheri* has antibiotic properties. The roots of the tree are used to make baskets, necklaces for young girls and fishing traps. Pounded roots mixed with fats are used for an ointment to relieve hemorrhoids. Powdered roots are taken orally in porridge to stop a bleeding

Scientific name	Medicinal use
	nose and to ease kidney pains. Leaves mixed with oil are used as an embrocation (liquid for rubbing on the body to relieve pain), to ease a stiff neck and backache. Crushed leaves are mixed with water and the resultant fluid.
Khaya nyasica	The bark is bitter, similar to quinine, and is used for colds. Oil from the seed is rubbed into the scalp to kill insects.
Ozoroa insignis	The roots and bark are considered to be cholagogue, purgative and vermifuge. A decoction is used to treat kidney and liver complaints; ulcers and hernias; throat infections; chest pain; diarrhoea; schistosomiasis.
Hymenocardia acida	The leaves, combined with the roots, are used for treating deficiency diseases and oedema caused by malnutrition. The root bark is eaten with porridge as a treatment for malaria. The sap from the roots is applied topically for treating earache and tooth-troubles.
Piliostigma thonningii	Tender leaves are chewed, and the juice swallowed to treat stomach-ache, coughs and snakebite. The roots are used to treat prolonged menstruation, hemorrhage and miscarriage in women and also for the treatment of coughs, colds, body pain and STDs.
Mimusops zeyheri	A root infusion is taken to treat candidiasis. A bark decoction is used to treat wounds and ulcers.
Ceratotheca sesamoides	The leaves, when eaten as a vegetable, act as a laxative. The leaves are steeped in water and the slimy liquid is dropped into the eye to treat conjunctivitis.
Combretum collinum	Most African people use boiled root decoction to treat constipation, headaches, stomachs, fever, dysentery and swellings, and as an anthelmintic for hookworm. The leaves are chewed, soaked in water and the juice drunk for chest complaints; it can also be used as an inhalant in a hot steam bath.
Senna singueana (Cassia singueana)	Extracts of the root bark have shown significant analgesic, antipyretic, anthelmintic and antiplasmodial activity. An infusion of the leaves is used as a remedy for venereal disease, malaria, convulsions, epilepsy, coughs, intestinal worms, constipation, heartburn and stomach-ache
Commiphora africana	The fruits are used for the treatment of typhoid fever and as a remedy for stomach problems. The fruits are chewed or pounded and used as a treatment against toothache and diseases of the gum.
Peltoforum africanum	African wattle is commonly used in African traditional medicine, especially the bark and the roots. They are taken internally to treat a range of digestive disorders and as general tonics, whilst externally they are used to treat wounds and sore.
Ficus sycamorous	The bark is used for the treatment of scrofula, coughs, and throat and chest diseases. The milky latex is used for treatment of dysentery and chest diseases or is applied to inflamed areas.
Xeroderris stulhmannii	The bark is purgative. It is used in traditional medicine to treat coughs, colds, rheumatic arthritis, stomach-ache, dysentery, eye infections, and wounds.
Flacourtia indica	The leaf is carminative, astringent and used as a tonic, an expectorant and for asthma, pain relief, gynecological complaints and as an anthelmintic, and treatment for hydrocele, pneumonia and intestinal worms.
Terminalia sericea	The leaves and roots are boiled in water and the infusion is taken orally for the treatment of coughs, diarrhoea and stomachache. The leaves can be used as an antibiotic for wounds. In the case of bleeding, a paste can be made by cooking the leaves in water and placing them on the wounds.
Cassia abbreviate	The leaves are smoked as a treatment for haematuria. The smoke of smouldering twigs is inhaled to cure headache. The powdered stem bark is applied to abscesses and added to food to cure diarrhoea. A decoction of the stem bark is used as a purgative and to cure malaria.
Adenia senensis	An infusion of the bark is used as a remedy for mental disorders and snakebite. The leaves and bark are boiled and the decoction inhaled to treat fever and influenza.

Scientific name	Medicinal use
Adansonia digitate	**T**he leaves are hyposensitive and an antihistamine. They are used to treat kidney and bladder diseases, asthma, general fatigue, diarrhoea, insect bites, and guinea worm. The fruit pulp, seed and bark are reputedly an antidote to Strophanthus poisoning. The pulp is widely used in Africa as a diaphoretic to combat fevers, and to treat dysentery.
Thespesia garckeana	A decoction of roots is taken in the treatment of painful menstruation; coughs and chest pains. An infusion made from the roots and leaves is dropped into the ear to treat earache or is taken orally as an antiemetic.
Friesodielsia obovata	The roots are boiled, and the decoction used for treating stomach-ache, infertility in women and as an antidote for snakebite.
Philenoptera violacea	The roots are used to treat stomach disorders, hookworms, and coughs.
Ziziphus abbysinica	The roots are boiled and the liquid drunk as a treatment for after-birth pains, stomach-ache, snakebite, and also to induce abortion. A decoction of the roots, mixed with those of *Rhynchosia resinosa*, is drunk as a treatment for stomach-ache. The roots are pounded and the powder is rubbed on the chest, which is first scarified, as a treatment for pneumonia
Stereospermum kunthianum	The pods are chewed with salt as a treatment for coughs. They are also used in the treatment of ulcers, leprosy, skin eruptions and venereal diseases. A leaf infusion is used for washing wounds. The macerated leaves are used to treat asthenia and exhaustion. The bark is used as a haemostatic and for treating wounds. A stem-bark decoction is used to cure bronchitis, pneumonia and coughs. The roots and leaves are used in the treatment of venereal diseases, respiratory ailments and gastritis.
Vangueria infausta	The root is anthelmintic, antidote and purgative. A popular snake-bite remedy, it is also used to treat a variety of complaints such as malaria, pneumonia, coughs and other chest troubles. A warm decoction of the roots is considered to be an effective remedy for heart ailments in Namibia. The leaves are applied externally as a treatment for swellings on the legs; inflammation of the navel in children; abdominal pain; and for the relief of dental pain.
Bidens pilosa	Its roots, leaves, and seeds are reported to have antibacterial, antidysenteric, anti-inflammatory, antimicrobial, antimalarial, diuretic, heptoprotective, and hypotensive properties. In Africa, B. pilosa is used to treat headaches, ear infections, hangovers, diarrhoea, kidney problems, malaria, jaundice, dysentery, burns, arthritis, ulcers, and abdominal problems. It is also used as an anaesthetic, coagulant, and treatment to ease childbirth. In sub-Saharan Africa, its fresh or dried shoots and young leaves are eaten as a leaf vegetable, especially in times of food scarcity.
Euphorbia hirta	Asthma weed is a very important herbal medicine both within its native range and also beyond. It has traditionally been used to treat respiratory system disorders including bronchitis, asthma, hay fever, emphysema, coughs, colds and laryngeal spasm, though in modern herbalism it is more used in the treatment of gastrointestinal disorders, including intestinal parasites, diarrhoea, peptic ulcers, heartburn, vomiting and amoebic dysentery. The plant is also used as a diuretic to treat uro-genital diseases, such as kidney stones, menstrual problems, sterility and venereal diseases. The plant has a reputation as an analgesic to treat severe headache, toothache, rheumatism, colic and pains during pregnancy. It is used as an antidote and pain relief of scorpion stings and snakebites.
Xerophyta retinervis	The roots are smoked to relieve asthma, and smoke from the whole plant is used to stop nosebleeds. Stem bark preparations are reported to have anti-inflammatory and analgesic properties. The active ingredient, called amentoflavone, is also found in gingko extract.
Elephantopus scaber	The plant is widely used as a medicinal herb in the tropics. It is anthelmintic, diaphoretic, diuretic, emmenagogue, emollient, febrifuge and tonic. It is used to treat conditions such as asthma, coughs and pulmonary diseases; dyspepsia, diarrhoea and dysentery; oedema; urethral discharges and venereal diseases. A decoction is used to treat fungal skin diseases.
Cyperus esculentus	The Tiger nuts are regarded as a digestive tonic, having a heating and drying effect on the digestive system and alleviating flatulence. They also promote urine production and menstruation.

Scientific name	Medicinal use
Tacca leontopetaloides	The inside of the root is squeezed in water and applied as a rinse to injured eyes. The starch from the tubers of the plant was used as a remedy for diarrhoea and dysentery. The root is also used as a thickener in medical preparations. The starch from the root is rubbed onto sores and burns.
Boophone disticha	The outer covering of the bulb is applied to boils and abscesses; fresh leaves are used to stop bleeding of wounds.
Aframomum alboviolaceum	The plant is used as a febrifuge.
Bidens schimperi	The roots are used to treat coughs and colds.

4 SENSITIVITY MAPPING

The figure and table below illustrate the areas considered to be of increased ecological sensitivity. The areas are depicted according to their sensitivity in terms of the presence or potential for floral SCC, habitat integrity and levels of disturbance, threat status of the habitat type, the presence of unique landscapes and overall levels of diversity (as discussed in Section 3). The table below presents the sensitivity of each identified habitat unit along with an associated conservation objective and implications for development.

Table 3: A summary of sensitivity of each habitat unit and implications for the proposed development.

Habitat Unit	Sensitivity	Conservation Objective	Development Implications
Degraded Miombo Woodland	Intermediate	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.	This habitat unit is of intermediate ecological sensitivity and if current land-uses persist, its sensitivity is unlikely to change and may even decline further. Significant areas of this habitat unit are currently being cleared to make way for agricultural land and grazing pastures. In addition, trees are being harvested and the wood converted into charcoal to be sold in the larger towns. The anthropogenic activities are the primary drivers behind the decreased plant diversity and sensitivity. It is recommended that where turbine and associated infrastructure footprints are located in this habitat unit, they be located in the more disturbed areas whilst also avoiding the foothills of the larger mountains. Vegetation clearance should be minimised and the construction footprints kept as small as possible, whist managing all edge effects.
Degraded Forest	Moderately High	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.	This habitat unit is of moderately high ecological sensitivity, however if current land-uses persist, its sensitivity is likely to decrease due to increasing pressure on these forests for firewood and timber. No turbines should be located in this habitat in order to ensure that the project does not contribute to the ongoing vegetation loss in this habitat. In addition, much of this habitat unit is located on mountainous slopes and smaller inselbergs which are not suitable for the establishment of turbines without significant vegetation clearance and habitat destruction.
Freshwater Habitat	Moderately High	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.	This habitat unit is of moderately high ecological sensitivity, and further impacts must be avoided where possible as the key drivers of modification of these systems are as a result of historical and current vegetation removal. Where turbine or other related infrastructure footprints are located in the freshwater habitat or their respective recommended buffers, the footprint should be moved.
Agricultural Areas	Moderately Low	Optimise development potential.	This habitat unit is of moderately low ecological sensitivity. The agricultural areas are important as a source of food and crop production for the local communities. However, from a floral ecological perspective these already degraded areas are ideal placement sites for the turbines, provided the agricultural area is not located within a delineated dambo.

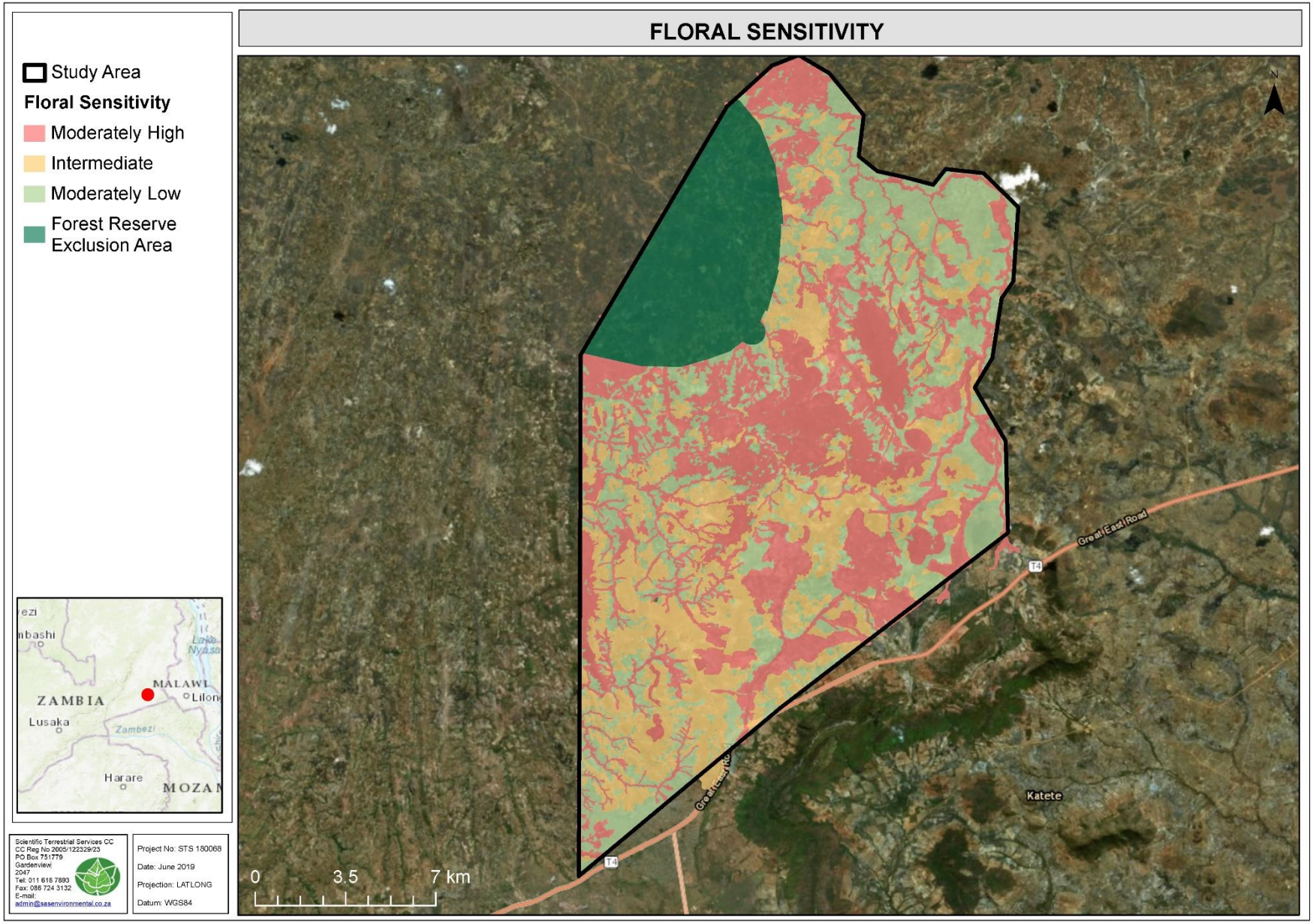


Figure 5: Sensitivity map pertaining to the floral assessment of the study area.

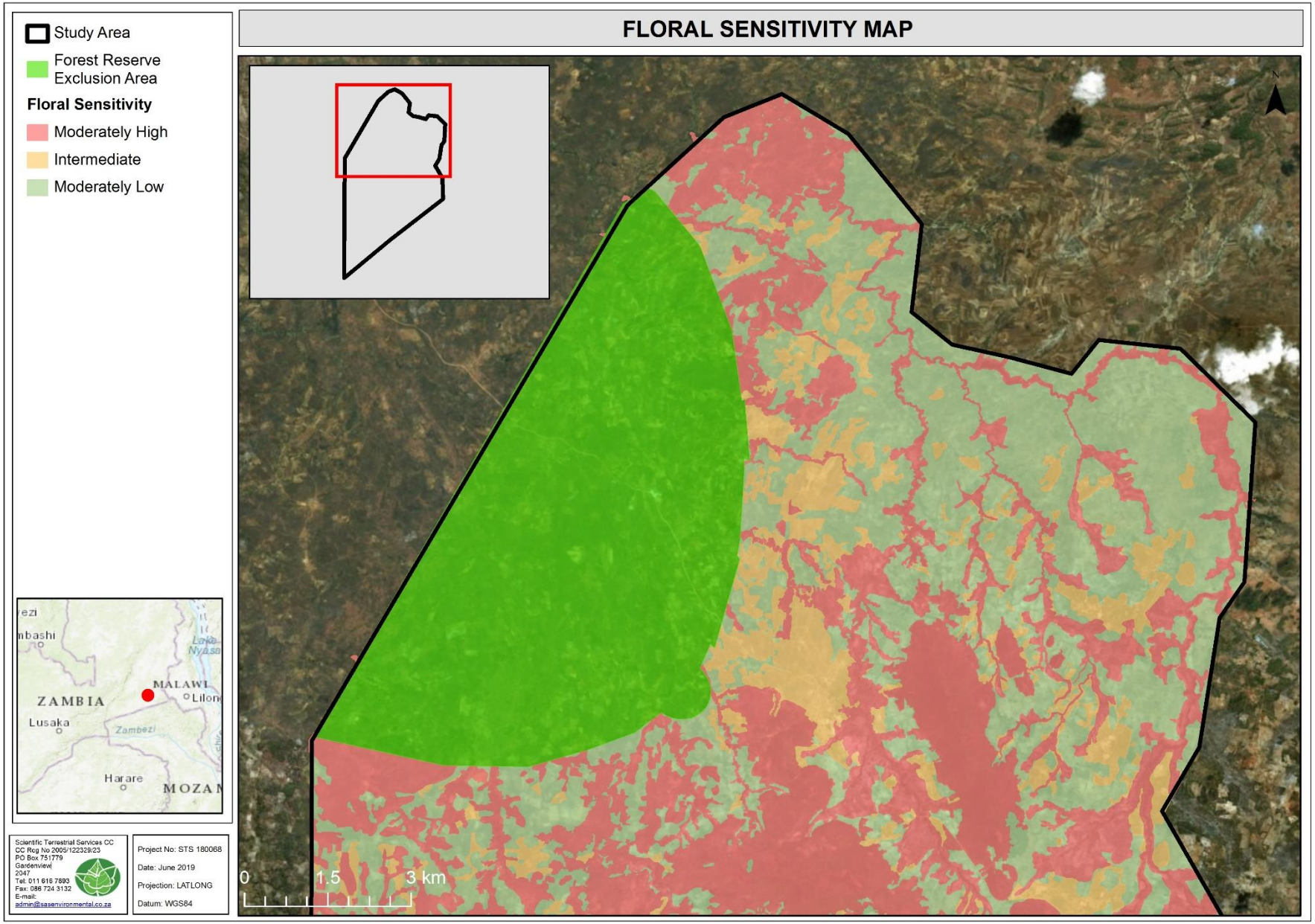


Figure 6: Sensitivity map pertaining to the floral assessment of the northern portion of the study area.

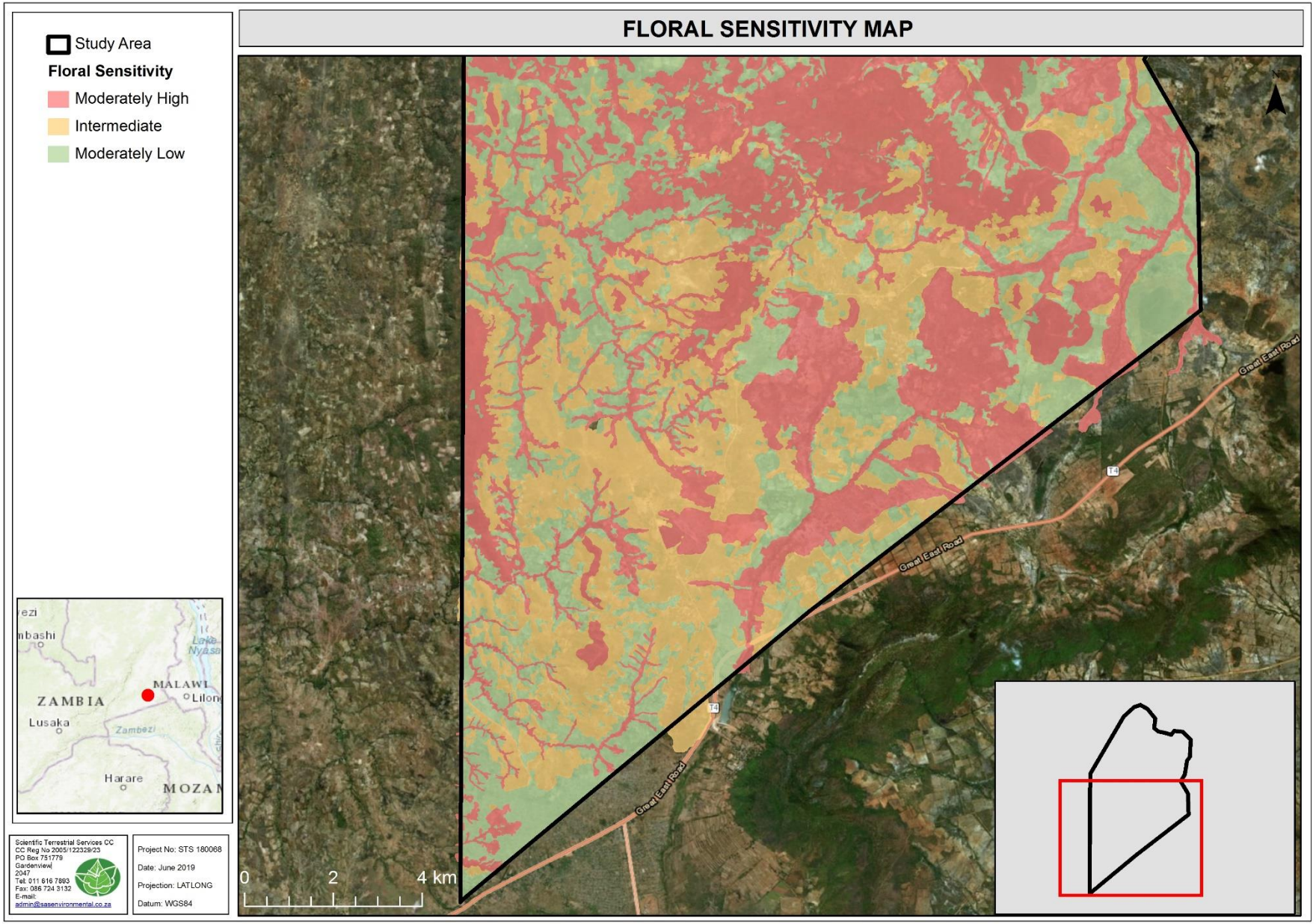


Figure 7: Sensitivity map pertaining to the floral assessment of the southern portion of the study area.

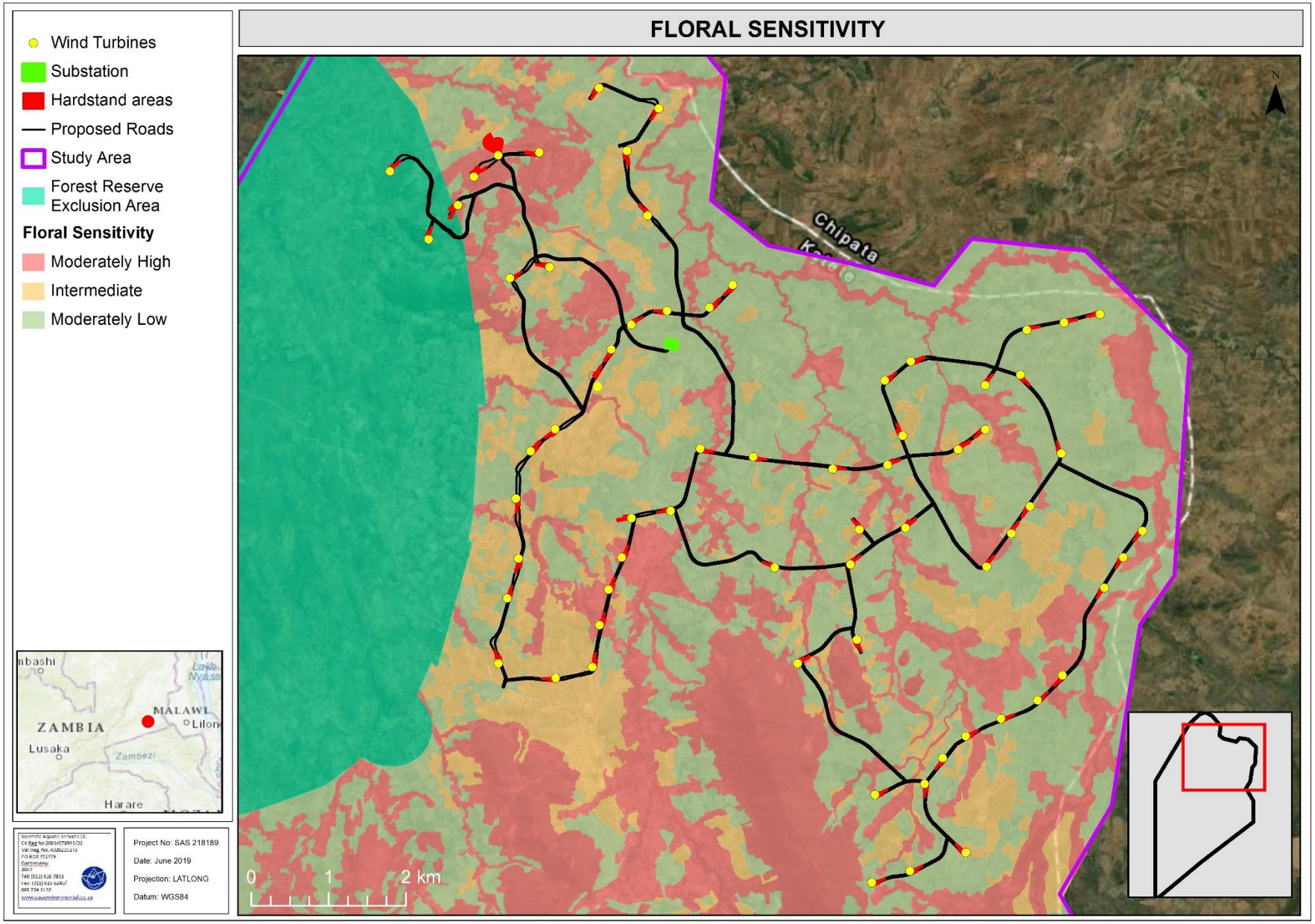


Figure 8: Sensitivity map pertaining to the floral assessment for the proposed layout.

5 IMPACT ASSESSMENT AND PROPOSED MANAGEMENT MEASURES

5.1 Project Components and Descriptions

Following the collecting, assessing and dissemination of the floral baseline data, a final proposed layout was then developed for the wind farm and associated structures / activities. Listed below are the impacting structures and associated activities that will be assessed within this impact assessment as part of Phase 1 of the project.

Wind Turbine Generators

For Phase 1 there could be between 20 and 60 wind turbines, with an individual capacity of between 4.2 and 5.3 MW. The turbines will range in hub height from 120 m to 150m, with a rotor diameter range of between 136 m and 158 m. Each turbine will have a concrete foundation of approximately 400 - 900 m2, to a depth of approximately 2.5 – 5 m. There will be a circular gravel hard standing area of approximately 800 m2 around each turbine that will be used during construction and for maintenance during the life span of the project.

Each turbine will have an electrical transformer, either on the inside or beside it outside.

Some turbines may have to be fenced off for safety reasons, but the land-use surrounding the turbines may continue, depending on the relative distances from the turbines.

Electrical Connections

The wind turbines will be connected to each other by means of medium voltage cables. The cables will be buried approximately 1 - 2 m below ground level. A substation (typically 80 m X 90 m) will be constructed within the site for collection of power from the wind turbines. The substation will then be connected to the National Grid through a new 330 kV power transmission line (with a 50m wayleave) to be constructed above ground between the wind farm substation and the existing Msoro Substation (located 30km north of the Project Site). The transmission line is covered in a separate ESIA report as it is planned to handover the transmission line to ZESCO for operation and maintenance.

Access Roads

The site will be accessed from the T4 main road running between Lusaka, Katete and Chipata. An internal gravel road network will need to be constructed to facilitate movement between turbines during construction and operation. This will include upgrading of existing roads within the area as well as constructing new access roads.

Roads will be 10 - 13 m wide including drainage, turning circles, passing points and cabling. Some existing public roads and bridge structures will need to be upgraded to facilitate the heavy loads and vehicle sizes associated with the turbine equipment transport, especially the mast sections and the blades.

The main access roads and internal service roads would be constructed or upgraded from material sourced from quarries or borrow pits within and around the area (if available). The exact location and number of quarries and borrow pits required are not known at this stage. All material will need to be sourced from quarries and/or borrow pits approved by the Ministry of Mines and Minerals Development.

Additional Infrastructure

A single-story Operations and Maintenance (O&M) building of around 160 m2 with a workshop, store, control room, offices, telecoms and ablution facilities will be constructed

5.2 Impact Assessment considerations and outcome

5.2.1 IMPACT: Loss of Floral Habitat and Species Diversity in the Degraded Miombo Woodland

The Degraded Miombo Woodland remaining within the footprint area of the wind farm has, and still is, being impacted upon as a result of local community activities, notably clearing for agricultural lands and wood harvesting for general firewood, charcoal production and general construction activities within the various villages. The remaining areas of habitat are becoming ever more isolated, creating “island” of none cleared vegetation amongst the agricultural fields. This has resulted in fragmented habitat units which may also impact on potential seed dispersal patterns, pollination of floral species and the loss of potential unique floral species.

Construction Phase: The construction phase will result in the clearing of vegetation for the access roads and turbine footprint/ laydown areas. This will lead to the loss of floral species in these areas whilst also leading to additional habitat fragmentation. With mitigation the consequence and significance of the impacts for this phase can be reduced from a low to very low. This will largely be dependent on the ability to mitigate edge effects stemming from the footprint areas and roads.

Operational Phase:

The wind farm will have a notably decreased nature of impact once operational. This is largely as a result of no further vegetation clearing or road construction taking place. The significance

both prior to and post mitigation is expected to be low. Post mitigation is not expected to be very low as the newly built roads will allow for greater access to the surrounding areas, leading to further wood harvesting leading to a loss of larger woody species.

The table below presents the perceived impact on the Degraded Miombo Woodland associated with the wind farm construction and operation in terms of floral species loss, both prior to and post mitigation measures.

Table 4: **Assessment of impact: Loss of habitat and species diversity.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Medium	Low	Low	Low
Geographic Extent	Regional	Localised	Localised	Localised
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Probable
Consequence	Low	Very Low	Low	Low
Significance	Low	Very Low	Low	Low

5.2.2 IMPACT: Loss of Floral Habitat and Species Diversity in the Degraded Forest

The proposed layout will impact upon small areas of Degraded Forest in the north of the proposed wind farm. These degraded forest patches are surrounded by existing agricultural activities, with increased levels of wood harvesting for charcoal manufacturing evident on some of the slopes. Although these forest patches are small, they are still considered important in terms of habitat provision for floral species, notably species adapted to living in the forest understory. In addition, these forest patches serve as a source for seeds / plant dispersal for surrounding areas, should wood harvesting cease or old agricultural lands be abandoned.

Construction Phase: The construction phase will result in the clearing of vegetation for the access roads and turbine footprint/ laydown areas. This will lead to the loss of floral species in these areas, whilst also leading to additional habitat fragmentation. With mitigation the consequence and significance of the impacts for this phase can be reduced from a low to very low. This will largely be dependent on the ability to mitigate edge effects stemming from the footprint areas and roads as well as taking into considerations the recommendations made in Section 5.3 regarding the moving of certain turbine footprints and access roads.

Operational Phase:

The wind farm will have a notably decreased nature of impact once operational. This is largely as a result of no further vegetation clearing or road construction taking place. The significance both prior to and post mitigation is expected to be low. Post mitigation is not expected to be very low as the newly built roads will allow for greater access to the surrounding areas, leading to further wood harvesting and habitat loss.

The table below presents the perceived impact on the Degraded Forest associated with the wind farm construction and operation in terms of habitat and florall species loss, both prior to and post mitigation measures.

Table 5: **Assessment of impact: Loss of habitat and species diversity.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Medium	Low	Low	Low
Geographic Extent	Regional	Localised	Localised	Localised
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Probable
Consequence	Low	Very Low	Low	Low
Significance	Low	Very Low	Low	Low

5.2.3 IMPACT: Loss of Floral Habitat and Species Diversity in the Freshwater Habitat

The wind farm will impact upon several freshwater habitats, most notably as a result of the many road crossings associated with this habitat, but also due to the placement of a number of the wind turbine footprints within freshwater systems (see freshwater report for details on the various freshwater system types). The freshwater habitat is one of the most extensive and important habitats within the area as it provides niche habitat for floral species associated with freshwater areas, notably species adapted to areas of increased / permanent water-logged soils. The freshwater habitat also functions as an important floral seed dispersal corridor due to its extent throughout the study area. Seeds are distributed through water as well as faunal species that frequent this habitat.

Construction Phase: The construction phase will result in the clearing of vegetation for the access roads and turbine footprint/ laydown areas. This will lead to the loss of riparian vegetation and habitat within the affected dambos. Consequently, this will lead to a loss of floral species abundance and diversity in these areas, whilst also contributing to additional habitat fragmentation. With mitigation the consequence and significance of the impacts for this phase can be reduced from a low to very low. This will largely be dependent on the freshwater crossing designs and the degree to which they hamper water flow and the extent of the vegetation clearance. Should there be extensive downstream impacts, then the significance of the impact will increase.

Operational Phase:

The wind farm will have a notably decreased nature of impact once operational provided no further vegetation clearance occurs and that all freshwater crossings are properly maintained and do not contribute to further habitat degradation. The freshwater habitat is considered to be an important and sensitive habitat system, as such any activities herein, without sound mitigation, will likely result in a high impact. With mitigation measures, impacts can be adequately reduced. Provided the river crossings are well managed and no additional impacts to the receiving environment occur, the post mitigation impacts for this phase are likely to be low.

The table below presents the perceived impact on the Freshwater habitat associated with the wind farm construction and operation in terms of habitat and floral species loss, both prior to and post mitigation measures.

Table 6: **Assessment of impact: Loss of habitat and species diversity.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	High	Medium	Medium	Low
Geographic Extent	Regional	Localised	Localised	Localised
Duration	Medium-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Probable
Consequence	High	Very Low	Medium	Low
Significance	High	Very Low	Medium	Low

5.2.4 IMPACT: Loss of Floral Habitat and Species Diversity in the Agricultural Areas

The agricultural areas are the dominant land form / use within the current wind farm layout. These areas have already been cleared of vegetation and are currently being used for crop cultivation or lying fallow. These habitats are of low sensitivity and provide limited habitat to floral species.

Construction Phase: Construction activities will lead to surface hardening techniques being used as part of the installation of the wind farm. Impacts expected from the construction will likely result from edge effects and footprint creep. Such impacts will be of increased severity where the footprint areas are nearby adjacent Freshwater habitats.

Operational Phase:

The operational phase of the turbines and roads within the agricultural areas should have a minimal impact to the receiving environment provided that all mitigation measures are in place and that edge effects are suitably managed.

The table below presents the perceived impact on the Agricultural Areas associated with the wind farm construction and operation in terms of habitat and floral species loss, both prior to and post mitigation measures.

Table 7: **Assessment of impact: Loss of habitat and species diversity.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Low	Very low	Low	Low
Geographic Extent	Localised	Localised	Localised	Localised
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Possible
Consequence	Very Low	Very Low	Low	Low
Significance	Very Low	Very Low	Low	Very Low

5.2.5 IMPACT: Loss of Sensitive Floral Species

The region has seen extensive transformation through clearance of vegetation from Forest and Miombo Woodland to agricultural areas as well as for charcoal production. No floral SCC were observed at the time of assessment, however species such as *Pterocarpus tinctorius* (*chrysothrix*), *Pterocarpus angolensis*, *Boophone disticha* and *Habenaria schimperiana* are of concern due to increased harvesting in the region.

The turbine footprints have been predominantly located within already disturbed areas and as such decreases the risk of impact to SCC. Where the access roads and footprints impact upon Freshwater and Degraded Forest habitats, these species may be placed at increased risk.

Construction Phase: The construction phase will result in the clearing of vegetation for the access roads and turbine footprint/ laydown areas. This will lead to the loss of habitat and potential disturbance to floral species. Provided all mitigation measures are followed the overall impact to floral SCC is likely to be Very Low.

Operational Phase:

The operational phase of the turbines and roads should have a minimal impact to the receiving environment for SCC provided that all mitigation measures are in place and that edge effects are suitably managed. Provided all mitigation measures are implemented the overall impact significance is likely to be Very Low.

The table below presents the perceived impact on floral SCC associated with the wind farm construction and operation in terms of habitat and floral species loss, both prior to and post mitigation measures.

Table 8: **Assessment of impact: Loss of Species of Conservation Concern.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Low	Very low	Low	Low
Geographic Extent	Localised	Localised	Localised	Localised
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Possible
Consequence	Very Low	Very Low	Low	Low
Significance	Very Low	Very Low	Low	Very Low

5.3 Integrated Impact Mitigation

The table below highlights the key integrated mitigation measures that are applicable to all the proposed activities associated with the proposed Unika Wind Farm in order to suitably manage and mitigate the ecological impacts that are associated with the various phases. Provided that all the management and mitigation measures as stipulated in this report are implemented the overall risk to faunal and floral diversity, habitat and sensitive species can be adequately mitigated and minimised.

Table 9: A summary of the integrated mitigatory requirements for the terrestrial habitat

Project phase	*Construction Phase*
Impact Summary	*Loss of floral habitat, species and sensitive species*
Management Measures	***Proposed mitigation and management measures:***

	Development footprint
	• It is recommended that the following towers be relocated in order to avoid impacts on the remining Degraded Forests habitat:
	  ○ T10 – Shift the location approximately 100m NNE into the agricultural fields;
	  ○ T07 – Shift turbine approximately 250m SE into the cleared areas;
	  ○ T05 – Shift approximately 320m to avoid the Degraded Forest. Additionally, the indicated disturbance footprint for this tower falls over a hill with a steep incline to the north of the turbine point. This will result in increased vegetation loss and a loss of habitat connectivity along the vegetated hillside;
	  ○ T06 – shift turbine footprint out of the Forest area to the agricultural areas surrounding the turbine; and
	  ○ Shift T36 North into the agricultural lands.
	• Where possible use existing roads to access the turbine footprints, minimising the need to clear vegetation for new roads;
	• Where turbines can be accessed from other turbine site negating the need for additional freshwater habitat crossings, this must be done;
	• The proposed road between T56 and T65 and T38 and T49 should not be considered, these sites can be accessed without the need for these additional roads, thereby minimising crossings of freshwater habits;
	• To avoid additional impacts to a large freshwater system, the proposed road between T36 and T46 should not be constructed. These turbine sites can be accessed from the north and south respectively through the other roads;
	• Reconsider the proposed road between T18 and T11. The proposed route between T23 and T12 will avoid the Degraded Forest habitat however a well-designed stream crossing will be required for this route;
	• Road between T01 and T02 should b reconsidered. Access to T01 can be gained through the upgrading of an existing informal road from T03 to T01;
	• Removal of vegetation must be restricted to what is absolutely necessary and should remain within the approved development footprint;
	• All mitigation measures and turbine relocation suggestions as per the Freshwater Report must be taken into consideration;
	• Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the construction activities. Additional road construction should be limited to what is absolutely necessary, and the footprint thereof kept to a minimal;
	• Informal fires by construction personnel should be prohibited, and no uncontrolled fires whatsoever should be allowed;

	• Care should be taken during the construction of the proposed wind farm to limit edge effects to surrounding natural habitat. This can be achieved by: - Demarcating all footprint areas during construction activities; - No construction rubble is to be disposed of outside of demarcated areas, and should be taken to a registered waste disposal facility; - All soils compacted because of construction activities should be ripped and profiled and reseeded; and - Manage the spread of AIP species, which may affect remaining natural habitat within surrounding areas; • Appropriate sanitary facilities must be provided during the construction of the wind farm and must be removed to an appropriate waste disposal site; • No temporary dump sites should be allowed in areas with natural vegetation. It is advised that waste disposal containers and bins be provided during the construction phase for all construction rubble and general waste; • If any spills occur, they should be immediately cleaned up to avoid soil contamination that can hinder floral rehabilitation later down the line. Spill kits should be kept on-site within workshops. In the event of a breakdown, maintenance of vehicles must take place with care, and the recollection of spillage should be practised, preventing the ingress of hydrocarbons into the topsoil; and • Upon completion of construction activities, it must be ensured that no bare areas remain, and that indigenous species be used to revegetate the disturbed area. **Floral SCC** • No collection or harvesting of floral SCC must be allowed by construction personnel; and • Edge effect control needs to be implemented to prevent further degradation and potential loss of floral SCC outside of the proposed development footprint area, notably where disturbance footprints are near areas of increased sensitivity.
Project phase	*Operational Phase*
Impact Summary	*Loss of floral habitat, species and sensitive species*
Management Measures	**Proposed mitigation and management measures:** - Disturbed areas are to be rehabilitated to a similar state as that of pre-disturbance conditions. Where this is not possible due to operational and maintenance requirements, it is recommended that at a minimum a suitable herbaceous layer is maintained within the footprint of the wind farm turbine so as to ensure that no erosion occurs; - Continually monitor the operational activities and infrastructure areas associated with the turbine footprints and the access roads to ensure edge effects are being controlled and any impacts such as erosion are timeously discovered and rectified; - Ensure that no unnecessary clearing of habitat occurs during the operational phase; and - Monitor the success of rehabilitation efforts of disturbed areas seasonally.

6 CONCLUSION

Scientific Terrestrial Services (STS) was appointed to conduct faunal and floral ecological assessments as part of the Environmental and Social Impact Assessment Process for the proposed Unika Power Wind Farm in Eastern Zambia. This section reports on the floral ecology in the vicinity of the study areas operations.

During the field assessment, a number of habitat units were identified. These habitat units are:

- Degraded Forest Habitat, comprising of several forest tree species, where trees exceeded 8m in height with large predominantly interlinking canopies. This habitat unit was observed primarily in the upper reaches of the large inselbergs and central mountainous areas of the study area This habitat however is continually being impacted upon and decreasing in extent and diversity due to the harvesting of timber for charcoal production, leading to the encroachment of miombo woodland species;
- Degraded Miombo Woodland Habitat, the dominant vegetation type within the study area and that of southern Zambia. The characteristics of this habitat unit were varied, with some of the more degraded areas being noted to have fewer characteristic/typical miombo floral species. The woodlands typically comprised of trees varying between 4 – 8m in height but without densely interlocking canopies;
- Freshwater Habitat, comprising of streams and dambos (wetlands). This habitat unit has been notably impacted upon as a result of vegetation clearance for agriculture (grazing and crop cultivation). The dambos and streams convey large amounts of water through the study area, however the large-scale removal of vegetation has resulted in increased peak water flows; leading to erosion within the dambos and that of the stream banks; and
- Transformed habitat, associated with cultivated fields and areas where vegetation has been cleared in order to provide increased grazing for livestock, both in association with the areas surrounding the villages and at some distance from villages where new fields are being cleared.

During the field assessment it was evident that due to the continued expansion of the resident communities and the current economic climate, there has been an increased push towards small scale crop production as well as the manufacturing of charcoal from harvested trees. The activities have led to the continuous and extensive loss of floral habitat and species diversity through vegetation clearance activities. Such activities have additionally benefitted communities with cattle and goats, which move are grazed in these cleared areas. The

increased levels of grazing have further led to a change in the species composition of the herbaceous layer.

The proposed construction of the wind turbines is likely to result in further vegetation clearance for the turbine footprints, access roads and the proposed new powerlines to link the turbines to the existing power grid. These activities will result in additional floral species and habitat loss, with potential unplanned spinoff impacts stemming from the increased levels of area access created by the new access roads. Such spinoff impacts include an increased level of wood harvesting in areas that may have previously been less accessible, leading to increased wood harvesting and habitat degradation.

From a floral perspective it is recommended that the sensitivity map is taken into consideration when refining the turbine and associated infrastructure footprint layout, and that as far as possible all infrastructure but especially turbines are located outside of the sensitive Freshwater and Degraded Forest habitats.

This report is to be used to guide the proponent, Environmental Assessment Practitioner (EAP) and regulating authorities, by means of the presentation of information on the baseline conditions, as to the future project layouts from an ecological risk management point of view as well as provide high level mitigation and management measures to help manage potential and existing impacts.

7 REFERENCES

NOTE: Reliable reference material at the required level of detail and accuracy is scant, and thus verified and accurate reference material was utilised. These references are internationally accepted and although many of them do not specifically cover the study area, the species ranges and distributions overlap. Notes on ecological and biological requirements allowed the specialists to reliably extrapolate data.

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APPENDIX A: Floral method of Assessment

Floral Species of Conservational Concern Assessment

Prior to the field visit, a record of floral SCC and their habitat requirements was acquired from the relevant in country and international lists. Throughout the floral assessment, special attention was paid to the identification of any of these SCC as well as the identification of suitable habitat that could potentially support these species.

The Probability of Occurrence (POC) for each floral SCC was determined using the following calculations wherein the distribution range for the species, specific habitat requirements and level of habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research.

Each factor contributes an equal value to the calculation.

Distribution						
	Outside of known distribution range					**Inside known distribution range**
Site score						
EVC 1 score	0	1	2	3	4	5
Habitat availability						
	No habitat available					**Habitat available**
Site score						
EVC 1 score	0	1	2	3	4	5
Habitat disturbance						
	0	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score						
EVC 1 score	5	4	3	2	1	0

[Distribution + Habitat availability + Habitat disturbance] / 15 x 100 = POC%

Vegetation Surveys

Vegetation surveys were undertaken by first identifying different habitat units and then analysing the floral species composition that was recorded during detailed floral assessments using the step point vegetation assessment methodology. Different transect lines were chosen throughout the entire study area within areas that were perceived to best represent the various plant communities. Floral species were recorded and a species list was compiled for each habitat unit. These species lists were also compared with the vegetation expected to be found within the relevant vegetation types as described in Section 4, which serves to provide an accurate indication of the ecological integrity and conservation value of each habitat unit (Evans & Love, 1957; Owensby, 1973).

Floral Habitat Sensitivity

The floral habitat sensitivity of each habitat unit was determined by calculating the mean of five different parameters which influence floral communities and provide an indication of the overall floristic ecological

integrity, importance and sensitivity of the habitat unit. Each of the following parameters are subjectively rated on a scale of 1 to 5 (1 = lowest and 5 = highest):

- **Floral SCC:** The confirmed presence or potential for floral SCC or any other significant species, such as endemics, to occur within the habitat unit;
- **Unique Landscapes:** The presence of unique landscapes or the presence of an ecologically intact habitat unit in a transformed region;
- **Conservation Status:** The conservation status of the ecosystem or vegetation type in which the habitat unit is situated based on local, regional and national databases;
- **Floral Diversity:** The recorded floral diversity compared to a suitable reference condition such as surrounding natural areas or available floristic databases; and
- **Habitat Integrity:** The degree to which the habitat unit is transformed based on observed disturbances which may affect habitat integrity.

Each of these values contribute equally to the mean score, which determines the floral habitat sensitivity class in which each habitat unit falls. A conservation and land-use objective is also assigned to each sensitivity class which aims to guide the responsible and sustainable utilization of the habitat unit in question. In order to present the results use is made of spider diagrams to depict the significance of each aspect of floral ecology for each vegetation type. The different classes and land-use objectives are presented in the table below:

Table A1: Floral habitat sensitivity rankings and associated land-use objectives.

Score	Rating significance	Conservation objective
1> and <2	Low	Optimise development potential.
2> and <3	Moderately low	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.
3> and <4	Intermediate	Preserve and enhance biodiversity of the habitat unit a surrounds while optimising development potential.
4> and <5	Moderately high	Preserve and enhance the biodiversity of the habitat u limit development and disturbance.
5	High	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.

APPENDIX B: Floral Species List

Table B1: Floral species encountered during the field assessments.

Species	Degraded Forest	Degraded Miombo Woodland	Freshwater Habitat (Dambos And Riparian)	Agricultural Areas
Trees				
Anona senegalensis		X	X	X
Terminalia sericea				X
Hexaloba monopetalus		X		X
Pericopsis angolensis	X			X
Mangifera indica				X
Crossopteryx febrifuga				X
Vachelia sieberiana				X
Terminalia sericea	X			X
Ficus sycamorous				X
Vangueria infausta				X
Xylomphis obovata				X
Stegnotaenia araliacea		X		X
Brachystegia boehmii	X	X		X
Dichrostachys cinerea	X	X		X
Julbenardia paniculata		X		X
Parinari curatelifolia		X		X
Uapaca siberiana				X
Azanza garkeana				X
Diospiros kirki	X			X
Flacourtia indica				X
Piliostigma thoningii		X		X
Dalbegiella nyasae				X
Julbernardia globiflora	X			
Brachystegia bussei	X			
Adenia senensis	X			
Lannea discolor	X	X		
Cassia singueana	X			
Pterocarpus angolensis	X	X		
Pterocarpus chrysothrix	X			
Dalbergia martini	X			
Combretum molle	X	X		
Brachystegia utilis	X	X		
Vachellia nigrescens	X			
Commiphora africana	X			
Erythrina abbyssinica	X			
Kigelia africana	X			
Diplorhyncus condylocarpon	X	X		
Pseudolacnostylis maprouneifolia	X	X		
Brachystegia longifolia	X			
Khaya nyasica			X	
Popowia obovata			X	
Combretum aedonogonium			X	
Senegalia polyacantha			X	
Cassia abbreviata		X	X	
Bauhinia petersiana			X	
Xeroderis stulhmani			X	
Psidium guajava			X	

Species	Degraded Forest	Degraded Miombo Woodland	Freshwater Habitat (Dambos And Riparian)	Agricultural Areas
Ficus sycamorous			X	
Syzigium cordatum			X	
Sterculia sp			X	
Mucuna coriacea			X	
Stereospermum kunthianum			X	
Vitex doniana			X	
Piliostigma thonningii			X	
Antidesma venosum			X	
Grewia caffra			X	
Markhamia obstifolia			X	
Ochna schweinfuthiana		X		
Diplorynchus condylocarpon		X		
Dyospyros kirkii		X		
Protea angolensis		X		
Uapaca sansibarica		X		
Julbernadia paniculata		X		
Julbernadia globiflora		X		
Rothmania sp		X		
Brinodia causina		X		
Ozoroa insignis		X		
Combretum sp		X		
Lannea edulis		X		
Swartzia madagascariensis		X		
Albizia harveyii		X		
Burkea africana		X		
Hymenocardia acida		X		
Ozoroa reticulata		X		
Vangueriopsis lanciflora		X		
Xeromphis obovata		X		
Combretum adenogonium		X		
Dyplorynchus condylocarpon		X		
Strychnos cocculoides		X		
Forbs and Graminoids				
Hyparrhenia spp				X
Solanum panduriformes				X
Sporobolus africanum			X	X
Setaria pumila				X
Hibiscus meeusei				X
Digitaria eriantha			X	X
Bidens schimperi				X
Chorchorus triden			X	X
Euphorbia hirta				X
Panicum spp.	X	X	X	
Bidens pilosa			X	
Solanum africanum		X	X	
Afromomum alboviolaceum		X		
Ledebouria revoluta		X		
Boophone disticha		X		
Chlorophytum clarae		X		
Costus spectabilis	X	X		
Cyperus esculenta			X	
Platycoryne buchanania			X	
Cyperus sp.			X	
Kyllinga pumila			X	

Species	Degraded Forest	Degraded Miombo Woodland	Freshwater Habitat (Dambos And Riparian)	Agricultural Areas
Habenaria schimperiana			X	
Gnidia chrysantha			X	
Ascolepis protea			X	
Hypoxis nyasica			X	
Drocera sp.			X	

APPENDIX C: SPECIALISTS DETAILS

Details, Expertise and Curriculum Vitae of Company and Author

SCIENTIFIC TERRESTRIAL SERVICES (STS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTOPHER HOOTON

PERSONAL DETAILS

Position in Company	Ecologist
Date of Birth	24 June 1986
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2013

EDUCATION

Qualifications

BTech Nature Conservation (Tshwane University of Technology)	2013
National Diploma Nature Conservation (Tshwane University of Technology)	2008

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Eastern Cape, Western Cape, Northern Cape, Freestate
Zimbabwe, Zambia

SELECTED PROJECT EXAMPLES

Faunal Assessments

- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Mzimvubu Water Project, Eastern Cape.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Setlagole Mall Development, North West.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Expansion and Upgrade of the Springlake Railway Siding, Hattingspruit, Kwa-Zulu Natal.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Styldrift tailings storage facility, return water dams, topsoil stockpile and other associated infrastructure, North West.
- Faunal assessment as part of the environmental assessment and authorisation process for the development of a proposed abalone farm, Brand se Baai, Western Cape.
- Faunal assessment as part of the environmental assessment and authorisation process for the development of a proposed abalone farm, Doringbaai, Western Cape.
- Vegetation composition and subsequent loss of carrying capacity for the Rand Water B19 and VG Residue Pipeline Project, Freestate.
- Faunal assessment as part of the environmental assessment and authorisation process for the Evander Shaft 6 Plant Upgrade, New Tailings Dam Area and Associated Tailings Delivery and Return Water Pipeline, Evander, Mpumalanga.

Previous Work Experience

- Spotted Hyaena Research Project, Phinda Private Game Reserve, KwaZulu Natal.
- Camera Trap Survey as part of the Munyawana Leopard Project, Mkuze Game Reserve, KwaZulu Natal.
- Lowveld Wild Dog Project, Savé Valley Conservancy, Zimbabwe.
- Lion collaring and Tracking as part lion management program, Savé Valley Conservancy, Zimbabwe.
- Junior Nature Conservator, Gauteng Department of Rural Development and Land Reform.

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TERRESTRIAL, AQUATIC AND WETLAND ECOLOGICAL STUDIES TO INFORM THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED UNIKA WIND FARM DEVELOPMENT IN THE EASTERN PROVINCE OF ZAMBIA

Prepared for

SLR Consulting

June 2019

Section C: Faunal Assessment

Prepared by: Scientific Terrestrial Services
Report author: C. Hooton
Report reviewer: A. Mileson
Report Reference: STS 180068
Date: November 2020

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ACRONYMS

EAP	Environmental Assessment Practitioner
EIS	Ecological Importance and Sensitivity
EN	Endangered
ESIA	Environmental and Social Impact
ESMP	Environmental and Social Management Plan
GIS	Geographic Information System
GPS	Global Positioning System
IEM	Integrated Environmental Management
IUCN	International Union for Conservation of Nature
LC	Least Concern
NT	Near Threatened
NYBA	Not yet been assessed
PES	Present Ecological State
POC	Probability of Occurrence
SCC	Species of Conservation Concern
STS	Scientific Terrestrial Services
VU	Vulnerable

1. INTRODUCTION

1.1 Background

Scientific Terrestrial Services (STS) was appointed to conduct faunal and floral ecological assessments as part of the Environmental and Social Impact Assessment (ESIA) process for the proposed Unika Wind Farm in Eastern Zambia, henceforth referred to as the "study area". The study area is situated approximately 800m from the T4 (Great East Road) highway. The study area spans an area of approximately 35,000 ha, and encompasses the villages of Gomani, Chibela, Mbangombe and Kachingwe.

This report aims to map, consider and describe the faunal species and associated ecological conditions with the study area according to the results of the survey. In addition, the habitat integrity, ecological importance and sensitivity is considered and discussed. In doing so this report must guide the proponent, Environmental Assessment Practitioner (EAP) and regulating authorities, by means of the presentation of information on the baseline conditions, as to the management of current and future mining operations from an ecological risk management point of view as well as the further studies and assessments required.

Following the assessments, the ecological risks were determined, and the analyses of the impacts associated with the project are presented in Section E (Impact assessment). Key mitigatory measures were identified in order to minimise the potential impacts on both the local and regional faunal ecology.

2 ASSESSMENT APPROACH

Initially, a desktop study was undertaken to gather background information regarding the site and its surrounding areas. This involved consulting maps, aerial photographs and digital satellite images in order to determine broad habitats and sensitive sites; a literature review concerning habitats, faunal species distributions and identifying the status of the land as well as conservation requirements and nearby conservation and protected areas. Following this, a summer (February 2019) field assessment was undertaken during which the data gathered during the desktop assessment phase was utilised to confirm the presence of potentially sensitive habitats and compile faunal species inventories for each habitat unit. The species lists include potential faunal Species of Conservation Concern (SCC) that may utilise the study area. Detailed explanations of the faunal methods of assessment are provided in Appendix A of this report. The faunal categories covered in this assessment are mammals, reptiles, amphibians, general invertebrates and arachnids.

3 FAUNAL ASSESSMENT RESULTS

3.1 Habitat Description

Habitat integrity combined with the overall availability of resources to faunal species is a large determinant factor in terms of species diversity and abundance, as well as influencing the likelihood of SCC occurrence. The study area was assessed in terms of the current levels of habitat integrity and habitat provision for faunal species as is outlined below.

After investigation, it is evident that four faunal habitat units exist within the study area, namely:

- Miombo Woodland Habitat;
- Degraded Forest Habitat;
- Agricultural Areas; and
- Freshwater Habitat.

The above-mentioned habitat units are discussed briefly below; for further information please see the floral report (Section B).

Miombo Woodland

This habitat unit has been subjected to disturbance from the local communities as it is predominantly associated with the low lying flat and undulating areas between the other habitat units. Vegetation clearing for agriculture and for charcoal production has resulted in

the loss of habitat for faunal species. These impacts combined with the increased human presence in the study area has resulted in a markedly low abundance of mammal species in this habitat, however, the abundance and diversity of invertebrates and reptiles does not appear to have suffered the same fate.

Degraded Forest

This habitat unit predominantly encompasses the mountainous and inselberg areas and is characterised by large tall trees with interlinking canopies. This habitat is continually being impacted upon and decreasing in extent and diversity due to the harvesting of timber for charcoal production, leading to the encroachment of miombo woodland species. Although this habitat unit has been subject to anthropogenic activities and impacts, it is still considered capable of providing habitat and resources to a number of faunal species.

Agricultural Areas

Associated with cultivated fields and areas where vegetation has been cleared in order to provide increased grazing for livestock, both in association with the areas surrounding the villages and at some distance from villages where new fields are being cleared. This habitat still provides rudimentary habitat and food resources for faunal species, notably insects and arachnids. It is possible that reptiles and small mammals will also utilise this habitat periodically.

Freshwater Habitat

This habitat unit comprises of the streams and dambos (wetlands) associated with the study area. This habitat unit has been impacted upon as a result of vegetation clearance for agriculture (grazing and crop cultivation). The dambos and streams convey large amounts of water through the study area, however the large-scale removal of vegetation has resulted in increased peak water flows; leading to erosion within the dambos and that of the stream banks. The streams and associated riparian vegetation still provide movement corridors for faunal species and as such are considered important for habitat connectivity. In addition, the freshwater areas provide suitable and stable habitat for insect species, notably those often associated with water bodies as well as a diversity of amphibian and reptile species.

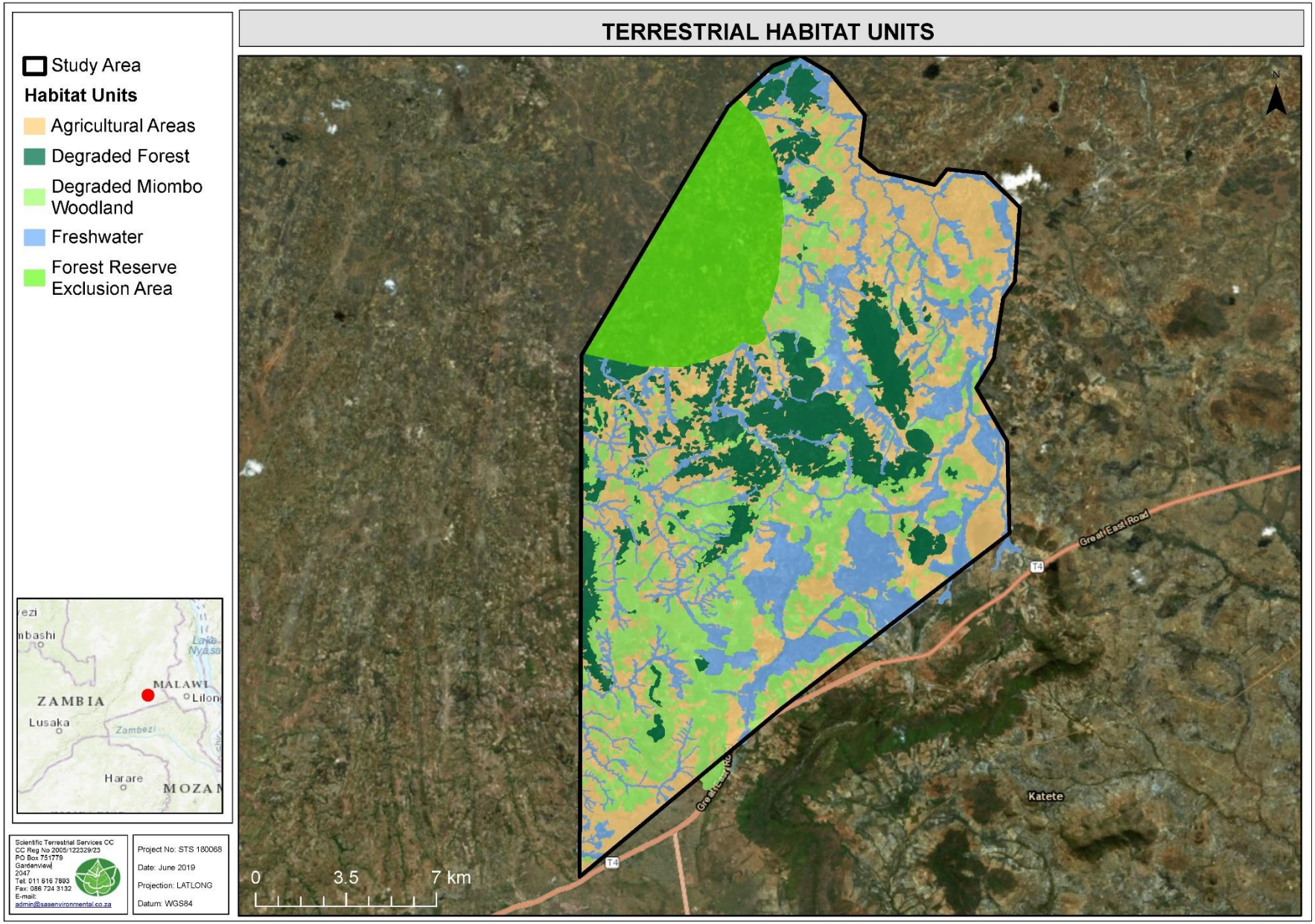


Figure 1: Conceptual illustration of the habitat units within the study area with current turbine location.

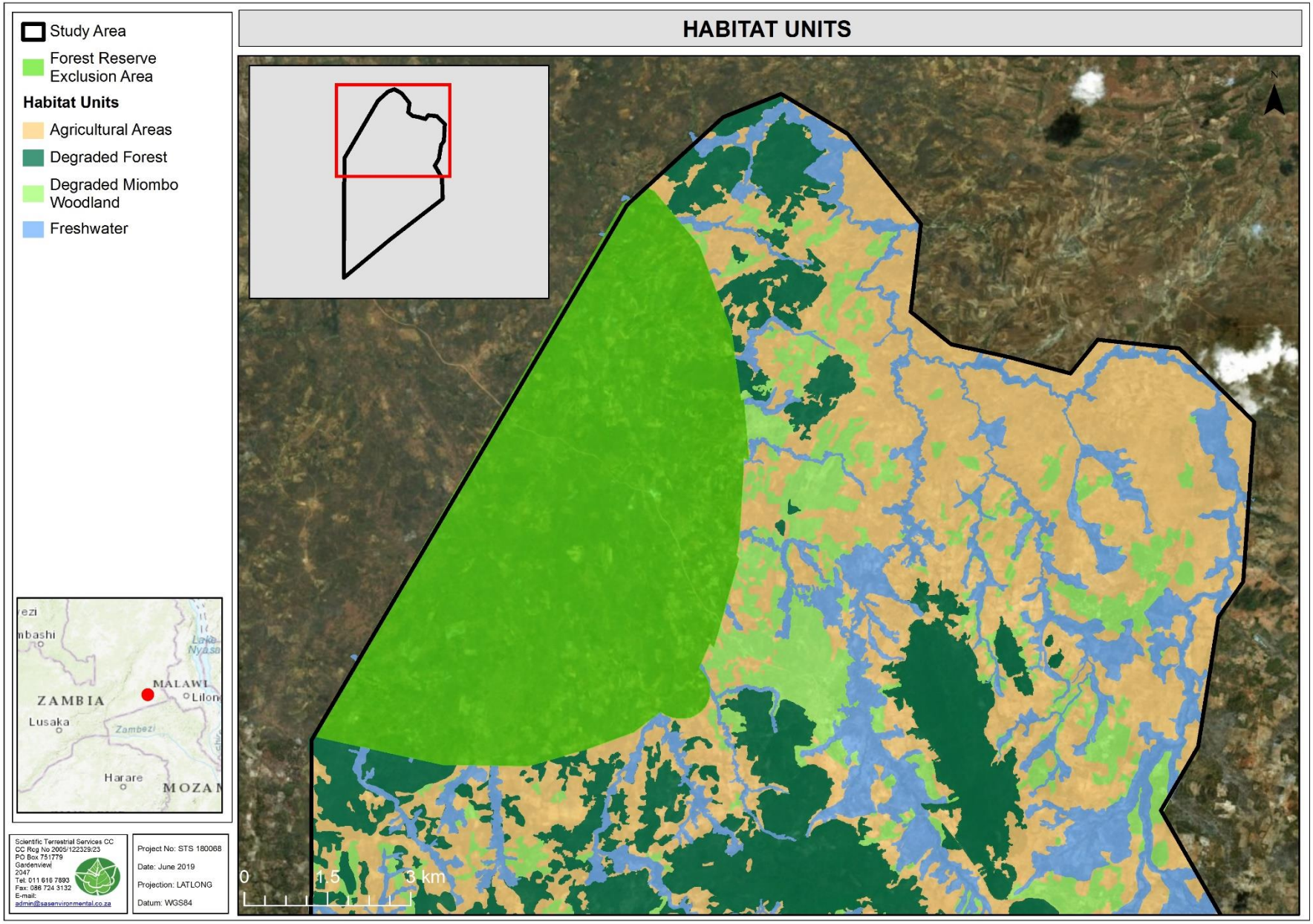


Figure 2: Conceptual illustration of the habitat units within the northern portion of the study area.

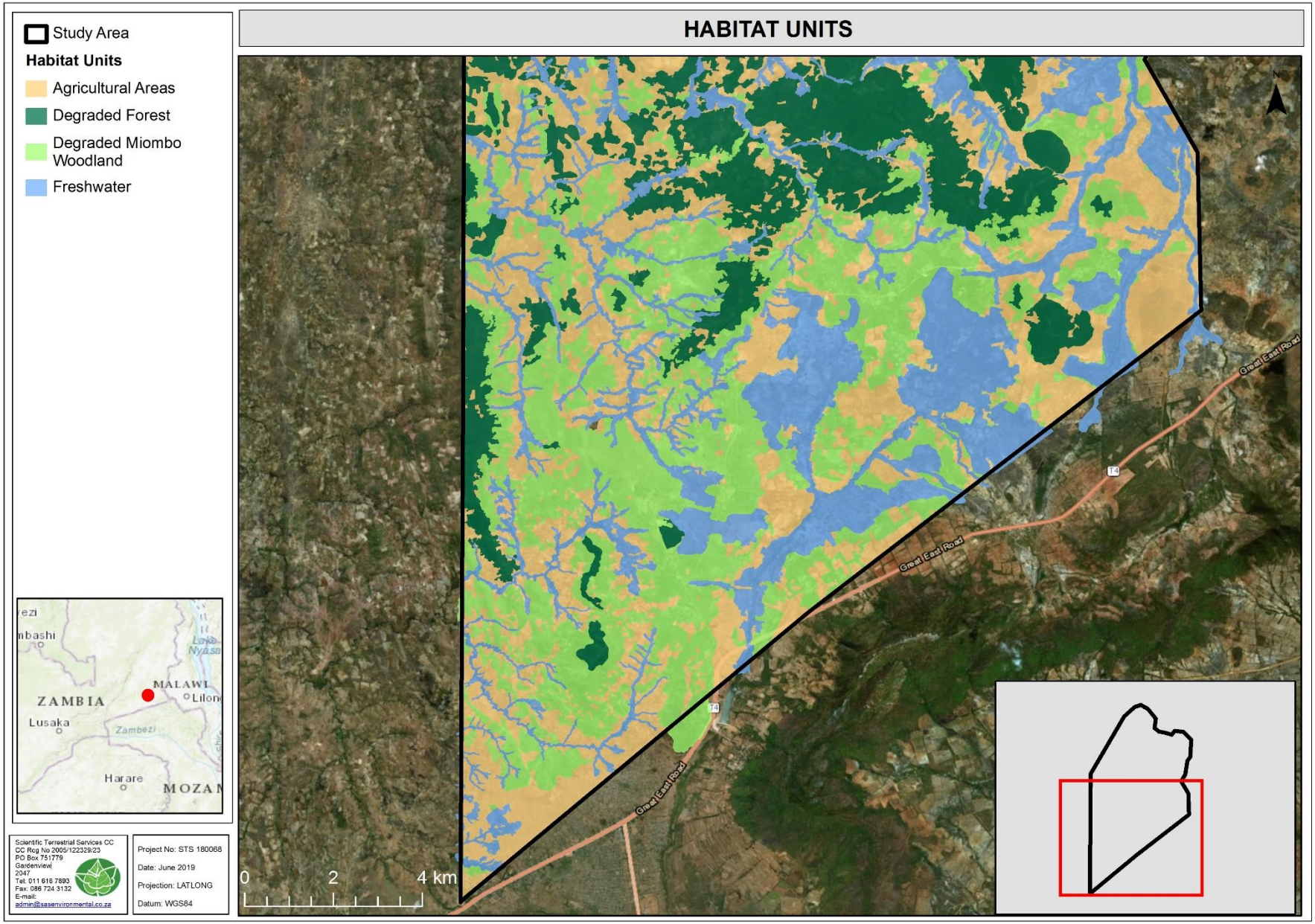


Figure 3: Conceptual illustration of the habitat units within the southern portion of the study area.

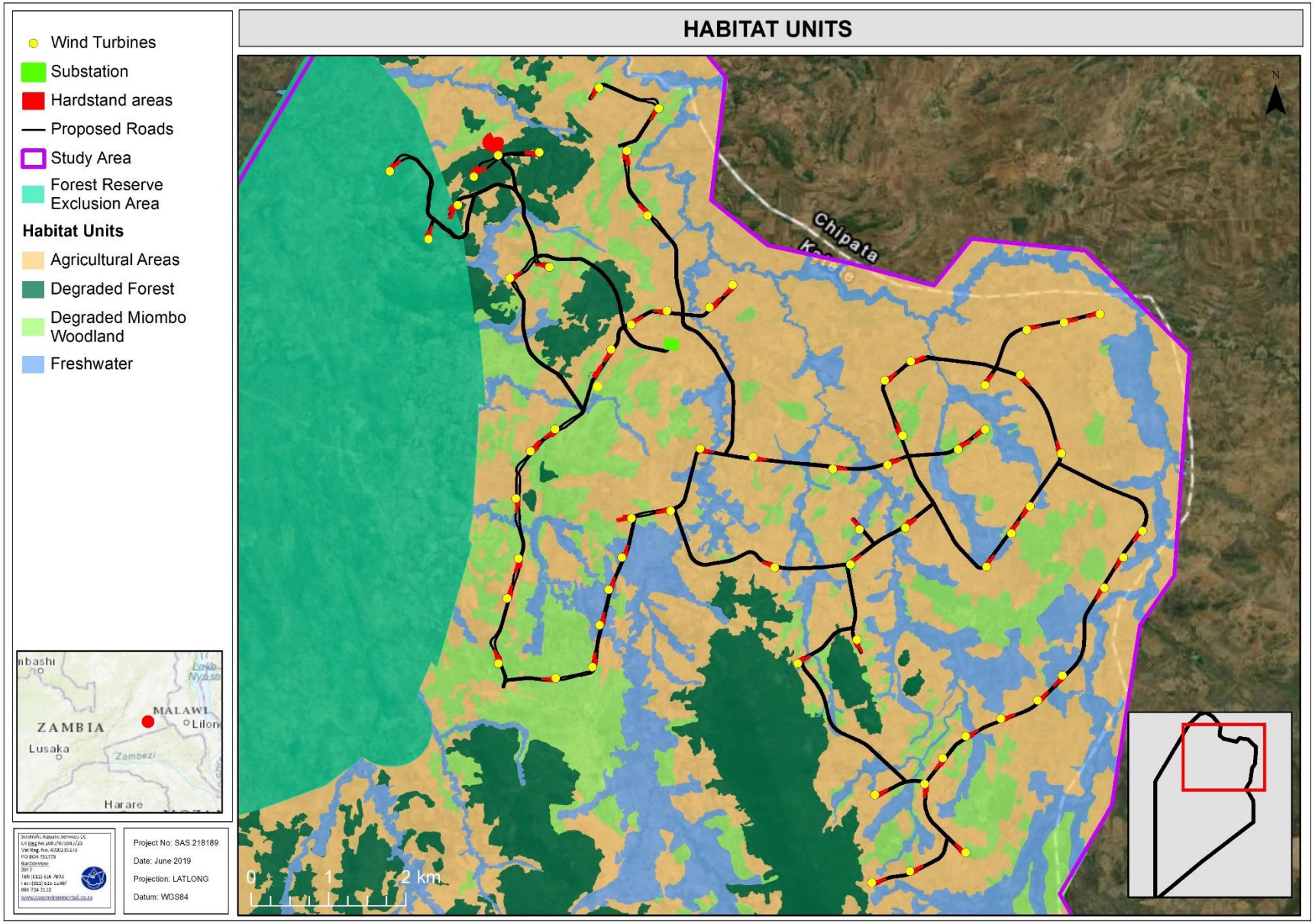


Figure 4: Conceptual illustration of the habitat units associated with the proposed layout.

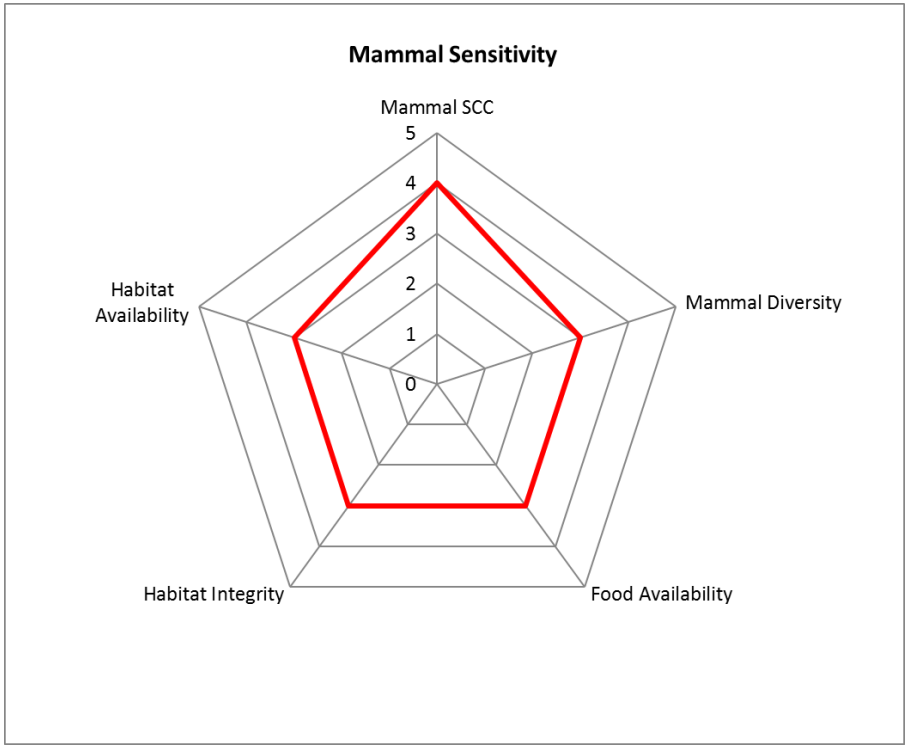
3.2 Mammals

Table 1: Mammal assessment for the Unika Wind Farm Project.

Mammals	**Photographs: Above**, habitat loss due to deforestation. **Bottom left** spoor likely of *Cricetomys ansorgei* (East African Pouched Rat) and **bottom right** *Heterohyrax brucei* (Yellow-spotted Hyrax) observed in one of the smaller inselbergs.

Mammal Sensitivity	Intermediate	Faunal Species of Conservation Concern (SCC)

Faunal Habitat Sensitivity Graph:



No mammal SCC were observed at the time of the assessment. Although not observed, it is possible that the following species may occur within the study area: *Eidolon helvum* (African Straw-coloured Fruit-bat, NT), *Otomops martiensseni* (Large-eared Free-tailed Bat, NT), *Hipposideros vittatus* (Commerson's Leafnosed Bat, NT) and *Aonyx capensis* (African Clawless Otter, NT). Of these species the proposed wind turbines pose the greatest threat to the bats, which are likely to utilise the large forest canopies and caves/crevices amongst the mountains for roosting. Bat mortalities are well documented with regards to wind turbines, and as such it is recommended that all mitigation measures as stipulated in the specialist bat study are taken into consideration and implemented. The impact of the turbines on *Aonyx capensis* is likely to be minimal to non-existent, as this species inhabits the freshwater systems with surface water and placement of turbines within these habitat units is not recommended and is unlikely. In addition to these species, although unlikely to occur in the study area due to poaching and the medicinal trade, *Smutsia temminckii* (Temminck's Ground Pangolin, VU) probably once did inhabit the Miombo Woodland in the study area.

General Discussion and key points

During the field assessment very limited signs of mammal species were observed. During consultations with the *Nduna* from the area, it was ascertained that over the years the cutting down of the forests for charcoal production, clearing of the miombo woodland areas for agriculture and the intensified subsistence hunting has resulted in a significant decrease and loss of mammals from the region. It is likely that as a result of the habitat loss and increased persecution levels that the remaining species have either sought refuge in the more inaccessible areas of the forest habitat or have migrated to areas which are deemed safer and have a decreased human presence.

The Forest habitat in this regard in the higher mountainous areas is still likely to harbour a few mammal species, notably those which are shy and secretive, such as the *Potamochoerus larvatus* (Bushpig), *Otolemur crassicaudatus* (Brown Greater Galago) and *Cercopithecus mitis* (Blue Monkey), although these species are likely to be under increased persecution as they are hunted for the bush meat trade. In addition, the freshwater systems may play host to *Ichneumia albicauda* (White-tailed Mongoose). The small predatory mammal *Otocyon megalotis ssp. virgatus* (Eastern Bat-eared Fox) is also likely to occur in the study area. The Miombo Woodlands and Freshwater Habitats are likely to provide habitat to smaller less conspicuous mammal species of the Rodentia family as well as small scrub hares. In addition, the Freshwater systems and associated riparian areas may provide movement corridors for mammal species, allowing them to traverse the study area under cover, minimising detection. Food resources are deemed adequate for the remaining species in the study area; however, the continued habitat modification has had a notable impact on such resources as well as the overall habitat integrity for mammals.

Business Case, Conclusion and Mitigation Requirements:

Habitat for mammals is still available in the forested areas in the central portion of the study area, however the increased persecution faced by mammals species due to them being perceived as a food source has inevitably resulted in a low recorded abundance. The miombo woodland is likely to be utilised by smaller mammals, but even in these areas persecution and habitat degradation has resulted in a low recorded diversity. The construction and operation of the wind turbines are unlikely to impact upon terrestrial mammals, provided the footprints remain outside of the designated sensitive areas and the construction footprints remain as small as possible.

Of concern is the possible impact that the wind farm turbines may have on bat species in the study area, notably as it is possible that bat SCC may occur within the forest areas. In this regard all guidelines and mitigations stipulated by the bat specialist studies should be adhered to and implemented.

3.3 Amphibians

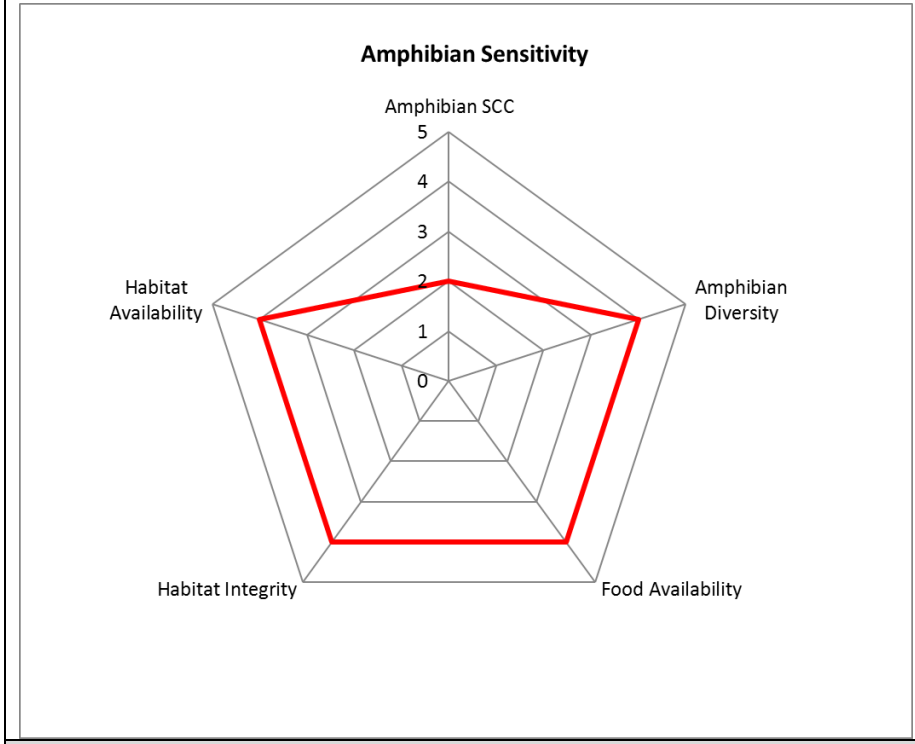
Table 2: Amphibian assessment for the Unika Wind Farm Project.

Amphibians	**Photographs: Top left:** *Hyperolius viridiflavus* (Common Reed Frog); **Top Right:** Foam nest of *Chiromantis xerampelina* (Grey Foam-nest Tree Frog); **Bottom left:** *Arthroleptis stenodactylus* (Common Squeaker) and **Bottom right:** *Phrynobatrachus mababiensis* (Mababe Puddle Frog).




Amphibian Sensitivity	Moderately High	Faunal Species of Conservation Concern (SCC)

Faunal Habitat Sensitivity Graph:



No amphibian SCC were observed within the study area. The available databases further do not indicate the possible current or historical occurrence of amphibian SCC in the study area.

General Discussion and key points

During the field assessment several amphibian species were observed, notably in the freshwater habitats associated with the Miombo Woodlands and the Forests. The abundance and diversity of amphibian species in the study area is largely attributable to the large areas of standing water and damp soils as well as a high level of food resources in the form of abundant insects. Amphibian species are often a good bio-indicator of ecosystem health, notably that of freshwater systems, as they are generally susceptible to pollution and unnatural toxicants in the water. Although the study area has been subjected to extensive habitat alteration, land use changes and forest clearing, it is evident that the water systems are still in good health. The Dambos, forest streams and streams in the Miombo Woodlands all provide high levels of suitable habitat both for foraging and breeding of amphibian species. The interconnectedness of the freshwater habitat further ensures that the overall habitat integrity for amphibian species remains moderately high, allowing for the free and relatively easy movement of such species throughout the study area.

Additional species that are expected to occur within the study area include but are not limited to *Sclerophrys gutturalis* (Guttural Toad), *Leptopelis bocagii* (Bocage's Tree Frog), *Breviceps poweri* (Power's Rain Frog), *Phrynobatrachus natalensis* (Natal Puddle Frog), *Tomopterna marmorata* (Marbled Sand Frog), *Sclerophrys pusilla* (Eastern Flat-backed Toad), *Arthroleptis xenodactyloides* (Dwarf Squeaker), *Hyperolius marginatus*, *Hemisus marmoratus* (Shovel-nosed Frog), *Schismaderma carens* (African Split-skin Toad) and frogs of the Genus Ptychadena (Ridged/Grass Frogs).

All the aforementioned species are likely to occur within the Freshwater Habitat and the associated areas of increased moisture surrounding these freshwater systems.

Business Case, Conclusion and Mitigation Requirements:

The study area, notably the freshwater systems are likely to support a moderately high diversity and abundance of amphibian species; as such the overall amphibian sensitivity is deemed to be moderately high. It is imperative that risks and impacts to amphibian species are minimised and that all proposed turbine footprints or those of associated infrastructure not be located within any of the Freshwater Habitats or within the recommended buffers so as to ensure that edge effects do not lead to unnecessary habitat degradation. Amphibian species currently fulfil an important ecological function in the study area as they help to regulate the abundance of insect species, and in turn are also utilised as a food resource by some reptile and avifaunal species.

Through ensuring that turbines are located outside of the Freshwater Habitat and relevant buffer zones, whilst implementing clear and concise mitigation measures and ecological appropriate building methods, the proposed wind turbine farm is unlikely to have a significant impact on the amphibian assemblage of the study area.

3.4 Reptiles

Table 3: Reptile assessment for the Unika Wind Farm Project.

Reptiles	**Photographs: Top row left to right:** *Varanus niloticus* (Nile Monitor) tracks and individual, *Afrotyphlops schmidti* (Schmidt's Blind-Snake) and *Trachylepis varia* (Variable Skink); **Bottom row left to right:** *Chamaeleo dilepis* (Flap-necked Chameleon), *Trachylepis margaritifera* (Rainbow Skink), *Agama armata* (Tropical Spiny Agama) and *Panaspis wahlbergi* (Wahlberg's Snake-eyed Skink).

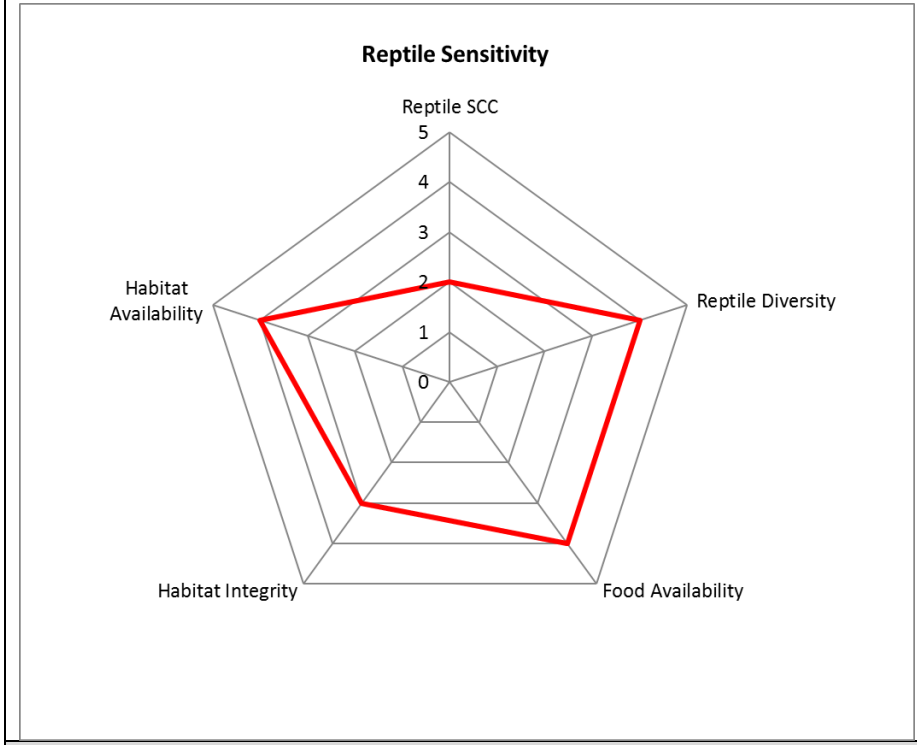







Reptile Sensitivity	Moderately High	Faunal Species of Conservation Concern (SCC)

Faunal Habitat Sensitivity Graph:



No reptile SCC were observed within the study area. Furthermore, the available databases do not indicate the possible current or historical occurrence of reptile SCC in the study area.

General Discussion and key points

During the field assessment several reptile species were observed throughout the study area but not in close proximity to the villages. Although the habitat within the study area has been degraded, reptile species show remarkable resilience to such degradation, often able to continue thriving in these changed environments. This is largely due to their ability to live in and amongst human populations with ease, whilst still finding adequate food resources to sustain themselves. The smaller lizards' and skinks' primary food resource is that of the abundant insect life in the study area, whilst the larger predatory snakes and lizards will rely on larger prey items such as rodents, other reptiles, amphibians and nestlings of bird species. Although not photographed, during the site assessment individuals of *Naja mossambica* (Mozambique Spitting Cobra) were often observed, as well as a snake most likely of the Genus Amblyodipsas (Purple-glossed Snakes). Both of these snakes were observed in and around the freshwater habitat, most likely foraging for small mammals and amphibians.

Business Case, Conclusion and Mitigation Requirements:

The reptile sensitivity associated with the study area is expected to be moderately high. The study area had a notably high abundance of reptile species throughout most of the habitat units, with even the village areas being inhabited by some of the smaller skinks. Although reptiles are often subjected to high levels of persecution, their small stature and ability to move about unnoticed helps to ensure that they can persist in most environments associated with humans.

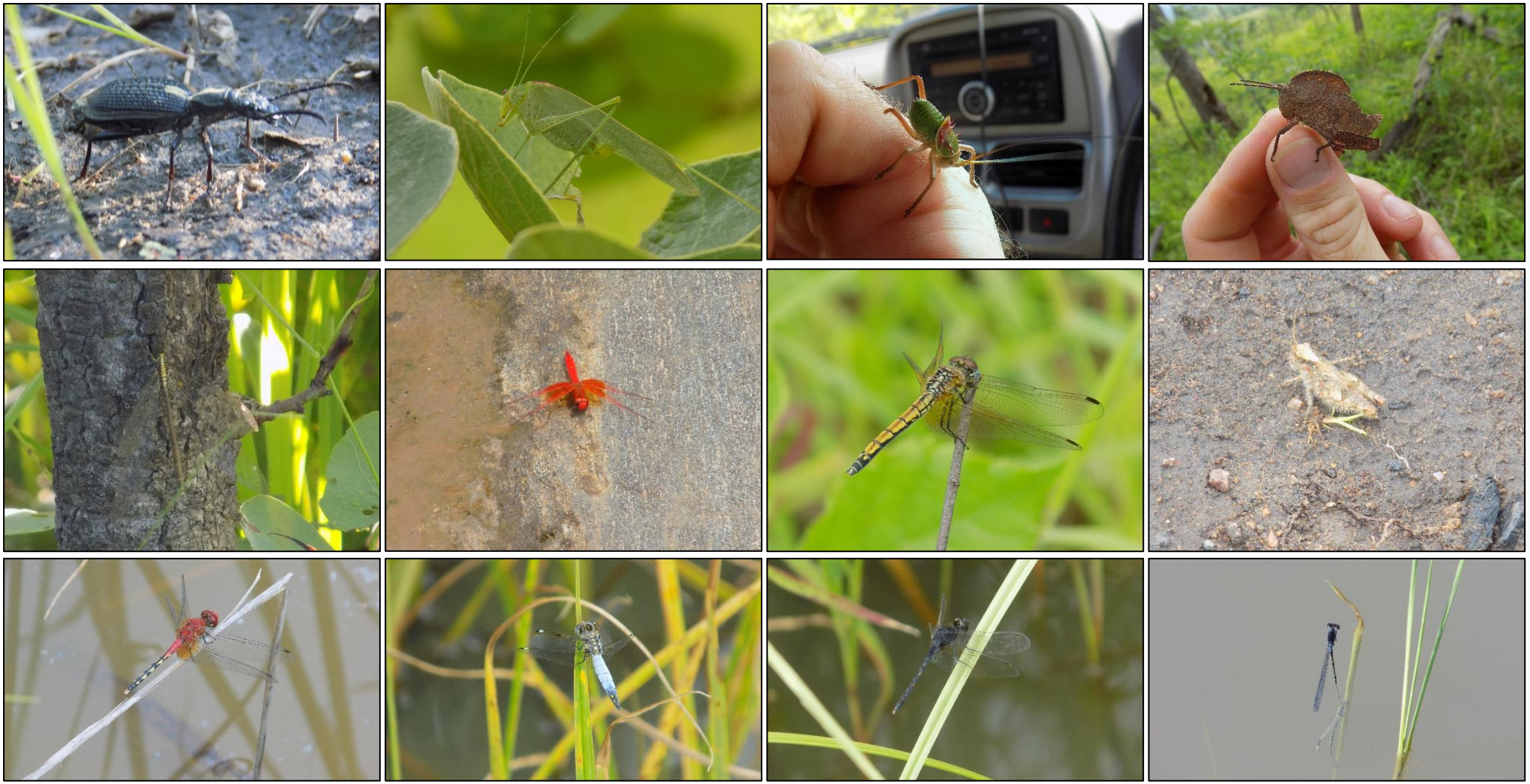
Provided that the turbine footprints and those of larger infrastructure such as substations and the Operations and Management building remain outside of the important reptile habitats such as the inselbergs with their rocky outcrops and the freshwater systems, the proposed development of the wind farm is unlikely to have a significant negative impact on reptile species in the study area. Construction and maintenance workers are to be made aware of the presence of reptile species as well as the risks associated with the larger venomous snakes. No construction workers are to try to catch or kill any reptile species encountered, and all workplaces are to be kept clean and free of rubbish that may attract rodents which are a primary food resource for larger snakes.

3.5 Insects

Table 4: Insect assessment for the Unika Wind Farm Project.

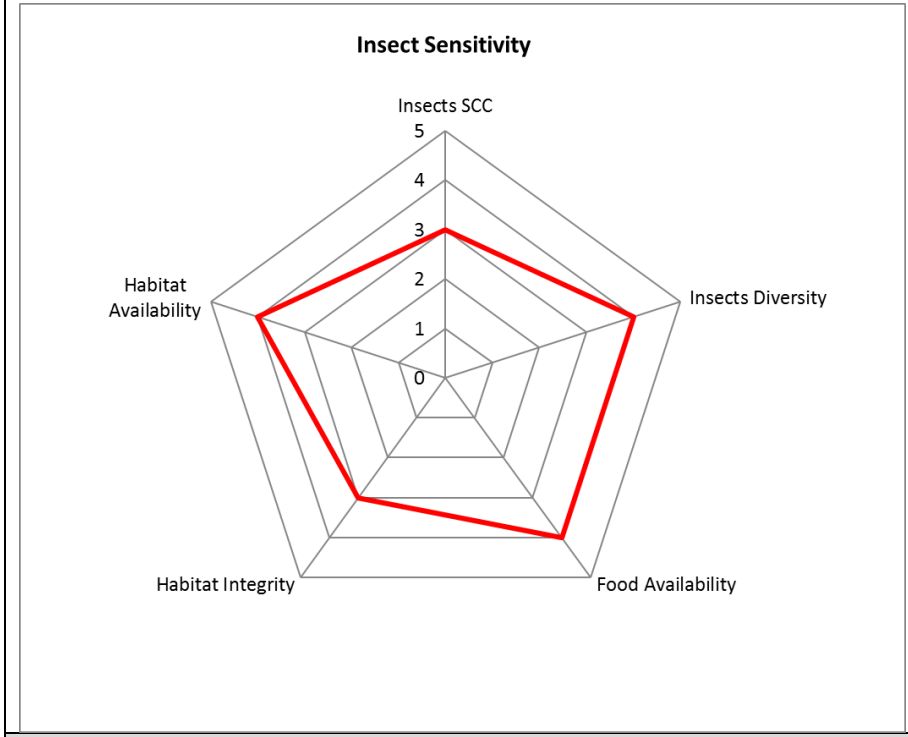
Insects	**Photographs: Top left to bottom right:** *Eretis* sp (Elfin's), *Acrea caldarena caldarena* (Black-tipped Acrea), *Charaxes guderiana guderiana* (Blue-spangled Emperor), *Leptomyrina hirundo* (Tailed Black-eye), *Acrea natalica* (Natal Acrea), *Precis octavia sesamus* (Gaudy Commodore), *Precis antilope* (Darker Commodore), *Sarangesa* sp (Elfin's), *Chiasmia* sp (Peacock), *Mylothris agathina* (Common Dotted Border).

Photographs: Top left to bottom right: *Cypholoba macilenta, Phaneroptera* sp (Leaf Katydids), *Acanthoplus* sp (Corn Cricket), *Hoplolopha* sp (Saw-backed Locust), *Hagenomyia tristis* (Gregarious Antlion), *Brachythemis lacustris* (Red Groundling), *Trithemis arteriosa* (Red-veined Dropwing), *Rachitopis* sp, *Diplacodes luminans* (Barbet), *Palpopleura deceptor* (Deceptive Widow), *Trithemis aconita* (Monkshood Dropwing), *Ischnura senegalensis* (March Bluetail).



Insect Sensitivity	Moderately High	Faunal Species of Conservation Concern (SCC)

Faunal Habitat Sensitivity Graph:



No insect SCC were observed within the study area. The available databases do not indicate the possible current or historical occurrence of insect SCC in the study area.

General Discussion and key points

Insect diversity and abundance was notably increased throughout the study area. This can be attributed to the high levels of food resources as well as increased and varied habitats that suit a diversity of insects. Flowering and fruit producing plants as well as the graminoid layer all provide increased food resources to insects, whilst the smaller insects themselves are preyed upon by larger predatory insects. A high abundance of insects is imperative for the overall functioning of the ecosystem, as the insects play an important role as pollinators as well as nutrient recyclers. Although habitat degradation is evident, the study area is still considered to be an important area in terms of habitat provision for insects, notably the hillside, forests and freshwater habitats.

In addition, insect overall provide the staple and important food resource for a variety of other species, without which many would not be able to survive.

Business Case, Conclusion and Mitigation Requirements:

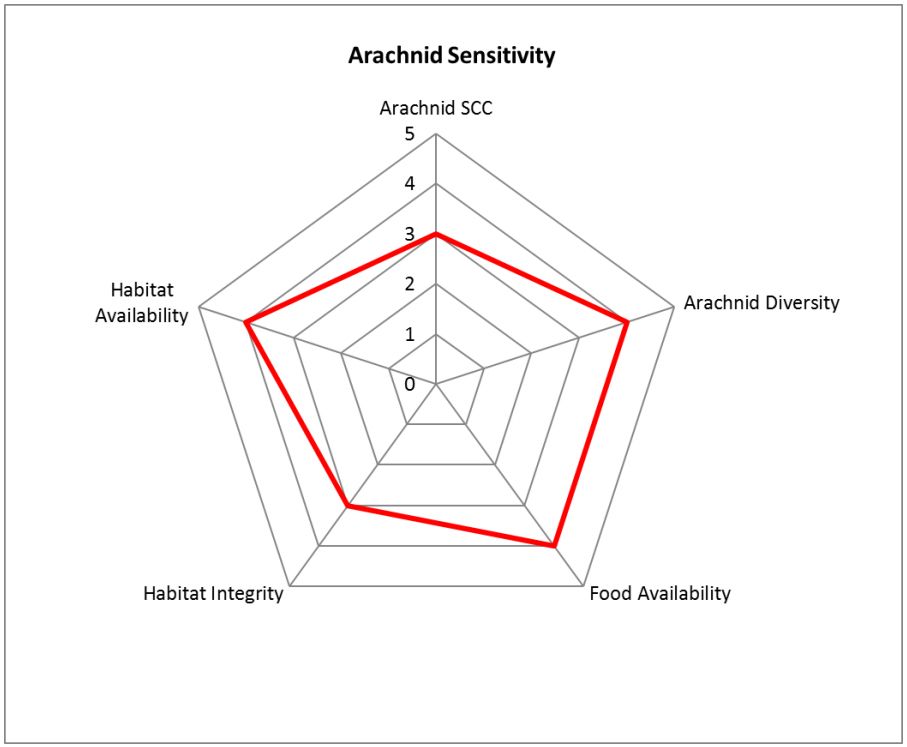
Insect diversity and abundance was evident throughout the study area, with the highest occurrences being in the Degraded Forest Habitat and the Freshwater Habitats. It must be ensured that as far as possible the turbine footprints are located outside of these important insect habitats. The loss or decrease in abundance of insects species will have far reaching and long term impacts not only to the ecological functioning of the habitats, but also to the other faunal species and agricultural activities undertaken by the local communities. The crops grown by the local communities are reliant on insects for pollination, without which, a notable decrease in crop yield would become apparent.

3.6 Arachnids

Table 5: Arachnid assessment for the Unika Wind Farm Project.

Arachnid Sensitivity	Moderately High	**Faunal Species of Conservation Concern (SCC)**

Faunal Habitat Sensitivity Graph:



No arachnid SCC are known to occur in the study area according to the available databases at the time of the assessment, with all species observed being considered common and widespread.

General Discussion and key points

Arachnid species are notoriously hard to detect over a relatively short period of time, which can often lead to the under estimation of diversity and abundance. As such, it is necessary to take into consideration the habitat conditions for arachnids as well as available resources, whilst also consulting available databases. During the field assessment particular attention was paid to searching out arachnid species, as they are known to be secretive and often elusive. By searching under rocks, fallen logs, shrubs and tree canopies, it was noted that the overall arachnid abundance and diversity of the study area was moderately high. This abundance and diversity of arachnid species can be sustained due to the increased levels of suitable habitat and high abundance of food resources, predominantly that of insects. Vegetation clearance has had an impact on the habitat integrity for arachnids, however the more open and cleared areas are now favoured by ground hunting spiders such as those belong to the Family Ctenidae (Wandering Spiders) and Family Lycosidae (Wolf Spiders). Like amphibians, a high abundance and diversity of arachnids further helps maintain insect population numbers, which if left uncontrolled would become problematic as well as possibly destructive.

Business Case, Conclusion and Mitigation Requirements:

The overall arachnid sensitivity for the study area is deemed to be moderately high, with the Degraded Forests and Freshwater Habitats being of increased importance for these species. Layout planning should take this into account and be adjusted accordingly, ensuring that as far as possible suitable arachnid habitat is not disturbed or lost.

Arachnids	**Photographs: Top row left to right:** *Hadogenes* sp (Flat Rock Scorpion), *Parabuthus* sp (Tick-tailed Scorpion), *Nephila senegalensis* (Banded-legged Nephila), *Anyphops* sp (Wall Spider), Family Theraphosidae (Baboon Spiders), *Leucauge* sp, *Nephila inaurata* (Red-legged Nephila), *Gasteracantha sanguinolenta* (Short-winged Kite Spiders)








3.7 Faunal Species of Conservational Concern Assessment

During field assessments, it is not always feasible to identify or observe all species within a given study area, largely due to the secretive nature of many faunal species, possible low population numbers, varying habits of species and dense vegetation cover. As such, and to specifically assess an area for faunal SCC, a Probability of Occurrence (POC) matrix is used, utilising a number of factors as outlined in Appendix A to determine the probability of faunal SCC occurrence within the study area. Species listed below whose known distribution ranges and habitat preferences according to the IUCN include the study area were taken into consideration.

Table 6: A summary of the potential SCC that may occur within the study area.

Scientific Name	Common Name	Threat Status	POC %
	Mammals		
Eidolon helvum	African Straw-coloured Fruit-bat	NT	70%
Aonyx capensis	African Clawless Otter	NT	70%
Otomops martiensseni	Large-eared Free-tailed Bat	NT	70%
Hipposideros vittatus	Commerson's Leafnosed Bat	NT	70%

The above listed species all have a relatively high probability of occurring within the study area. The above listed species are most likely to occur within and around the Degraded Forest and Freshwater Habitats, as these habitats provide suitable movement and refuge areas, as well as areas for foraging and roosting.

3.8 Faunal Sensitivity

The figure below illustrates the areas considered to be of increased ecological sensitivity. The areas are depicted according to their sensitivity in terms of the presence or potential faunal SCC, habitat integrity and availability, levels of disturbance and overall the levels of faunal diversity. Table 7 below presents the sensitivity of each identified habitat unit along with an associated conservation objective and implications for development.

Table 7: A summary of sensitivity of each habitat unit and implications for development.

Habitat Unit	Sensitivity	Conservation Objective	Development Implications
Degraded Miombo Woodland	Intermediate	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.	This habitat unit is of intermediate ecological sensitivity and if current land-uses persist, its sensitivity is unlikely to change and may even decline further. Significant areas of this habitat unit are currently being cleared to make way for agricultural land and grazing pastures. In addition, trees are being harvested and the wood converted into charcoal to be sold in the larger towns. The anthropogenic activities are the primary drivers behind the decreased faunal diversity and sensitivity for this area. It is recommended that where turbine footprints are located in this habitat unit, they be located in the more disturbed areas whilst also avoiding the foothills of the larger mountains and hills. Vegetation clearance should be minimised and the construction footprints kept as small as possible, whist managing all edge effects.
Degraded Forest	Moderately High	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.	This habitat unit is of moderately high ecological sensitivity, however if current land-uses persist, its sensitivity is likely to decrease due to increasing pressure on these forests for firewood and timber. No turbines should be located in this habitat in order to ensure that the project does not contribute to the ongoing vegetation loss in this habitat. In addition, this habitat unit provides suitable habitat to bat SCC as well as the more common faunal species seeking refuge and areas of increased habitat integrity.
Freshwater Habitat	Moderately High	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.	This habitat unit is of moderately high ecological sensitivity, and further impacts must be avoided where possible as the key drivers of modification of these systems are as a result of historical and current habitat loss. Where turbine footprints are located in the freshwater habitat or their respective recommended buffers, the footprint should be moved, as impacts to this habitat unit will lead to a loss of faunal diversity and habitat connectivity.
Agricultural Areas	Moderately Low	Optimise development potential.	This habitat unit is of moderately low ecological sensitivity for faunal species. The agricultural areas are important as a source of food and crop production for the local communities. However, from a faunal ecological perspective these already degraded areas are ideal placement sites for the turbines, provided the agricultural area is not located within a delineated dambo.

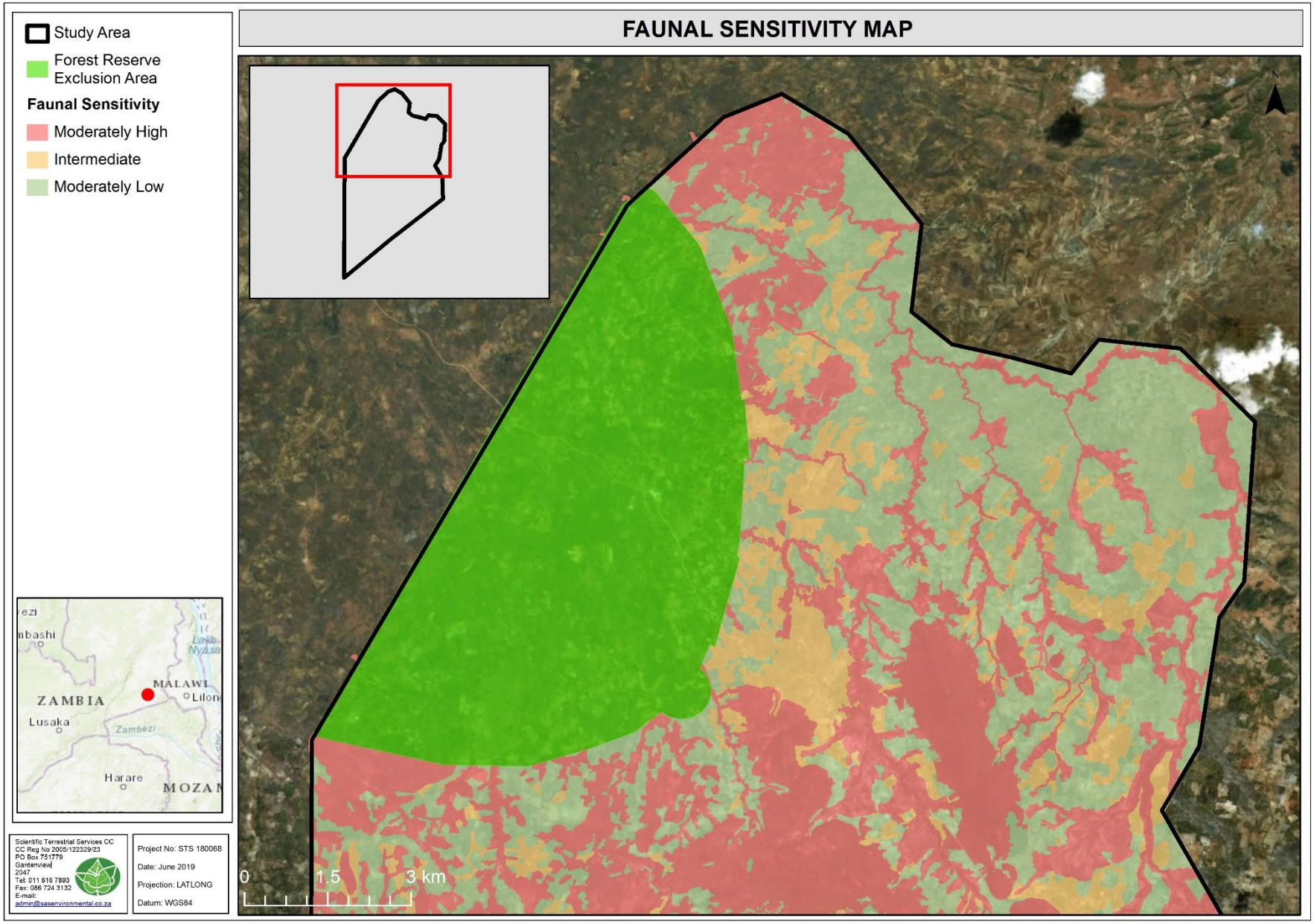


Figure 5: Sensitivity map pertaining to the faunal assessment of the northern portion of the study area.

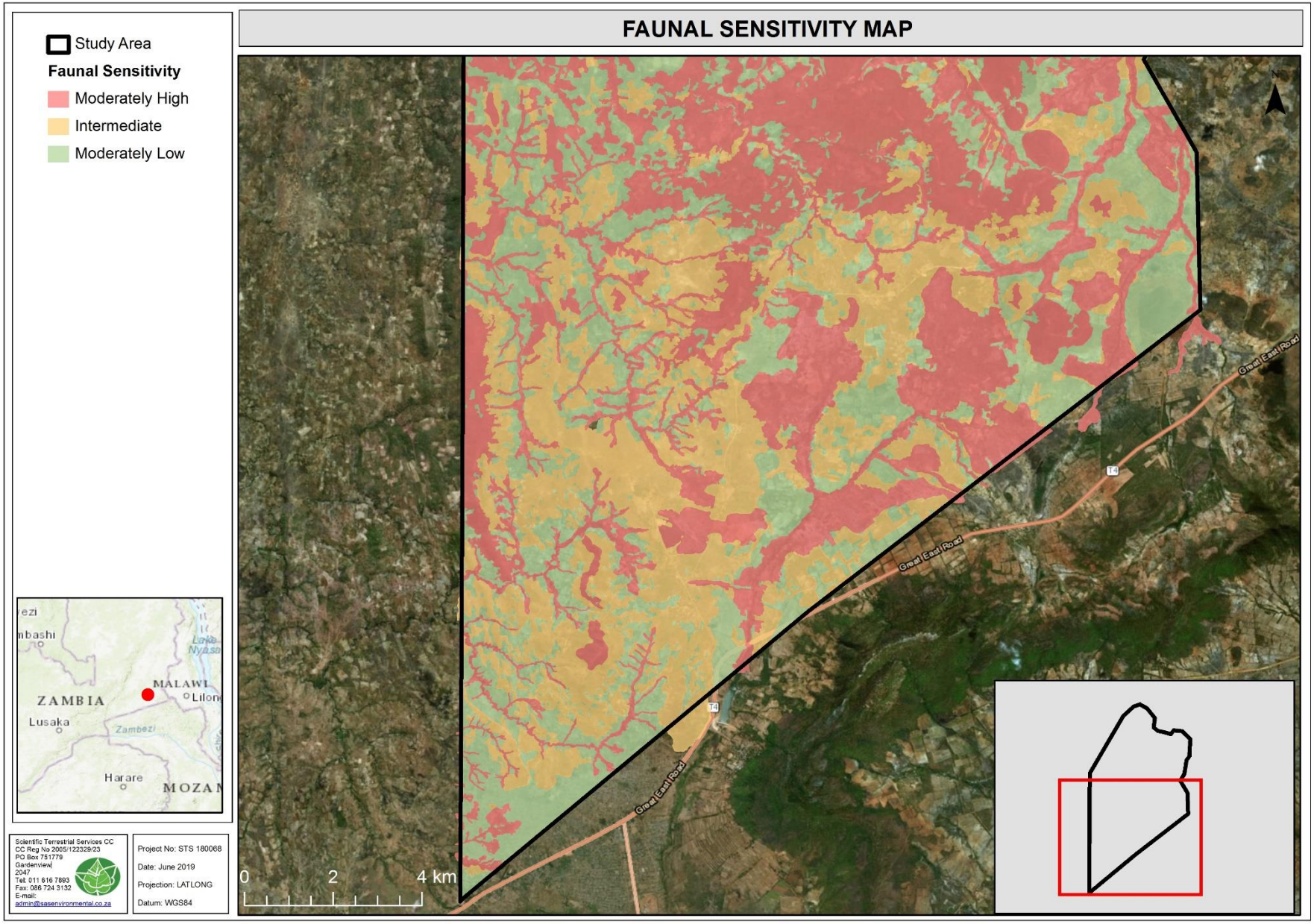


Figure 6: Sensitivity map pertaining to the faunal assessment of the southern portion of the study area.

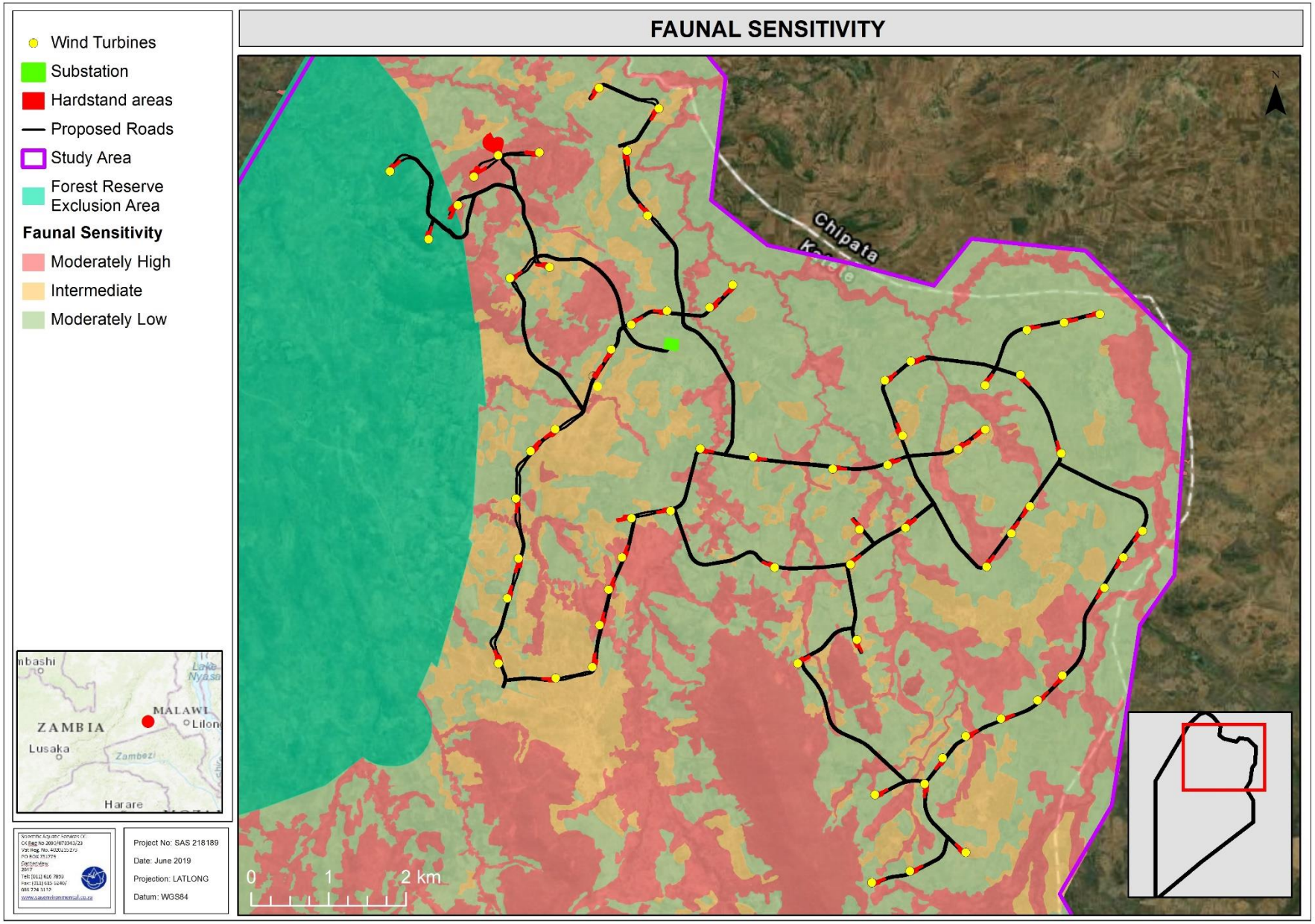


Figure 7: Zoomed in sensitivity map pertaining to the current proposed layout.

4 IMPACT ASSESSMENT AND PROPOSED MANAGEMENT MEASURES

4.1 Project Components and Descriptions

Following the collecting, assessing and dissemination of the faunal baseline data, a final proposed layout was then developed for the wind farm and associated structures / activities. Listed below are the impacting structures and associated activities that will be assessed within this impact assessment as part of Phase 1 of the project.

Wind Turbine Generators

For Phase 1 there could be between 20 and 60 wind turbines, with an individual capacity of between 4.2 and 5.3 MW. The turbines will range in hub height from 120 m to 150m, with a rotor diameter range of between 136 m and 158 m. Each turbine will have a concrete foundation of approximately 400 - 900 m2, to a depth of approximately 2.5 – 5 m. There will be a circular gravel hard standing area of approximately 800 m2 around each turbine that will be used during construction and for maintenance during the life span of the project.
Each turbine will have an electrical transformer, either on the inside or beside it outside.
Some turbines may have to be fenced off for safety reasons, but the land-use surrounding the turbines may continue, depending on the relative distances from the turbines.

Electrical Connections

The wind turbines will be connected to each other by means of medium voltage cables. The cables will be buried approximately 1 - 2 m below ground level. A substation (typically 80 m X 90 m) will be constructed within the site for collection of power from the wind turbines. The substation will then be connected to the National Grid through a new 330 kV power transmission line (with a 50m wayleave) to be constructed above ground between the wind farm substation and the existing Msoro Substation (located 30km north of the Project Site). The transmission line is covered in a separate ESIA report as it is planned to handover the transmission line to ZESCO for operation and maintenance.

Access Roads

The site will be accessed from the T4 main road running between Lusaka, Katete and Chipata. An internal gravel road network will need to be constructed to facilitate movement between turbines during construction and operation. This will include upgrading of existing roads within the area as well as constructing new access roads.

Roads will be 10 - 13 m wide including drainage, turning circles, passing points and cabling. Some existing public roads and bridge structures will need to be upgraded to facilitate the heavy loads and vehicle sizes associated with the turbine equipment transport, especially the mast sections and the blades.

The main access roads and internal service roads would be constructed or upgraded from material sourced from quarries or borrow pits within and around the area (if available). The exact location and number of quarries and borrow pits required are not known at this stage. All material will need to be sourced from quarries and/or borrow pits approved by the Ministry of Mines and Minerals Development.

Additional Infrastructure

A single-story Operations and Maintenance (O&M) building of around 160 m2 with a workshop, store, control room, offices, telecoms and ablution facilities will be constructed.

4.2 Impact Assessment considerations and outcome

4.2.1 IMPACT: Loss of Faunal Habitat and Species Diversity in the Degraded Miombo Woodland

The Degraded Miombo Woodland remaining within the footprint area of the wind farm has, and still is, being impacted upon as a result of local community activities, notably, clearing for agricultural lands and wood harvesting for general firewood, charcoal production and general construction activities within the various villages. The remaining areas of habitat are becoming ever more isolated, creating “island” effects in terms of habitat provision for faunal species. This has resulted in fragmented faunal populations and lower species diversity and abundance in the proposed turbine areas.

Construction Phase: The construction phase will result in the clearing of vegetation for the access roads and turbine footprint/ laydown areas. This will lead to the loss of habitat and faunal species in these areas, whilst also leading to additional habitat fragmentation. With mitigation the consequence and significance of the impacts for this phase can be reduced from a low to very low. This will largely be dependant on the ability to mitigate edge effects stemming from the footprint areas and roads.

Operational Phase:

The wind farm will have a notably decreased nature of impact once operational. This is largely as a result of no further vegetation clearing or road construction taking place. The significance both prior to and post mitigation is expected to be low. Post mitigation is not expected to be very low as the newly built roads will allow for greater access to the surrounding areas, leading to further wood harvesting and habitat loss.

The table below presents the perceived impact on the Degraded Miombo Woodland associated with the wind farm construction and operation in terms of habitat and faunal species loss, both prior to and post mitigation measures.

Table 8: **Assessment of impact: Loss of habitat and species diversity.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Medium	Low	Low	Low
Geographic Extent	Regional	Localised	Localised	Localised
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Probable
Consequence	Low	Very Low	Low	Low
Significance	Low	Very Low	Low	Low

4.2.2 IMPACT: Loss of Faunal Habitat and Species Diversity in the Degraded Forest

A small area of Degraded Forest will be impacted upon in the north of the proposed wind farm. These degraded forest patches are fairly small and are surrounded by existing agricultural activities, with increased levels of wood harvesting for charcoal manufacturing evident on some of the slopes. Although these forest patches are small, they do still provide habitat for smaller faunal species whilst provide a semblance of habitat connectivity (movement corridor) between the larger forest patch to the south and north.

Construction Phase: The construction phase will result in the clearing of vegetation for the access roads and turbine footprint/ laydown areas. This will lead to the loss of habitat and faunal species in these areas, whilst also leading to additional habitat fragmentation. With mitigation the consequence and significance of the impacts for this phase can be reduced

from a low to very low. This will largely be dependent on the ability to mitigate edge effects stemming from the footprint areas and roads.

Operational Phase:

The wind farm will have a notably decreased nature of impact once operational. This is largely as a result of no further vegetation clearing or road construction taking place. The significance both prior to and post mitigation is expected to be low. Post mitigation is not expected to be very low as the newly built roads will allow for greater access to the surrounding areas, leading to further wood harvesting and habitat loss.

The table below presents the perceived impact on the Degraded Forest associated with the wind farm construction and operation in terms of habitat and faunal species loss, both prior to and post mitigation measures.

Table 9: **Assessment of impact: Loss of habitat and species diversity.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Medium	Low	Low	Low
Geographic Extent	Regional	Localised	Localised	Localised
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Probable
Consequence	Low	Very Low	Low	Low
Significance	Low	Very Low	Low	Low

4.2.3 IMPACT: Loss of Faunal Habitat and Species Diversity in the Freshwater Habitat

The wind farm will impact upon several freshwater habitats, most notably as a result of the many road crossings associated with this habitat, but also due to the placement of a number of the wind turbine footprints within freshwater systems (see freshwater report for details on the various freshwater system types). The freshwater habitat is one of the most extensive and important habitats within the area as it provides niche habitat for water dependant species, serves as a prominent source of water and connects several disjunct habitat units throughout the larger area.

Construction Phase: The construction phase will result in the clearing of vegetation for the access roads and turbine footprint/ laydown areas. This will lead to the loss of riparian

vegetation and habitat within the affected dambos. Consequently, this will lead to a loss of faunal species abundance and diversity in these areas, whilst also contributing to additional habitat fragmentation. With mitigation the consequence and significance of the impacts for this phase can be reduced from a low to very low. This will largely be dependent on the freshwater crossing designs and the degree to which they hamper water flow and the extent of the vegetation clearance. Should there be extensive downstream impacts, then the significance of the impact will increase.

Operational Phase:

The wind farm will have a notably decreased nature of impact once operational provided no further vegetation clearance occurs and that all freshwater crossings are properly maintained and do not contribute to further habitat degradation. The freshwater habitat is considered to be an important and sensitive habitat system, as such any activities herein, without sound mitigation, will likely result in a high impact. With mitigation measures, impacts can be adequately reduced. Provided the river crossings are well managed and no additional impacts to the receiving environment occur, the post mitigation impacts for this phase are likely to be low.

The table below presents the perceived impact on the Freshwater habitat associated with the wind farm construction and operation in terms of habitat and faunal species loss, both prior to and post mitigation measures.

Table 10: **Assessment of impact: Loss of habitat and species diversity.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	High	Medium	Medium	Low
Geographic Extent	Regional	Localised	Localised	Localised
Duration	Medium-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Probable
Consequence	High	Very Low	Medium	Low
Significance	High	Very Low	Medium	Low

4.2.4 IMPACT: Loss of Faunal Habitat and Species Diversity in the Agricultural Areas

The agricultural areas are the dominant land form / use within the current wind farm layout. These areas have already been cleared of vegetation and are currently being used for crop cultivation or lying fallow. These habitats are of low sensitivity and provide limited habitat to faunal species.

Construction Phase: Construction activities will lead to surface hardening techniques being used as part of the installation of the wind farm. Impacts expected from the construction will likely result from edge effects and footprint creep. Such impacts will be of increased severity where the footprint areas are nearby adjacent Freshwater habitats.

Operational Phase:

The operational phase of the turbines and roads within the agricultural areas should have a minimal impact to the receiving environment provided that all mitigation measures are in place and that edge effects are suitably managed.

The table below presents the perceived impact on the Agricultural Areas associated with the wind farm construction and operation in terms of habitat and faunal species loss, both prior to and post mitigation measures.

Table 11: **Assessment of impact: Loss of habitat and species diversity.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Low	Very low	Low	Low
Geographic Extent	Localised	Localised	Localised	Localised
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Possible
Consequence	Very Low	Very Low	Low	Low
Significance	Very Low	Very Low	Low	Very Low

4.2.5 IMPACT: Loss of Sensitive Faunal Species

Due to extensive habitat transformation associated with the clearance of vegetation from Forest and Miombo Woodland to agricultural areas as well an ever increasing persecution / hunting by local community members, there are limited opportunities remaining for faunal SCC

within the areas surrounding that of the proposed wind farm. The turbine footprints have been predominantly located within already disturbed areas and as such decreases the risk of impact to SCC. The numerous freshwater crossings may pose a threat to the SCC *Aonyx capensis* (African Clawless Otter, NT), however, this species is more likely to occur within the larger river systems to the east of the current proposed wind farm layout.

Construction Phase: The construction phase will result in the clearing of vegetation for the access roads and turbine footprint/ laydown areas. This will lead to the loss of habitat and potential disturbance to faunal species, notably the disturbance of potential foraging grounds. Impacts expected from the construction will likely result from edge effects and footprint creep.

Operational Phase:

The operational phase of the turbines and roads should have a minimal impact to the receiving environment for SCC provided that all mitigation measures are in place and that edge effects are suitably managed.

The table below presents the perceived impact on faunal SCC associated with the wind farm construction and operation in terms of habitat and faunal species loss, both prior to and post mitigation measures.

Table 12: **Assessment of impact: Loss of Species of Conservation Concern.**

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Low	Very low	Low	Low
Geographic Extent	Localised	Localised	Localised	Localised
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Definite	Definite	Possible
Consequence	Very Low	Very Low	Low	Low
Significance	Very Low	Very Low	Low	Very Low

4.3 Integrated Impact Mitigation

The table below highlights the key integrated mitigation measures that are applicable to all the proposed activities associated with the proposed Unika Wind Farm in order to suitably manage and mitigate the ecological impacts that are associated with the various phases. Provided that all the management and mitigation measures as stipulated in this report are implemented the overall risk to faunal and floral diversity, habitat and sensitive species can be adequately mitigated and minimised.

Table 13: A summary of the integrated mitigatory requirements for the terrestrial habitat

Project phase	*Construction Phase*
Impact Summary	*Loss of faunal habitat, species and sensitive species*

Management Measures	***Proposed mitigation and management measures:***
	Development footprint
	• It is recommended that the following towers be relocated in order to avoid impacts on the remining Degraded Forests habitat:
	  ○ T10 –Shift the location approximately 100m NNE into the agricultural fields;
	  ○ T07 – Shift turbine approximately 250m SE into the cleared areas;
	  ○ T05 – Shift approximately 320m to avoid the Degraded Forest. Additionally, the indicated disturbance footprint for this tower falls over a hill with a steep incline to the north of the turbine point. This will result in increased vegetation loss and a loss of habitat connectivity along the vegetated hillside;
	  ○ T06 – shift turbine footprint out of the Forest area to the agricultural areas surrounding the turbine; and
	  ○ Shift T36 North into the agricultural lands.
	• Where possible use existing roads to access the turbine footprints, minimising the need to clear vegetation for new roads;
	• Where turbines can be accessed from other turbine site negating the need for additional freshwater habitat crossings, this must be done;
	• The proposed road between T56 and T65 and T38 and T49 should not be considered, these sites can be accessed without the need for these additional roads, thereby minimising crossings of freshwater habits;
	• To avoid additional impacts to a large freshwater system, the proposed road between T36 and T46 should not be constructed. These turbine sites can be accessed from the north and south respectively through the other roads;
	• Reconsider the proposed road between T18 and T11. The proposed route between T23 and T12 will avoid the Degraded Forest habitat however a well-designed stream crossing will be required for this route;
	• Road between T01 and T02 should b reconsidered. Access to T01 can be gained through the upgrading of an existing informal road from T03 to T01;
	• Removal of vegetation must be restricted to what is absolutely necessary and should remain within the approved development footprint;
	• All mitigation measures and turbine relocation suggestions as per the Freshwater Report must be taken into consideration;
	• Clearing of vegetation should take place in a phased manner. This will allow for faunal species within the footprints to relocate naturally and avoid harm;
	• Smaller species such as scorpions and reptiles will be less mobile during rainfall events and cold days (winter) and as such will not readily able to move out of an area ahead of ground clearing activities. As such should any be observed in the construction site during clearing and construction activities, they are to be carefully and safely moved to an area of similar habitat outside of the disturbance footprint. Construction personnel are to be educated about these species and instructed not to kill them. Smaller scorpion species and harmless reptiles should be carefully relocated by a suitably nominated construction person. For larger venomous snakes, a suitably

	trained specialist, or on-site personnel, should be contacted to carry out the relocation of the species, should it not move off on its own; • Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the construction activities. Additional road construction should be limited to what is absolutely necessary, and the footprint thereof kept to a minimal; • No hunting or trapping of faunal species is to be allowed by construction personnel; • Informal fires by construction personnel should be prohibited, and no uncontrolled fires whatsoever should be allowed; • Care should be taken during the construction of the proposed wind farm to limit edge effects to surrounding natural habitat. This can be achieved by: - Demarcating all footprint areas during construction activities; - No construction rubble is to be disposed of outside of demarcated areas, and should be taken to a registered waste disposal facility; - All soils compacted because of construction activities should be ripped and profiled and reseeded; and - Manage the spread of AIP species, which may affect remaining natural habitat within surrounding areas; • Appropriate sanitary facilities must be provided during the construction of the wind farm and must be removed to an appropriate waste disposal site; • No temporary dump sites should be allowed in areas with natural vegetation. It is advised that waste disposal containers and bins be provided during the construction phase for all construction rubble and general waste; • If any spills occur, they should be immediately cleaned up to avoid soil contamination that can hinder floral rehabilitation later down the line. Spill kits should be kept on-site within workshops. In the event of a breakdown, maintenance of vehicles must take place with care, and the recollection of spillage should be practised, preventing the ingress of hydrocarbons into the topsoil; and • Upon completion of construction activities, it must be ensured that no bare areas remain, and that indigenous species be used to revegetate the disturbed area. **Faunal SCC** • No collection / persecution of faunal SCC must be allowed by construction personnel; • Edge effect control needs to be implemented to prevent further degradation and potential loss of faunal SCC outside of the proposed development footprint area, notably where disturbance footprints are near areas of increased sensitivity; and • Should the presence of any faunal SCC be noted, or their breeding sites be located within the development footprint a suitably qualified specialist should be consulted on the best way to proceed.
Project phase	*Operational Phase*
Impact Summary	*Loss of faunal habitat, species and sensitive species*
Management Measures	**Proposed mitigation and management measures:** - Disturbed areas are to be rehabilitated to a similar state as that of pre-disturbance conditions. Where this is not possible due to operational and maintenance requirements, it is recommended that at a minimum a suitable herbaceous layer is maintained within the footprint of the wind farm turbine so as to ensure that no erosion occurs; - Continually monitor the operational activities and infrastructure areas associated with the turbine footprints and the access roads to ensure edge effects are being controlled and any impacts such as erosion are timeously discovered and rectified; - Ensure that no unnecessary clearing of habitat occurs during the operational phase; - No hunting/trapping of faunal species or collecting of plants is allowed within the operational zones; - Monitor the success of rehabilitation efforts of disturbed areas seasonally; - Lighting pollution and its effect on fauna (with special mention of invertebrates and bats) must be effectively mitigated with the following guidelines in mind with due cognizance take of health and safety requirements: • Downward facing lights must be installed and limited to absolutely essential areas; • Covers/light diffusers must be installed to lessen the intensity of illumination where possible; • Outside lights are to utilise bulbs of varying wave lengths that do not attract insects.

5 CONCLUSION

Scientific Terrestrial Services (STS) was appointed to conduct faunal and floral ecological assessments as part of the Environmental and Social Impact Assessment process for the proposed Unika Wind Farm in Eastern Zambia. Following the field assessment, it is evident that four faunal habitat units exist within the study area, namely:

Miombo Woodland

This habitat unit has been subjected to disturbance from the local communities as it is predominantly associated with the low lying flat and undulating areas between the other habitat units. Vegetation clearing for agriculture and for charcoal production has resulted the loss of habitat for faunal species. These impacts combined with the increased human presence in the study area has resulted in a markedly low abundance of mammal species in this habitat, however, the abundance and diversity of invertebrates and reptiles does not appear to have suffered the same fate.

Degraded Forest

This habitat unit predominantly encompasses the mountainous and inselberg areas and is characterised by large tall trees with interlinking canopies. This habitat however is continually being impacted upon and decreasing due to the harvesting of timber for charcoal production, leading to the encroachment of miombo woodland species. Although this habitat unit has been subject to anthropogenic activities and impacts, it is still considered capable of providing habitat and resources to a number of faunal species.

Agricultural Areas

Associated with cultivated fields and areas where vegetation has been cleared in order to provide increased grazing for livestock, both in association with the areas surrounding the villages and at some distance from villages where new fields are being cleared. This habitat still provides rudimentary habitat and food resources for faunal species, notably insects and arachnids. It is possible that reptiles and small mammals will also utilise this habitat periodically.

Freshwater Habitat

This habitat unit comprises of the streams and dambos (wetlands) associated with the study area. This habitat unit has been notably impacted upon as a result of vegetation clearance for agriculture (grazing and crop cultivation). The dambos and streams convey large amounts of water through the study area, however the large-scale removal of vegetation has resulted in increased peak water flows; leading to erosion within the dambos and that of the stream

banks. The streams and associated riparian vegetation do however still provide movement corridors for faunal species and as such are considered important for habitat connectivity. In addition, the freshwater areas provide suitable and stable habitat for insect species, notably those often associated with water bodies as well as a diversity of amphibian and reptile species.

The proposed construction of the wind turbines and associated infrastructure is likely to result in vegetation clearance for the turbine footprints, access roads and the proposed new powerlines to link the turbines to the existing power grid. These activities will result in faunal habitat loss and possible faunal species persecution. If unmanaged and unmitigated the impacts associated with the development of the wind farm will have a significant negative effect on the faunal assemblages present. It is recommended that the sensitivity maps are taken into consideration when refining the project footprint layout, and that as far as possible turbines are located outside of the sensitive Freshwater and Degraded Forest habitats.

This report is to be used to guide the proponent, Environmental Assessment Practitioner (EAP) and regulating authorities, by means of the presentation of information on the baseline conditions, as to the future wind turbine layouts from an ecological risk management point of view as well as provide high level mitigation and management measures to help manage potential and existing impacts.

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APPENDIX A: Faunal Method of Assessment

Faunal Assessment Methodology

It is important to note that due to the nature and habits of fauna, varied stages of life cycles, seasonal and temporal fluctuations along with other external factors, it is unlikely that all faunal species will have been recorded during the site assessment. The presence of human habitation within the study area and the associated anthropogenic activities will have an impact on faunal behaviour and in turn the rate of observations

Mammals

Mammal species were assessed through the use of direct visual observations and the use of spoor, dung and scat. Further information and data was gathered from community members.

Reptiles

Reptiles were identified during the field survey. Suitable applicable habitat areas (wetland areas and fallen dead trees) were inspected and all reptiles observed were recorded. The data gathered during the assessment along with the habitat analysis provided an accurate indication of which reptile species are likely to occur on the Study area. Specific attention was given to reptile SCC listed by the IUCN.

Amphibians

Identifying amphibian species is done by the use of direct visual identification along with call identification technique. Amphibian species flourish in and around wetland, riparian and moist grassland areas. It is unlikely that all amphibian species will have been recorded during the site assessment, due to their cryptic nature and habits, varied stages of life cycles and seasonal and temporal fluctuations within the environment. The data gathered during the assessment along with the habitat analysis provided an accurate indication of which amphibian species are likely to occur within the Study area as well as the surrounding area.

Invertebrates

Whilst conducting transects through the study area, all insect species visually observed were identified, and where possible photographs taken. Furthermore, at suitable and open sites within the study area sweep netting was conducted, and all the insects captured identified.

It must be noted that due to the cryptic nature and habits of insects, varied stages of life cycles and seasonal and temporal fluctuations within the environment, it is unlikely that all insect species will have been recorded during the site assessment period. Nevertheless, the data gathered during the assessment along with the habitat analysis provided an accurate indication of which species are likely to occur in the Study area at the time of survey.

Arachnids

All suitable habitat areas where spiders and scorpions are likely to reside were searched. Specific attention was paid to searching for Mygalomorphae arachnids (Trapdoor and Baboon spiders) as these arachnids are generally considered to have low population numbers and are hard to locate.

Faunal Species of Conservational Concern Assessment

The Probability of Occurrence (POC) for each faunal SCC was determined using the following four parameters:

- Species distribution;
- Habitat availability;
- Food availability; and
- Habitat disturbance.

The accuracy of the calculation is based on the available knowledge about the species in question. Therefore, it is important that the literature available is also considered during the calculation.
Each factor contributes an equal value to the calculation.

Scoring Guideline				
Habitat availability				
No Habitat	**Very low**	**Low**	**Moderate**	**High**
1	2	3	4	5
Food availability				
No food available	**Very low**	**Low**	**Moderate**	**High**
1	2	3	4	5
Habitat disturbance				
Very High	**High**	**Moderate**	**Low**	**Very Low**
1	2	3	4	5
Distribution/Range				
Not Recorded		**Historically Recorded**		**Recently Recorded**
1		3		5

[Habitat availability + Food availability + Habitat disturbance + Distribution/Range] / 20 x 100 = POC%

Faunal Habitat Sensitivity

The sensitivity of the study area for each faunal class (i.e. mammals, reptiles, amphibians and invertebrates) was determined by calculating the mean of five different parameters which influence each faunal class and provide an indication of the overall faunal ecological integrity, importance and sensitivity of the Study area for each class. Each of the following parameters are subjectively rated on a scale of 1 to 5 (1 = lowest and 5 = highest):

- **Faunal SCC:** The confirmed presence or potential for faunal SCC or any other significant species, such as endemics, to occur within the habitat unit;
- **Habitat Availability:** The presence of suitable habitat for each class;
- **Food Availability:** The availability of food within the Study area for each faunal class;
- **Faunal Diversity:** The recorded faunal diversity compared to a suitable reference condition such as surrounding natural areas or available faunal databases; and
- **Habitat Integrity:** The degree to which the habitat is transformed based on observed disturbances which may affect habitat integrity.

Each of these values contribute equally to the mean score, which determines the suitability and sensitivity of the Study area for each faunal class. A conservation and land-use objective is also assigned to each sensitivity class which aims to guide the responsible and sustainable utilization of the Study area in relation to each faunal class. The different classes and land-use objectives are presented in the table below:

Table A1: Faunal habitat sensitivity rankings and associated land-use objectives.

Score	Rating significance	Conservation objective
1> and <2	Low	Optimise development potential.
2> and <3	Moderately low	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.
3> and <4	Intermediate	Preserve and enhance biodiversity of the habitat unit and surrounds while optimising development potential.
4> and <5	Moderately high	Preserve and enhance the biodiversity of the habitat unit limit development and disturbance.
5	High	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.

APPENDIX B: Faunal Species List

Mammal species observed

Scientific name	Common Name	IUCN Status
Cricetomys ansorgei	East African Pouched Rat	LC
Heterohyrax brucei	Yellow-spotted Hyrax	LC

LC = Least Concern

Amphibian species

Scientific name	Common Name	IUCN Status
Chiromantis xerampelina	Grey Foam-nest Tree Frog	LC
Arthroleptis stenodactylus	Common Squeaker	LC
Phrynobatrachus mababiensis	Mababe Puddle Frog	LC
Hyperolius viridiflavus	Common Reed Frog	LC

LC = Least concerned

Reptile species observed

Scientific name	Common Name	IUCN Status
Varanus niloticus	Nile Monitor)	LC
Afrotyphlops schmidti	Schmidt's Blind-Snake	LC
Chamaeleo dilepis	Flap Necked Chameleon	LC
Trachylepis varia	Variable Skink	LC
Trachylepis margaritifera	Rainbow Skink	LC
Agama armata	Tropical Spiny Agama	LC
Naja mossambica	Mozambique Spitting Cobra	LC
Genus Amblyodipsas	Purple-glossed Snakes	LC
Panaspis wahlbergi	Wahlberg's Snake-eyed Skink	LC

LC = Least Concerned, NYBA = Not yet been assessed by the IUCN.

Insect species observed

Scientific Name	Common Name	IUCN Status
Acrea caldarena caldarena	Black-tipped Acrea	LC
Charaxes guderiana guderiana	Blue-spangled Emperor	LC
Leptomyrina hirundo	Tailed Black-eye	LC
Acrea natalica	Natal Acrea	LC
Eretis sp	Elfin's	NYBA
Precis octavia sesamus	Gaudy Commodore	LC
Precis antilope	Darker Commodore	LC
Sarangesa sp	Elfin's	NYBA
Chiasmia sp	Peacock	LC
Mylothris agathina	Common Dotted Border	LC
Cypholoba macilenta	N/A	NYBA
Phaneroptera sp	Leaf Katydids	NYBA

Scientific Name	Common Name	IUCN Status
Acanthoplus sp	Corn Cricket	NYBA
Hoplolopha sp	Saw-backed Locust	NYBA
Hagenomyia tristis	Gregarious Antlion	NYBA
Brachythemis lacustris	Red Groundling	NYBA
Trithemis arteriosa	Red-veined Dropwing	LC
Rachitopis sp	Grasshopper	NYBA
Diplacodes luminans	Barbet	LC
Palpopleura deceptor	Deceptive Widow	LC
Trithemis aconita	Monkshood Dropwing	LC
Ischnura senegalensis	March Bluetail	NYBA
Truxaloides sp	N/A	NYBA
Macrotermes natalensis	Large Fungus-growing Termites	NYBA
Odontotermes sp	Termites	NYBA
Eurema hecabe solifera	Common Grass Yellow	LC
Hamanumida Daedalus	Guinea Fowl Butterfly	LC
Family Tenebrionidae	Darkling Beetles	NYBA
Paracinema sp	Grasshopper	NYBA
Mylabris sp	Blister/CMR beetles	NYBA
Phalanta phalanta	Common Leopard	LC
Heteracris sp	Grasshopper	NYBA
Gastrimargus sp	Grasshopper	NYBA
Family Mydidae	Mydas Flies	NYBA
Family Mutillidae	Velvet Ants	NYBA
Solenopsis punctaticeps	Fire Ant	NYBA
Trithemis stictica	Jaunty Dropwing	LC
Family Curculionidae	Weevils	NYBA
Junonia natalica natalica	Brown Pansy	LC
Copgogryllus sp	Mute Crickets	NYBA
Pachycondyla tarsata	African Stink Ant	NYBA
Family Cerambyciae	Longhorn Beetles	NYA
Family Cicadidae	Cicadas	NYBA
Papilio Dardanus	Swallowtail	NYBA

NYBA = Not Yet Been Assessed, LC = Least Concern

Arachnid species observed

Scientific name	Common Name	IUCN Red List Status
Family Agelenidae	Funnel-web Spider	NYBA
Hadogenes sp	Flat Rock Scorpion	NYBA
Parabuthus sp	Tick-tailed Scorpion	NYBA
Nephila senegalensis	Banded-legged Nephila	NYBA
Anyphops sp	Wall Spider	NYBA
Family Theraphosidae	Baboon Spiders	NYBA
Leucauge sp	N/A	NYBA
Nephila inaurata	Red-legged Nephila	NYBA
Gasteracantha sanguinolenta	Short-winged Kite Spiers	NYBA

Scientific name	Common Name	IUCN Red List Status
Nilus sp	Fish-eating Spiders	NYBA
Baryphas sp	Jumping Spiders	NYBA

NYBA = Not Yet Been Assessed

APPENDIX C: SPECIALISTS DETAILS

Details, Expertise and Curriculum Vitae of Company and Author

SCIENTIFIC TERRESTRIAL SERVICES (STS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTOPHER HOOTON

PERSONAL DETAILS

Position in Company	Ecologist
Date of Birth	24 June 1986
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2013

EDUCATION

Qualifications

BTech Nature Conservation (Tshwane University of Technology)	2013
National Diploma Nature Conservation (Tshwane University of Technology)	2008

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Eastern Cape, Western Cape, Northern Cape, Freestate
Zimbabwe, Zambia

SELECTED PROJECT EXAMPLES

Faunal Assessments

- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Mzimvubu Water Project, Eastern Cape.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Setlagole Mall Development, North West.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Expansion and Upgrade of the Springlake Railway Siding, Hattingspruit, Kwa-Zulu Natal.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Styldrift tailings storage facility, return water dams, topsoil stockpile and other associated infrastructure, North West.
- Faunal assessment as part of the environmental assessment and authorisation process for the development of a proposed abalone farm, Brand se Baai, Western Cape.
- Faunal assessment as part of the environmental assessment and authorisation process for the development of a proposed abalone farm, Doringbaai, Western Cape.
- Vegetation composition and subsequent loss of carrying capacity for the Rand Water B19 and VG Residue Pipeline Project, Freestate.
- Faunal assessment as part of the environmental assessment and authorisation process for the Evander Shaft 6 Plant Upgrade, New Tailings Dam Area and Associated Tailings Delivery and Return Water Pipeline, Evander, Mpumalanga.

Previous Work Experience

- Spotted Hyaena Research Project, Phinda Private Game Reserve, KwaZulu Natal.
- Camera Trap Survey as part of the Munyawana Leopard Project, Mkuze Game Reserve, KwaZulu Natal.
- Lowveld Wild Dog Project, Savé Valley Conservancy, Zimbabwe.
- Lion collaring and Tracking as part lion management program, Savé Valley Conservancy, Zimbabwe.
- Junior Nature Conservator, Gauteng Department of Rural Development and Land Reform.

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TERRESTRIAL, AQUATIC AND WETLAND ECOLOGICAL STUDIES TO INFORM THE ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED UNIKA WIND FARM DEVELOPMENT IN THE EASTERN PROVINCE OF ZAMBIA

Prepared for

SLR Consulting

June 2019

Revised: November 2020

Section D: Freshwater Ecology, Goods and Services Assessments

Prepared by: Scientific Aquatic Services
Report author: A. Mileson
Report Reviewers: C. Hooton
S. van Staden (Pri.Sci.Nat)
Report Reference: SAS 218189
Date: June 2019
Revised: November 2020

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ACRONYMS

CR	Critically Endangered
EC	Electric Conductivity or Ecological Category (to be defined in context of the text)
EIS	Ecological Importance and Sensitivity
EN	Endangered
ESHIA	Environmental, Social and Health Impact Assessment
GIS	Geographic Information System
GPS	Global Positioning System
PES	Present Ecological State
POI	Points of Interest
SCC	Species of Conservation Concern
SAS	Scientific Aquatic Services

1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a wetland ecological assessment as part of the Environmental and Social Impact Assessment (ESIA) process for the proposed Unika Wind Energy Farm (WEF) in Eastern Zambia, henceforth referred to as the “study area”. The study area is situated approximately 800m from the T4 (Great East Road) highway near the town of Katete. The study area spans an area of approximately 33,350 hectares (ha), and encompasses the villages of Gomani, Chibela, Mbangombe and Kachingwe.

This report aims to map, consider and describe the watercourses of the study area. In addition, the integrity, ecological importance and sensitivity, including the provision of goods and services of the various watercourses, is considered and presented. In doing so this report must guide the proponent, Environmental Assessment Practitioner (EAP) and regulating authorities, by means of the presentation of information on the baseline conditions, as to the management of the planned WEF operations from an ecological risk management point of view as well as the further studies and assessments required.

The results of this study are based on a single assessment conducted over a period of four days in February 2019, towards the end of the summer rainfall season in Zambia. Although this placed certain limitations on the study such as the necessity to infer seasonal changes, it is nevertheless the opinion of the ecologist that this survey allowed for sufficient data collection to provide an adequate understanding of the various freshwater systems, and to determine potential ecological risks and analyses of the impacts associated with the proposed WEF.

Subsequent to the site investigation, the preliminary layout provided for the purposes of the initial site assessment was refined. The impact assessment presented in this report is therefore based on the refined layout received by the specialist in November 2020. Additionally, key mitigatory measures aimed at minimising the potential impacts on both the local and regional ecology of the freshwater resources associated with the WEF, have been provided on the basis of the refined layout.

1.1 Structure of This Report

This report forms part of a suite of reports produced for the purposes of providing a terrestrial, freshwater and aquatic ecological investigation of the study area as provided by the proponent. This report specifically deals with the freshwater and aquatic ecological components of the

study. Background information pertaining to the study area, including (for example) information regarding the applicable aquatic ecoregions, is contained in Section A: Summary and Background Information (STS, 2019). Section A contains all relevant legal information, assumptions and limitations, and background data and maps, and should therefore be read in conjunction with this report. The following structure is applicable to this report:

Section 1: Introduction

Provides an introduction and the structure of this specific report (Section D: Wetland Baseline Study).

Section 2: Assessment Approach

Provides summaries of the relevant methodology and definitions applicable to this report, a description of the sensitivity mapping and the risk assessment approach.

Section 3: Results of the Field Investigation

This section reports the following:

- A description and delineation of all watercourses associated with the MR201 according to the Department of Water Affairs and Forestry (DWAF)[1] (2008) "A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". All features are mapped according to their ecological sensitivity;
- The classification of the watercourses according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);
- A high-level discussion of the Ecostatus of the watercourses, encompassing aspects such as impacts on the hydraulic regimes, geomorphological processes, water quality and habitat and biota of the watercourses; and
- A high-level summary of the goods and services provision of the watercourses to the surrounding communities.

Section 4: Impact Statement and Proposed Management Measures

Provides a brief impact statement of the anticipated impacts associated with the proposed project, and guidelines for managing such impacts.

Section 5: Conclusion

Summarises the key findings and recommendations based on the risk assessment outcomes.

[1] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.

2 FRESHWATER RESOURCE ASSESSMENT APPROACH

2.1 Definition of Wetlands and Riparian Zones

Wetlands are defined by the Ramsar Commission as "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*". As per this definition, a wetland also contains "*riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands*" (Article 2.1, Ramsar Commission). These "riparian zones of habitats" includes vegetation, known as "riparian vegetation", occurring within the area between the water body and the surrounding higher lying areas.

Wetlands of Zambia, according to the Food and Agriculture Organization of the United Nations (FAO) are divided into swamps, floodplains and dambos, defined as follows:

a) Swamps – these are vast, usually inundated, depressions that consist essentially of floating vegetation and wet peaty land;
b) Floodplains – these are zones along major river systems that are low-lying and are seasonally flooded;
c) Dambos – these are seasonally or permanently wet grassy valleys, depressions, or seepage zones on slopes which are polygenetic in origin. They can be defined as a wide and low lying gently sloping treeless grass covered depression, which is seasonally waterlogged by seepage from surrounding high ground assisted by rainfall and has water tables for most part of the year in the upper 50-100 cm of the soil profile from which they drain into streams.

According to RAMSAR, wetlands as defined above are areas which support vegetation, known as "riparian vegetation", occurring within the area between the water body and the surrounding higher lying areas. These "riparian zones of habitats" includes vegetation, known as "riparian vegetation", occurring within the area between the water body and the surrounding higher lying areas. According to the FAO, riparian forest (in a Zambian context) is defined as "an edaphically controlled type of vegetation occurring along rivers and lakes. It is characterized mainly by *Diospyros mespiliformis, Khaya athothetica, Parinari excels* and *Syzygium cordatum* associated with *Fauria saligna and Raphia* palms. The species are in excess of

900."[2] Ramsar does not provide a definition of riparian habitat, thus, since riparian habitat is sometimes associated with watercourses and is considered an integral part of a watercourse, the extent of riparian vegetation was included in the delineations presented in this report.

In order to further refine the definition of wetland and riparian habitat, the definitions as provided in neighbouring countries' legislation were also consulted. In this regard, South Africa's National Water Act, 1998 (Act 36 of 1998) provides a detailed definition of both wetland and riparian habitat, as follows:

Wetland means-

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

Riparian habitat includes-

"the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas".

For the purposes of this report, the terms "watercourse" and "drainage systems" comprise both wetlands (including swamps, floodplains and dambos as defined above) as well as rivers with an associated riparian zone. Where it is necessary to distinguish between such features, the specific term is utilized.

2.2 Delineation of Watercourses

Taking the definitions above (Section 2.1) for wetland and riparian habitat into consideration, the delineation of the various watercourses (which includes dambos/wetlands and rivers) were initially undertaken using desktop methods, making use of historical and current digital satellite imagery, and was based on identifying features displaying a diversity of digital signatures. In this regard, specific mention is made of the following:

- Vegetation associated with wetlands and riparian zones: a distinct increase in density as well as shrub size near flow paths;

[2] http://www.fao.org/docrep/005/ac455e/ac455e02.htm#b12-2.1.1.5.%20Riparian%20forests. Retrieved 17 November 2017.

- Hue: with water flow paths often showing as white/grey or black and outcrops or bare soils displaying varying chroma created by varying vegetation cover, geology and soil conditions; and
- Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions.

These delineations were subsequently verified and where necessary, refined, during the site assessment undertaken in February 2019.

Due to the extent, terrain and road conditions of the study area which had an influence on accessibility, digital satellite imagery was used to identify points of interest (POI) prior to the field survey, in order to ensure that as many areas as possible were assessed and ground-truthed during the site visit (refer to Figure 1). These were defined taking the following into consideration:

- A geographic spread of points was selected to ensure that conditions in all areas were addressed;
- Ensuring that features displaying a diversity of digital signatures were identified in order to allow for field verification. In this regard, the digital signatures described above were taken into consideration; and
- POIs were selected in areas where the watercourses of concern were likely to be relatively accessible, for example, along roads and tracks.

The presence of any wetland characteristics, as defined by the Ramsar Commission, were used to determine if the selected POIs identified from the digital satellite imagery could be considered to contain areas displaying wetland or riparian characteristics.

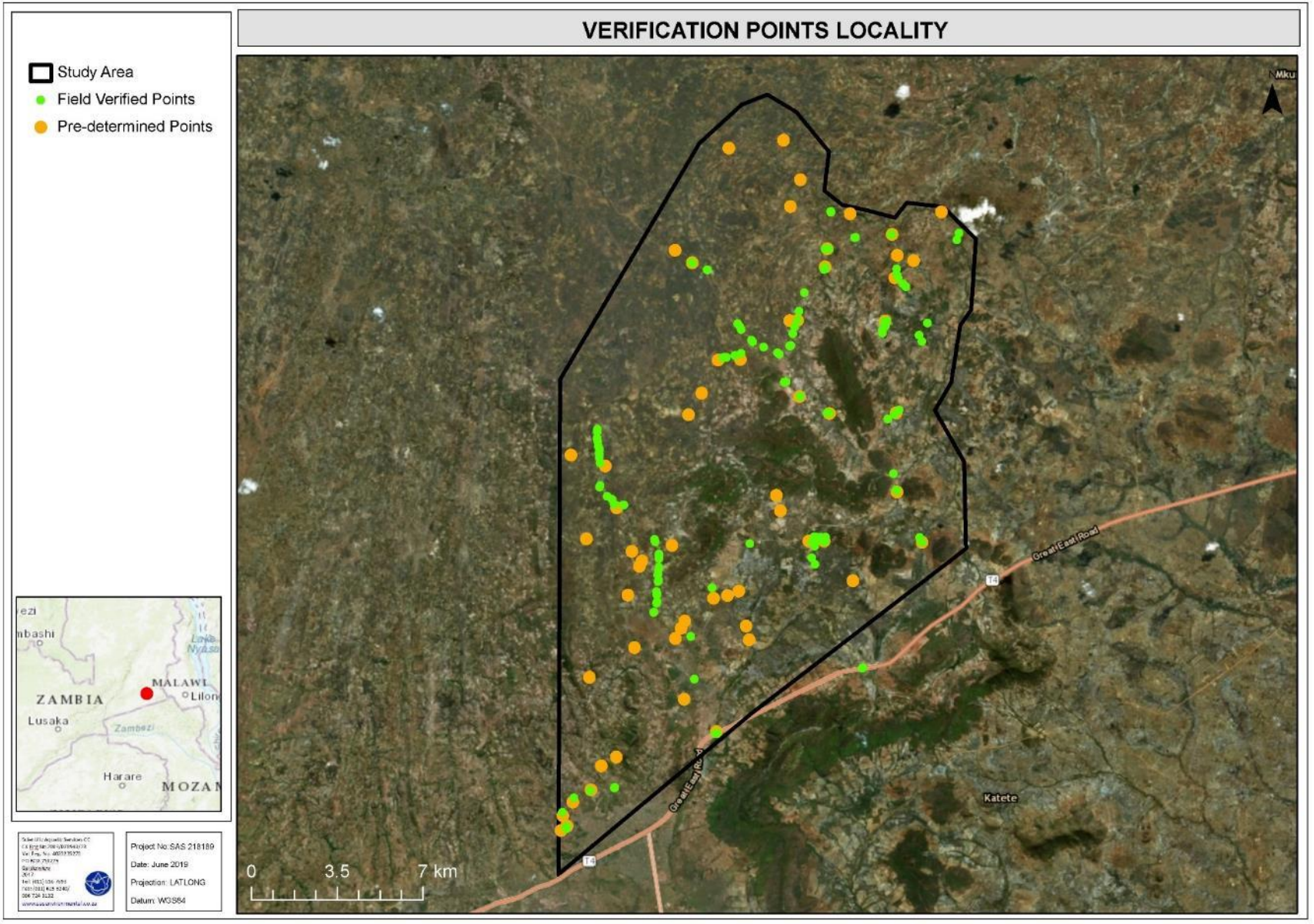


Figure 1: Conceptual depiction of the locality of pre-determined and field verified watercourse assessment points.

2.3 Characterisation of Watercourses

Factors influencing the habitat integrity of the watercourses identified during the field surveys were noted, and the functioning, ecological and socio-cultural goods and services (Ecoservices) provided by the various features was assessed. In the absence of protocols developed specifically for Zambian wetland systems, “best practice” methods developed for the African continent (such as the various wetland assessment tools developed in South Africa), were utilised and adapted where necessary in order to ensure the most appropriate and accurate characterisation of the resources. Whilst detailed assessments of the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and goods and services provision were not undertaken, the methods referred to above were utilised as a guideline to gauge the ecostatus of the drainage systems.

In addition to the delineation of the watercourses, field observation of the systems was undertaken at as many points of interest as possible, in order to define the following important aspects of the wetland ecology:

- Wetland characterisation and classification was undertaken according to the method of Ollis *et al.* (2013);
- The ecostatus of the watercourses, encompassing aspects such as hydraulic connectivity and regimes, geomorphological processes, water quality, habitat and biota. In assessing the ecostatus, impacts to the aforementioned aspects are taken into consideration; and
- Provision of goods and services of the watercourses to the surrounding communities, including ecological service provision which may not necessarily be of direct benefit to humans but is crucial to the ongoing ecological functioning of the environment as a whole.

2.4 Sensitivity Mapping

All of the ecological features within the study area were considered, and sensitive areas were delineated with the use of a Global Positioning System (GPS) to augment the mapping of the features undertaken with digital satellite imagery. A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps.

The sensitivity map should guide the design and layout of the proposed WEF, particularly the placement of laydown areas, turbines and access roads.

Due to the extent and complex hydraulic connectivity of these drainage systems, the extent of the study area, and nature of the terrain preventing access to much of the study area, it was

not feasible to access nor assess each system individually. Therefore, extrapolation of the extent of the features was undertaken by comparing data verified *in situ* to high resolution digital satellite imagery, in order to map features across the study area.

3 RESULTS OF WATERCOURSE ASSESSMENT

3.1 Delineation of Watercourses

Figures 4 to 6 below depict the position of the various wetland systems within the study area based on the combination of delineation methods employed i.e. digital satellite imagery and field verification. During the field assessment, the following indicators were used to delineate the boundaries of the watercourses:

- Terrain units were used as the primary indicator, as the terrain of the study area has well-defined low-lying areas where water is likely to collect and/or move through the landscape;
- Vegetation was utilised as a secondary indicator. Although in some of the dambo systems, floral species typically associated with terrestrial habitats were identified such as *Boophone disticha* and *Terminalia sericea*, in those areas, soils were typically sandy and likely to be inundated for only a short period in the year, allowing for the establishment of such species. In those areas which are saturated for longer periods, various sedge species, orchids, and graminoid species adapted to moist conditions were identified (Figure 3); and
- Soil morphological characteristics (Figure 2) typically associated with wetland conditions, such as gleying or mottling were 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. This indicator was used to identify gleyed soils where the soil is a greyish/greenish/bluish colour due to the leaching out of iron.

Figure 2: Representative photographs of soil samples within dambo wetland systems, illustrating typical soil morphological characteristics including mottling (top) and gleying (bottom) associated with a fluctuating water table.

Figure 3: Two of the floral species typically associated with the wetland systems: *Ascolepis protea* (left) and *Cyperus esculenta* (right).

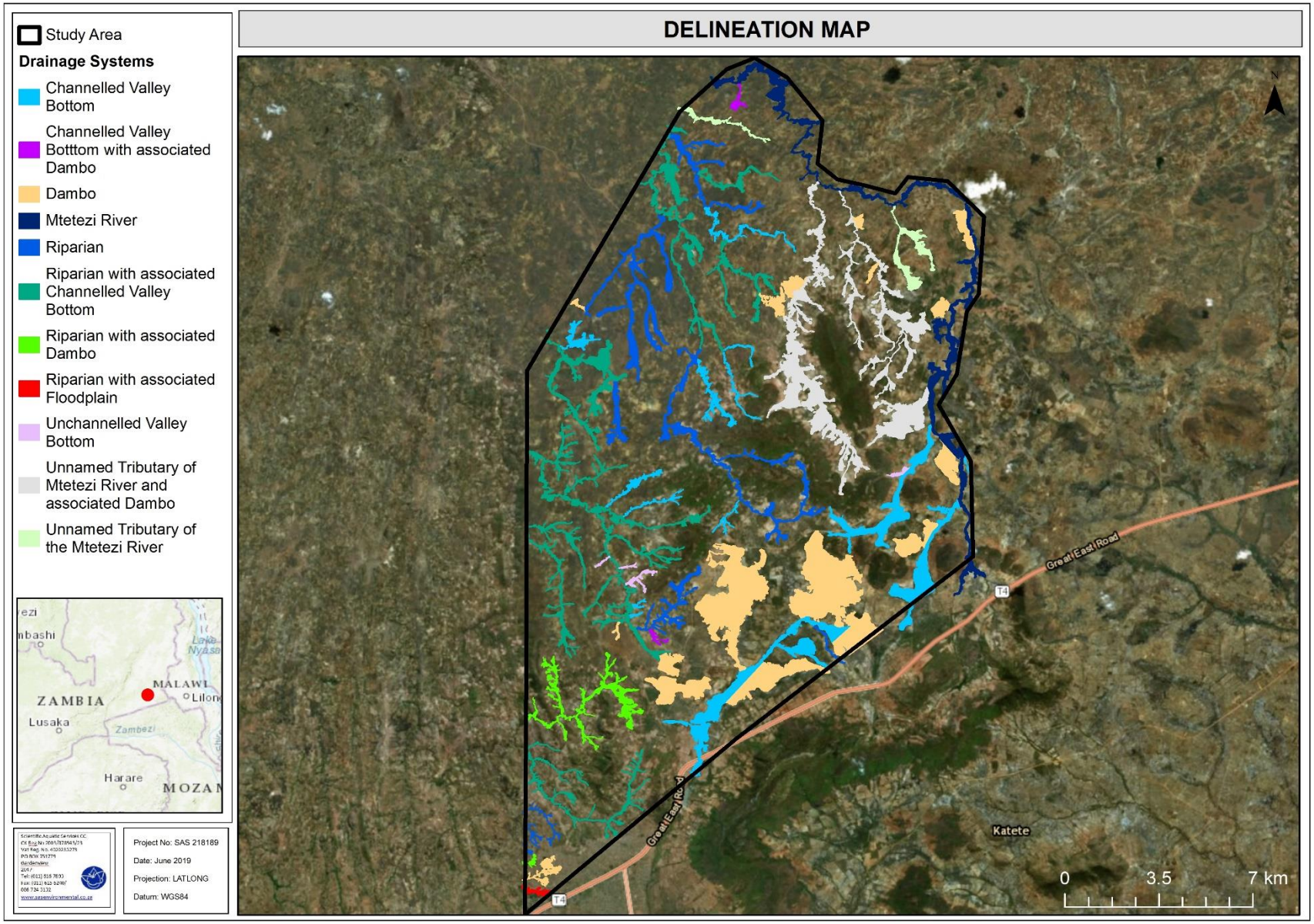


Figure 4: Conceptual depiction of the freshwater resource delineation in relation to the study area.

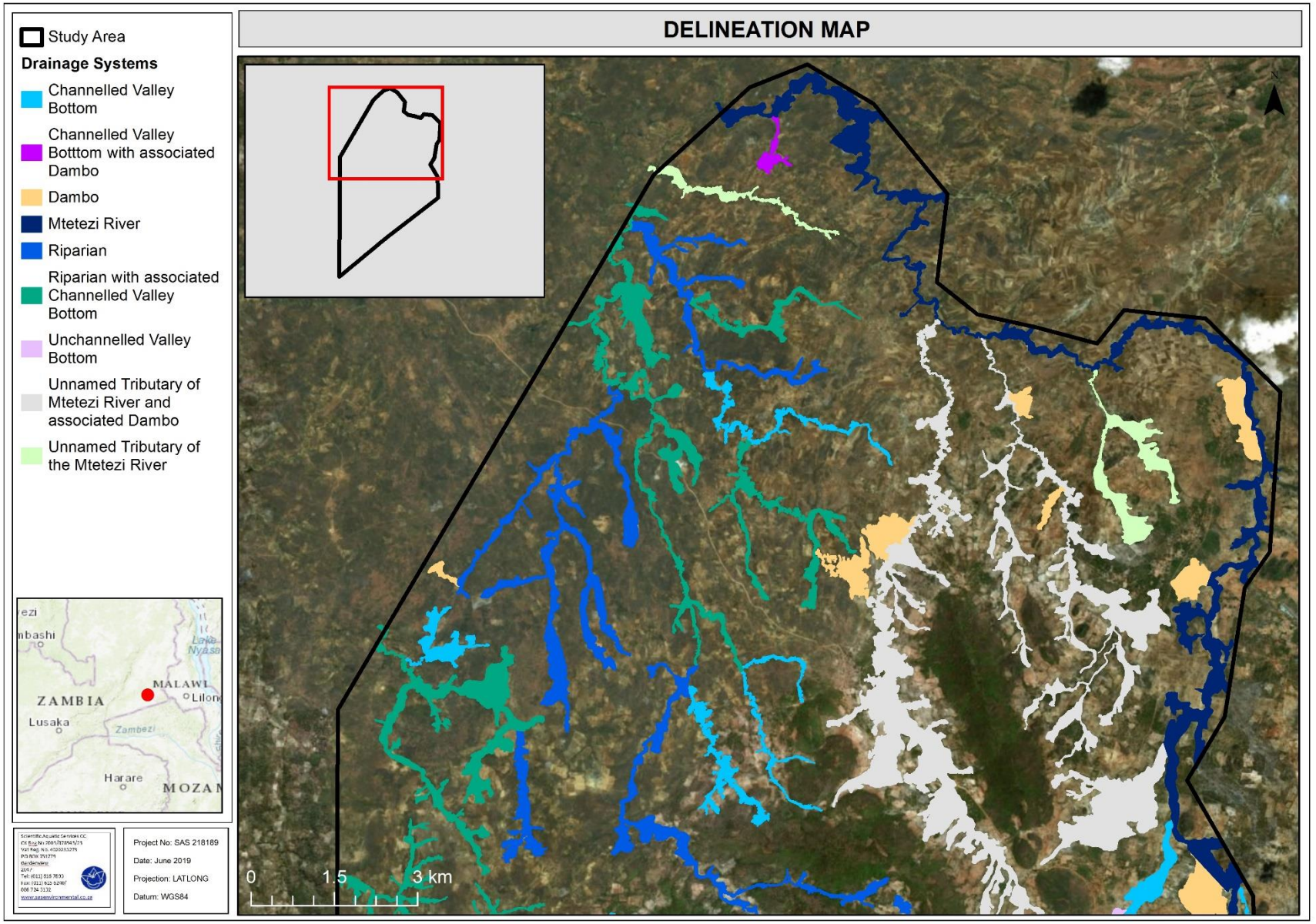


Figure 5: Conceptual depiction of the freshwater resource delineation in relation to the northern portion of the study area

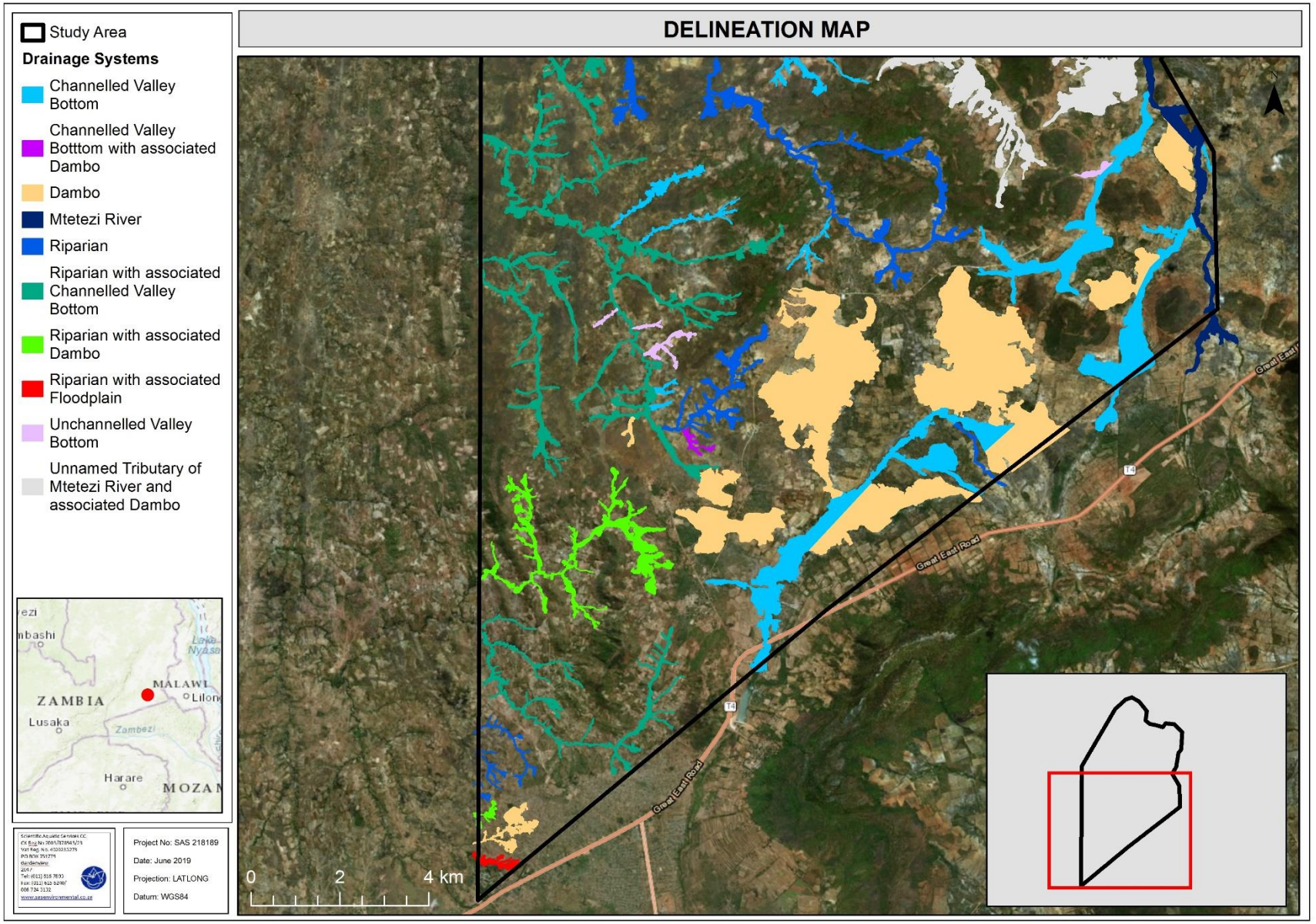


Figure 6: Conceptual depiction of the freshwater resource delineation in relation to the southern portion of the study area

3.2 System Definition and Characterisation

During the site assessment conducted over four days in February 2019, numerous extensive drainage systems were identified within the study area, many of which are interlinked and extend far beyond the boundaries of the study area. The identified watercourses were classified using the guidelines provided by Ollis *et al*., (2013) (please refer to Appendix A) but taking into consideration the descriptions of wetlands commonly used in Zambia as outlined in Section 2.1 of this report. At a high level, these watercourses were classified as Inland Systems falling within the Middle Zambezi – Luangwa and Lower Zambezi Aquatic Ecoregions (please refer to Section A for a description of the characteristics of these Aquatic Ecoregions). The identified drainage systems comprised four primary hydrogeomorphic (HGM) types: rivers with associated riparian vegetation and in some cases with associated floodplains, valley bottom wetlands (both channelled and unchannelled), and what are referred to locally (in Zambia) as 'dambos' – the latter being characterised by relatively even topography and situated in low-lying areas.

Table 1: Summary of the Classification system for the various watercourses identified within the study area.

Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit
Ecoregion: The study area falls within the Zambezian Headwater Aquatic Ecoregion	**Valley floor:** The typically gently sloping, lowest surface of a valley	**River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
		Floodplain wetland: the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
		Channelled Valley Bottom: a valley-bottom wetland with a river channel running through it. **Unchannelled Valley Bottom:** a valley-bottom wetland without a river channel running through it.
	Plain: an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land	**Dambo –** seasonally or permanently wet grassy valleys, depressions, or seepage zones on slopes which are polygenetic in origin. They can be defined as a wide and low lying gently sloping treeless grass covered depression, which is seasonally waterlogged by seepage from surrounding high ground assisted by rainfall and has water tables for most part of the year in the upper 50-100 cm of the soil profile from which they drain into streams.

Whilst there were distinct differences between the different HGM types (e.g. between the rivers with associated riparian zones and dambos), it was noted during the site assessment that conditions were largely homogenous within each group of the various drainage systems. For example, dambos were all characterised by the same floral species composition and vegetation communities throughout the site, and the rivers had distinctive riparian zones

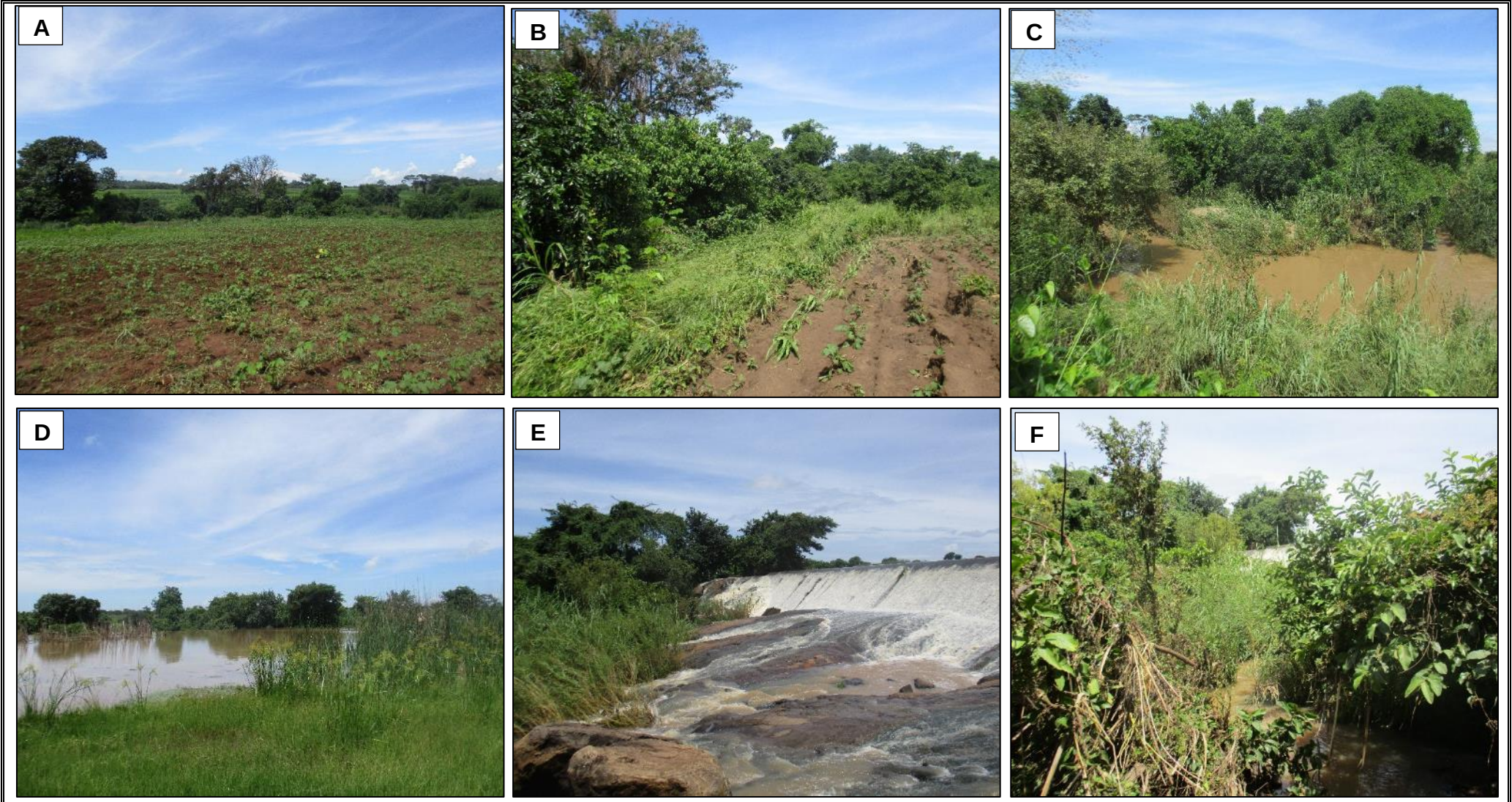
characterised by woody species (with species composition unvaried). Very few of the rivers had distinct, or extensive floodplains, and therefore, although acknowledged in the table above, these were not delineated nor depicted separately in the figures in this report but were included in the discussions pertaining to the relevant riverine systems.

For the purposes of this report, the watercourses were discussed in terms of system type (e.g. river, channelled valley bottom, dambo), key characteristics, ecostatus including ecological integrity, sensitivity and importance, and in terms of goods and services provision. The latter is considered of particular importance in the context of the rural setting of the study area.

3.3 Watercourse Analysis and Discussion

The dashboard style reports below summarise the findings of the field verification in terms of relevant aspects (hydrology, geomorphology and vegetation components) of wetland and riparian ecology. These dashboard reports aim to present all the pertinent facts pertaining to each system in as concise and visually appealing a manner as possible and in as limited a space as possible and preferably on one page.

Table 2: Discussion: Mtetezi River



Photograph notes: Representative photographs of the Mtetezi River, taken at two assessment points. Photographs A and B depict clearing of vegetation for crop cultivation. The turbidity of the river at the time of the assessment is clearly visible in photograph C. Photograph D depicts one of the smaller impoundments identified along the reach of the river within the study area, whilst photographs E and F are of the area immediately downstream of the same impoundment depicted in photograph D.

<table>
<tr><td>Goods and Services Provision</td><td>The Mtetezi River forms the eastern border of the study area, flowing in a northerly and north-western direction. Access to the river is hindered along much of the reach within the study area by dense vegetation and hilly terrain, thus reliance on the river is not as high as anticipated in such a rural area. Many of the villages located in the eastern portion of the study area have access to community boreholes, thus reliance on the river for water is moderate although impoundments were noted and it is likely that these are utilised by local communities for watering of cattle, swimming and fishing. Additionally, it was observed during the site visit that fishing in the river occurs daily.</td><td rowspan="2">Watercourse characteristics relating to (PES and EIS) discussions:
a) Hydraulic regime
The hydraulic regime of the Mtetezi River has been altered primarily by the presence of impoundments, both within the study area and downstream thereof. Of particular mention is the Katete dam located upstream (south) of the study area which provides the town of Katete with water. Although no other instream infrastructure was noted within the reach of the river within the study area, the T4 road traverses the river, necessitating a bridge crossing (therefore piers within the river).

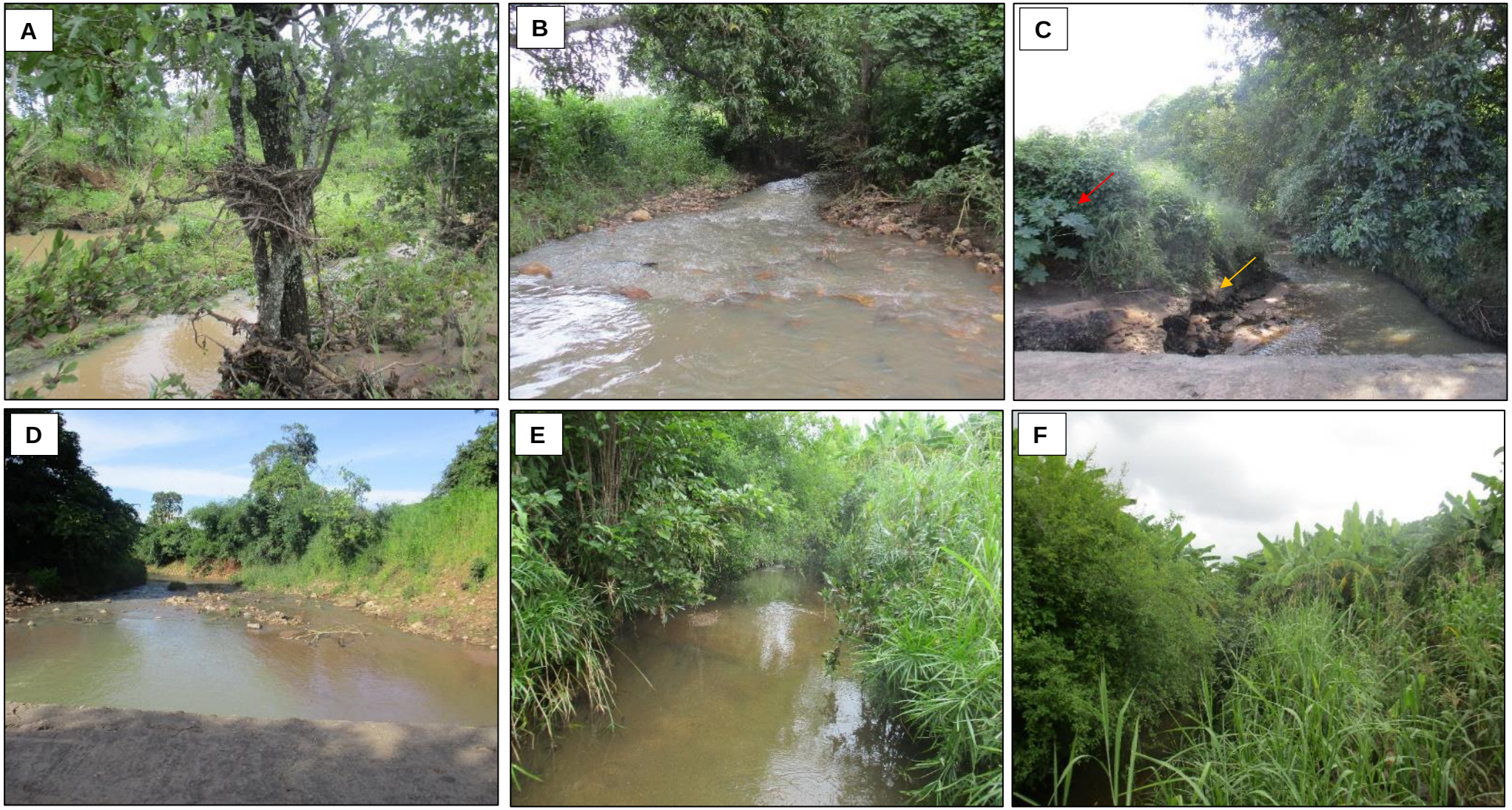
b) Geomorphology and sediment balance
Although the entire reach of the river could not be accessed and assessed those areas which were surveyed were noted to be moderately incised. This was attributed to vegetation clearing in the adjacent areas, leading to increased runoff entering the river and potentially at increased velocity, causing scouring and bank incision. Apart from the aforementioned impoundments, no other significant impacts on the geomorphological regime were noted. Increased sediment is expected due to cultivation adjacent to the river in some areas.

c) Water quality
Significant rainfall occurred during the week of the assessment in February 2019, resulting in large volumes of sediment being transported into the river, causing turbidity. Due to steep inclines at the assessment points as well as the depth and velocity of the water at the time of assessment, it was not possible to safely access the river to assess basic water quality parameters. Based on water quality parameters obtained in other river systems within the study area, and taking into account the surrounding land uses however, water quality is expected to be relatively unimpaired.

d) Habitat and biota
Due to the connectivity to surrounding undisturbed areas, relatively remote locality and inaccessibility of the river, it is expected that it provides an important faunal migratory corridor. Although minimal fauna were observed during the site assessment, snakes were encountered often in riparian areas, including at one survey point along the Mtetezi River. As noted in the PES discussion, vegetation clearing has occurred in some areas, but where clearing has not occurred the floral species composition and structure remains largely natural.</td></tr>
<tr><td>Ecostatus discussion</td><td>Although not formally assessed, the Mtetezi River is considered to be of moderate to high ecological integrity. Clearing of vegetation has occurred in some areas to make way for crop cultivation, although this is not extensive as yet. The remaining vegetation comprised indigenous woody species representative of the vegetation throughout the study area and greater surrounds. The impoundments noted above will have had an impact on the hydraulic regime of the system, however no other instream impacts (such as road crossings or weirs) were observed either during the site assessment or on digital satellite imagery.</td></tr>
<tr><td colspan="3">Business case, conclusion and mitigation recommendations:
The Mtetezi River is perhaps the most important drainage system within the study area from an ecological perspective, as well as from a socio-economic perspective reliance (albeit this reliance is largely on the reach of the river upstream of the study area). Based on the initial site layout provided for the purposes of the field investigation, no infrastructure is planned within 100m of the Mtetezi River, and it is strongly recommended that this status quo remains. In line with regional best practice guidelines, a 32m buffer around all watercourses has been recommended, and it is strongly advised that this be taken into consideration during further planning of the proposed project, particularly in regard to the Mtetezi River. Should it be necessary to encroach within this buffer zone, it must be ensured that no infrastructure is placed within the delineated riparian zone associated with the river, and that mitigation measures be implemented at all times but particularly during construction.

Site specific mitigation measures will be developed for the proposed project following the finalisation of the layout, and this will take into consideration the nature of the activity, the duration thereof, and proximity to specific watercourses.</td></tr>
</table>

Table 3: Discussion: Riverine systems (excluding the Mtetezi River)



Photograph notes: Photographs of various riverine systems identified within the study area, illustrating the generally turbid water even where the flood waters of the previous days' rain had subsided, as well as the deposition of debris, indicating how high the water had risen (photograph A). Some alien vegetation (*Ricinus communis* – castor oil bush) can be seen in photograph C (red arrow) whilst bank incision is apparent in the same photograph (orange arrow). Photograph F illustrates the proximity of crop cultivation (banana trees) and *Zea mays* (maize) to the river resulting in loss of indigenous vegetation.

<table>
<tr><td>Goods and Services Provision</td><td>Although some of the larger villages within the study area have access to communal boreholes and are able to obtain groundwater for domestic purposes such as cooking, the rivers are utilised extensively for bathing, washing of clothes, fishing and as previously mentioned, crop cultivation within the floodplains. In those areas where natural vegetation remains, it was apparent that the rivers provide a level of ecological services such as flood attenuation and sediment trapping. In addition, as with the Mtetezi River and indeed most of the drainage systems in the study area, biodiversity maintenance is deemed high, as the connectivity to undisturbed areas provides refugia and foraging habitat for fauna.</td><td rowspan="2">Watercourse characteristics relating to ecostatus discussion:
a) Hydraulic regime
The hydraulic regimes of the various riverine systems have not been notably impacted, except where some instream infrastructure, such as weirs and road crossings (informal and formal) has been constructed. The occurrence of heavy rains at the start of the site assessment enabled assessment of how such infrastructure causes alterations to flow regimes, with flow being concentrated at specific points either around or through the centre of such infrastructure. Additionally, it was apparent that debris occasionally becomes lodged against instream infrastructure, impeding flow and causing turbulence. Aside from these impacts however, no formal abstraction (e.g. pump stations) or unnatural water inputs were observed.

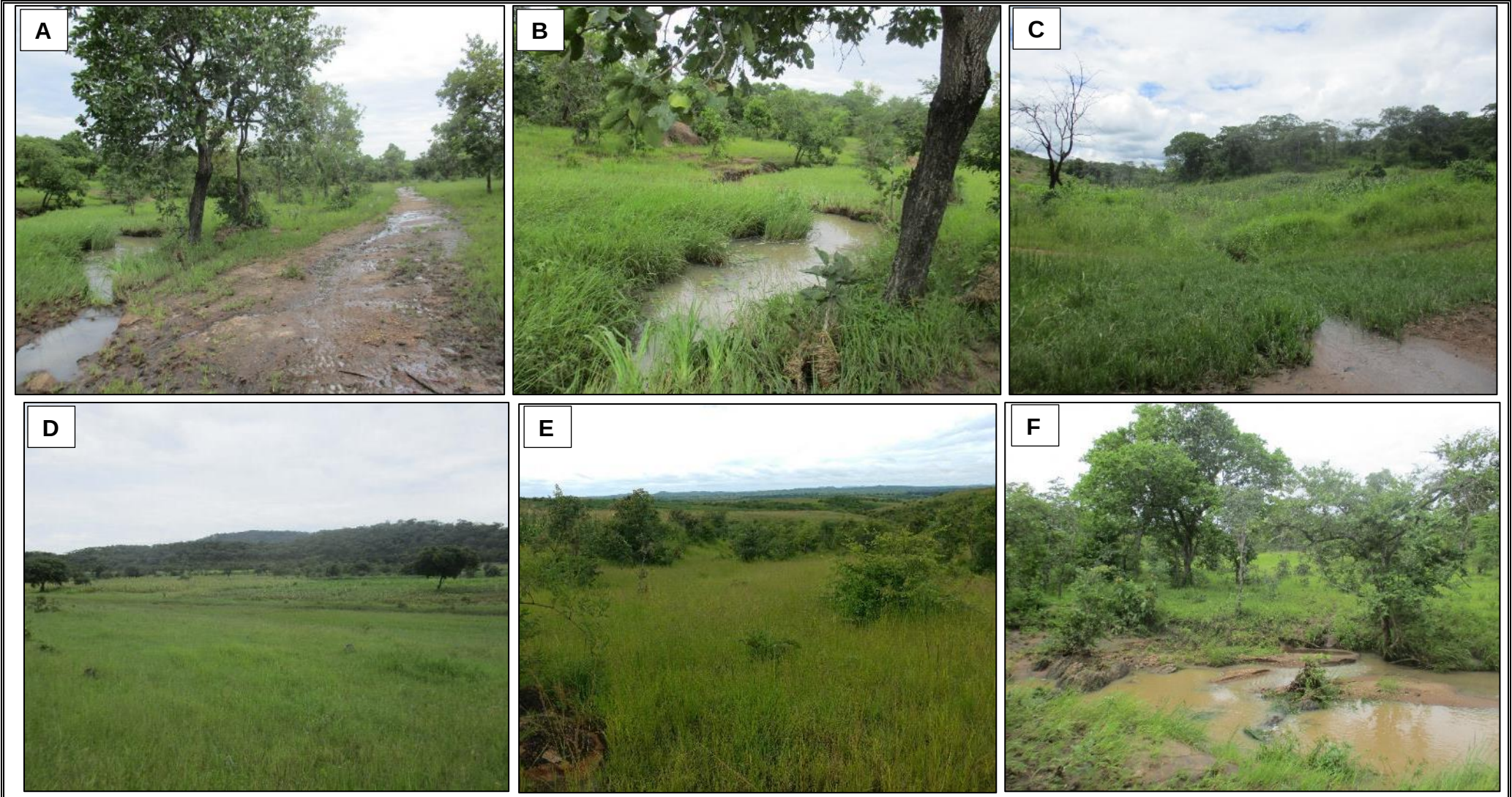
b) Geomorphology and sediment balance
The proximity of subsistence agriculture to the rivers (as depicted in photograph F above) has resulted in increased volumes of sediment transported into the rivers. This in turn has resulted in scouring and as depicted in photograph C above, bank incision. Where bank incision was observed, in most instances it was not considered severe.

c) Water quality
Although information pertaining to the reference state of these rivers is scarce, it is considered possible that the clearing of vegetation and disturbance of soils has contributed to the increased turbidity of the rivers. It must be noted that the assessment took place during a period of relatively high rainfall though, and therefore this may be considered a natural state due to the dispersal of sediment in stormwater runoff. Basic water quality parameters (temperature, pH and Electrical Conductivity [EC]) were measured at five sites. At all five sites, pH ranged from 7.07 to 7.60, and EC ranged between 1.2mS/m to 3.0mS/m. These results indicate that water quality is relatively unimpaired, save for increased turbidity and possibly increased nutrients.

d) Habitat and biota
Instream habitat in the majority of the rivers observed comprised a combination of biotopes, including sand, gravel and mud (GSM), rocks and overhanging vegetation (e.g. photographs B, C and E above), although very little instream vegetation was observed.

In terms of riparian habitat, as with the Mtetezi River, the rivers within the study area are considered to be important faunal migratory corridors as they provide connectivity to undisturbed, natural areas. Additionally, reptile and amphibian species were observed within several of these systems, indicating that breeding and foraging habitat is available and utilised.</td></tr>
<tr><td>Ecostatus discussion</td><td>Due to the nature of the terrain, the majority of riverine systems that were assessed were close to human settlement, and therefore have undergone various impacts such as altered geomorphologic regimes (e.g. increased sediment loads originating from adjacent crop fields). More remote and inaccessible reaches of the various rivers are likely to remain in a largely natural condition, with impacts mostly limited to those occurring upstream, such as impaired water quality due to discharge of domestic effluent.</td></tr>
<tr><td colspan="3">Business case, conclusion and mitigation recommendations:
As with the Mtetezi River, the smaller riverine systems in the study area are deemed to be of increased ecological integrity except for those reaches within close proximity to human settlement. Even then, the nature and extent of impacts is limited and is not considered to be severe or irreversible. According to the initial infrastructure layout, some infrastructure is located within the riparian zones associated with these riverine systems. Aside from ecological impacts that will occur if turbines are placed within these areas, from an engineering perspective this is not feasible and therefore the delineations and buffers presented in this map must be taken into consideration during future planning stages. Road crossings may be acceptable, if a high level of mitigation takes place, for example, retention of hydraulic connectivity and pollution prevention during construction.</td></tr>
</table>

Table 4: Discussion: Valley bottom wetland systems.



Photograph notes: Various channelled and unchannelled valley bottom wetland systems noted during the site assessment. Although the floral species composition did not vary significantly between the systems observed, the structure of the vegetation community differs, thus providing a variety of niche habitats. Again, as illustrated in photographs C and D, reliance on the wetlands for direct benefits (in this case, fertile soils and water) for subsistence agriculture is relatively high.

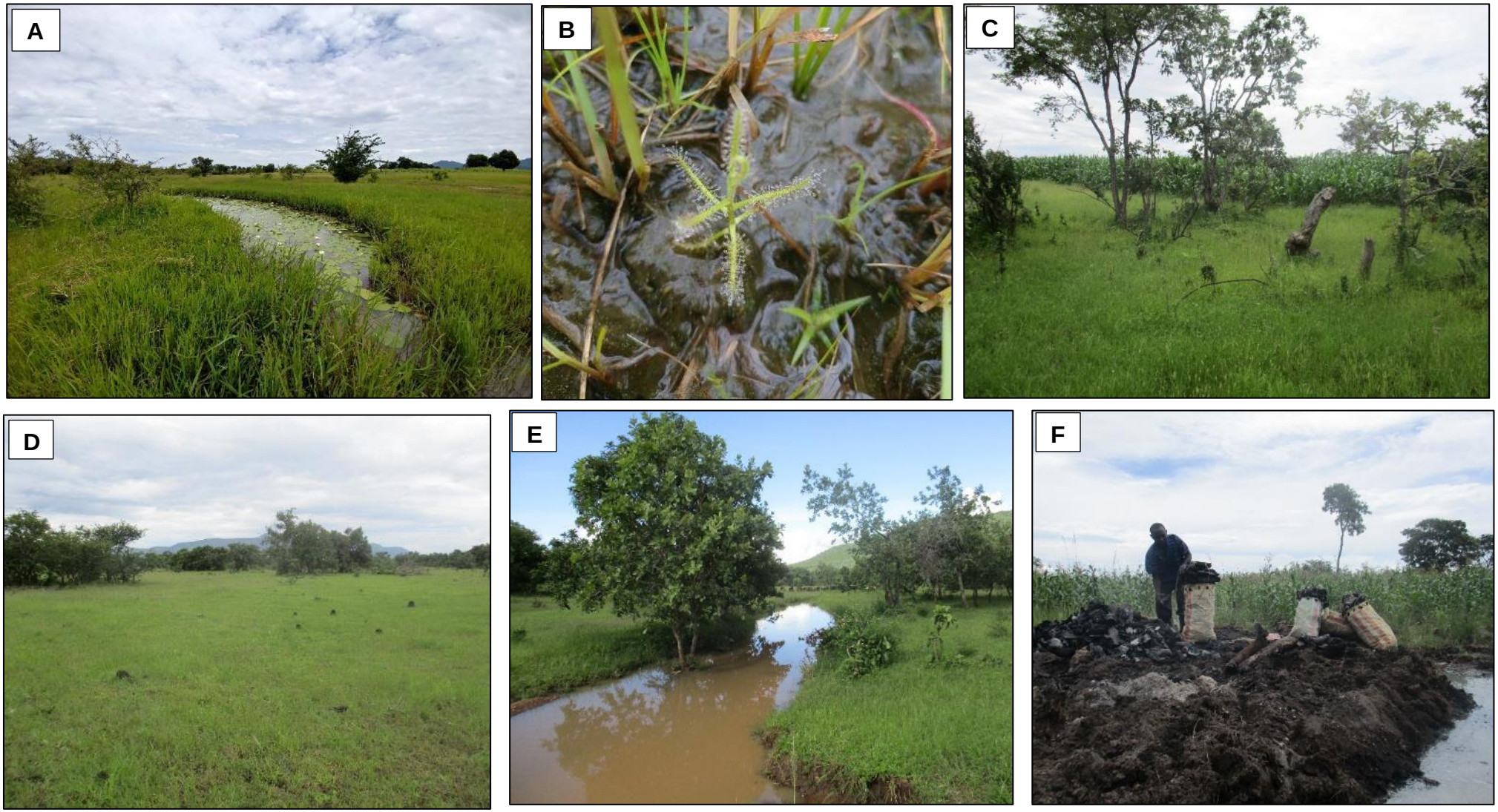
<table>
<tr><td>Goods and Services Provision</td><td>At the time of the assessment, reliance on the valley bottom wetland systems for socio-cultural service provision was not as high when compared to the riverine systems or the dambo areas (discussed in Table 4 below). In areas where terrestrial arable land is limited and therefore at a premium, the valley bottom wetland systems were utilised for subsistence farming. Whilst not directly observed, removal of woody species for the charcoal manufacturing process became apparent when utilising digital satellite imagery for the purposes of delineating watercourses. Although not directly observed, it is very likely, particularly in the more remote areas, that channelled valley bottom wetlands are relied upon for water provision both for domestic and agricultural purposes.</td><td rowspan="2">Watercourse characteristics relating to ecostatus discussion:
a) Hydraulic regime
No impacts on the hydraulic regime were observed within the valley bottom systems, with the exception of very few informal road crossings which may potentially impede flow and cause accumulation of natural debris (e.g. branches, grass stalks etc.) Within the channelled valley bottom systems, no impacts on hydraulic connectivity or flow regimes were observed. Some impacts on the vadose zone (i.e. the movement of water through soils, specifically the recharge zone) may have occurred due to soil disturbances relating to agriculture. This would need to be ascertained by a suitably qualified soils specialist if required. Therefore, the hydraulic regime is deemed to be in a largely natural state.

b) Geomorphology and sediment balance
Soil disturbances and informal road crossings were the most commonly observed impacts on the geomorphological processes of these wetland systems. Vegetation loss due to agriculture is likely to have contributed to increased sediment inputs, in turn leading to an altered sediment budget and possibly changes to sediment distribution within the wetlands. Although some stream bank incision was apparent in certain systems, erosion was not considered severe at the time of the assessment and is therefore not considered a significant modifier.

c) Water quality
Water quality parameters, where measured, indicated that aside from turbidity, water quality is relatively unimpaired. This is as anticipated due to the remote geographic setting and the fact that the rivers are more regularly utilised for domestic purposes. Increased nutrients are expected due to increased faecal matter from domestic livestock however.

d) Habitat and biota
With the exception of those areas cleared for crop cultivation, vegetation remains in a largely natural state although it was noted when delineating the watercourses post-fieldwork that woody species have encroached in some areas, transforming the temporary zones from grassland to bushveld. This could potentially result in increased water use over time, as well as influencing the distribution of wetland-dependent faunal species which have a preference for open spaces. Nevertheless, the habitat remains in a largely natural state as this encroachment is presently limited in extent and severity.</td></tr>
<tr><td>Ecostatus discussion</td><td>With the exception of the conversion of wetland areas from ‘natural’ conditions to agricultural land and the related encroachment of woody species as a result, and very limited informal road crossings, very few impacts were observed within these systems. As a result, the ecological integrity of the valley bottom wetland systems is considered to be in a largely natural state. These systems are considered important not only for maintenance of biodiversity and habitat provision, but also for the recharge of larger drainage systems within the study area. Thus, retention of habitat and hydraulic connectivity is critically important.</td></tr>
<tr><td colspan="3">Business case, conclusion and mitigation recommendations:
As with the riverine systems within the study area, avoidance of the valley bottom wetland systems must be a high priority during future planning, although it is acknowledged that linear developments such as roads and powerlines may out of necessity have to traverse the wetlands. Should this be required, it is not considered a fatal flaw, but must be carefully mitigated – for example, by limiting the placement of infrastructure within the delineated wetland boundaries, preventing development upgradient of wetlands as much as feasible, limiting the project footprint (in this regard, it is preferred that existing roads are upgraded rather than constructing new roads) and ensuring that soils are protected and erosion prevented. No turbines should be placed within the delineated wetland boundaries.</td></tr>
</table>

Table 5: Discussion: Dambos and floodplain wetland systems



Photograph notes: Examples of some of the extensive dambos identified within the study area. The photographs depict the relatively even topography characteristic of these wetlands, as well as the homogenous vegetation found within them. As can be seen in Photographs C, E, and F, the wetlands provide direct benefits to the communities in terms of high-quality soils for subsistence farming, grazing for domestic livestock and charcoal manufacturing. Several unique (although not threatened) floral species were identified within the dambos, such as the carnivorous "Sundew" *Drosera sp.*

<table>
<tr><td>Goods and Services Provision</td><td>The low-lying, extensive dambos appeared to be the most utilised of all the watercourses within the study area in terms of socio-economic uses. Because of the relatively flat topography these systems are generally easily accessed and are therefore preferred in terms of agriculture (both crop cultivation and livestock husbandry) as well as charcoal manufacturing (as illustrated in photograph F above).</td><td rowspan="2">Watercourse characteristics relating to ecostatus discussion:
a) Hydraulic regime
Disturbances to the soils within dambo areas may have led to altered movement of groundwater within the vadose zone of the wetlands, in turn potentially altering the hydraulic regime of these systems, although confirmation of this did not form part of the scope of this study. Additionally, the increased woody component within these systems, visible on digital satellite imagery, may have resulted in increased water use.

b) Geomorphology and sediment balance
The primary impact on geomorphological processes is disturbances to soils, and informal road crossings. Movement of sediment through the wetlands is driven largely by movement of surface water, thus is likely to only be transported through the dambos during the rainy season. Some patches of erosion were observed within areas subjected to long-term cultivation, however re-establishment of pioneer graminoid species, as observed in some of these areas, will halt the erosion.

c) Water quality
Although surface water was present in some dambos at the time of the assessment, it was due to rainfall received and is not likely to be present during the dry season. Based on water quality parameters recorded in the various riverine and channelled valley bottom systems, water quality within the dambos is likely to be relatively unimpaired, although potentially has high sediment loads due to the disturbances to soils.

d) Habitat and biota
The dambos provide essential habitat for a variety of faunal and floral species, including (as depicted above) Drosera sp., numerous orchid species (e.g. Platycoryne buchanania, Habenaria schimperiana), Ascolepis protea and Hypoxis nyasica amongst many others. Faunal species observed included Hyperolius marmoratus, Arthroleptis stenodactylus and Phrynobatrachus mababiensis along with numerous species belonging to the Odonata (dragonfly, damselfly) order.</td></tr>
<tr><td>Ecostatus discussion</td><td>As with all watercourses within the study area, the primary modifiers of the dambo systems are related to subsistence agriculture, although due to the relatively flat terrain the extent of cultivation with the dambos is greater than in the other HGM types. Overall, the dambos are deemed to be in a largely natural to modified ecological condition, and reinstatement of natural conditions (if it were to be permitted) could occur with little to no human intervention.

These expansive wetland systems are considered very important for the provision of ecological (i.e. indirect) services such as flood attenuation, trapping of sediment, and biodiversity maintenance) and for direct socio-cultural benefits in particular, crop cultivation, charcoal manufacturing and provision of grazing for livestock. Discussions with a local Nduna revealed that traditionally, local residents avoided cultivation within these wetland areas, however due to increased populations and lack of available arable land the communities surrounding the wetlands have been forced to encroach into the wetlands.</td></tr>
<tr><td colspan="3">Business case, conclusion and mitigation recommendations:
As with all the identified watercourses, the dambos are deemed to be of increased ecological importance and sensitivity, and development within these areas should be avoided as much as possible. Where it is necessary, it must be limited to low-impact developments of minimum extents and well-mitigated throughout the life of the development. To this end, the placement of turbines within these areas is not supported, although as with the valley bottom systems, it is acknowledged that it may be necessary for liner infrastructure to traverse the systems. As previously mentioned, is preferable to upgrade existing road infrastructure rather than constructing new roads, whilst limiting the footprint of powerlines by placing them adjacent to the roads as much as possible. Mitigations must also include preventing development upgradient as far as possible, ensuring soils are protected and erosion prevented.</td></tr>
</table>

3.4 Legislative Requirements and Buffer Zone Recommendations

As far as could be ascertained, no detailed legislation specific to the management or protection of wetlands in Zambia currently exists and only broad objectives in terms of biodiversity resource protection, including wetlands, are presented. In terms of Schedule 3 of the Zambian Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997, the following considerations are applicable to this project:

Section 1. Ecological considerations, including

(a) Biological diversity

(i) Effect on number, diversity, breeding sites, etc. of flora and fauna

(ii) Breeding populations of fish and game;

(b) Sustainable use including:

(ii) Nutrient cycles;

(iii) Aquifer recharge, water run-off rates, etc.

Section 5. Water

(1) Effects of surface water quality and quantity.

(2) Effects on underground water quality and quantity.

(3) Effects on the flow regime of the water course.

At the 1992 Earth Summit in Rio de Janeiro, world leaders agreed on a comprehensive strategy for meeting socio-economic needs while ensuring that we leave a healthy and viable world for future generations "*Sustainable Development*". One of the key agreements adopted at Rio was the Convention on Biological Diversity. This pact among the vast majority of the world's governments sets out commitments for maintaining the world's ecological underpinnings as society about the business of economic development.

The Ministry of Tourism, Environment and Natural Resources (MTENR) is the Focal Institution for the implementation of Convention on Biological Diversity (CBD). The Environment and Natural Resources Management Department acts, on behalf of the National Government as a liaison with the international Secretariat of the Convention. It is also in charge of the general follow-up of the CBD implementation. In order to achieve goals a wetland policy was developed. The aim of the policy is twofold: firstly to ensure the wise use of wetlands and their resources, and secondly, to create a comprehensive, stakeholder-based institutional and legal framework for their management. The specific objectives are:

- To promote the integrity and natural productivity of wetland ecosystems and the maintenance of their functions and values to conserve their biodiversity;
- To promote their socio-economic development potential and contribution to the local and national economy;
- To strengthen the legal and institutional framework for their management;
- To promote a multi-sectoral approach to planning and management;
- To develop public education and awareness;
- To promote research, inventorying and monitoring of wetland resources
- To conserve wetlands;
- To promote international action of national interest for the conservation of wetlands;
- To restore degraded wetlands;
- To promote community participation and ensure equitable sharing of benefits;
- To provide training and strengthen the capacity of wetland conservation institutions; and
- To promote “new” and created wetlands.

Clear guidelines on wetland resource management are however still lacking in Zambia. However, whilst buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of freshwater ecological services), reduce impacts on freshwater resources arising from surrounding activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015), it should be noted that buffer zones are not considered to be effective mitigation against impacts such as water quality and quantity degradation, hydrological changes arising from stream flow reduction, impoundments or abstraction which require site-specific mitigation measures (Macfarlane *et. al,* 2015). In line with regional best practice, a 32m buffer is therefore recommended and should be taken into consideration during future planning in order to ensure that no infrastructure is inadvertently placed within watercourses or close proximity thereof. These buffer zones are conceptually depicted in the figures below.

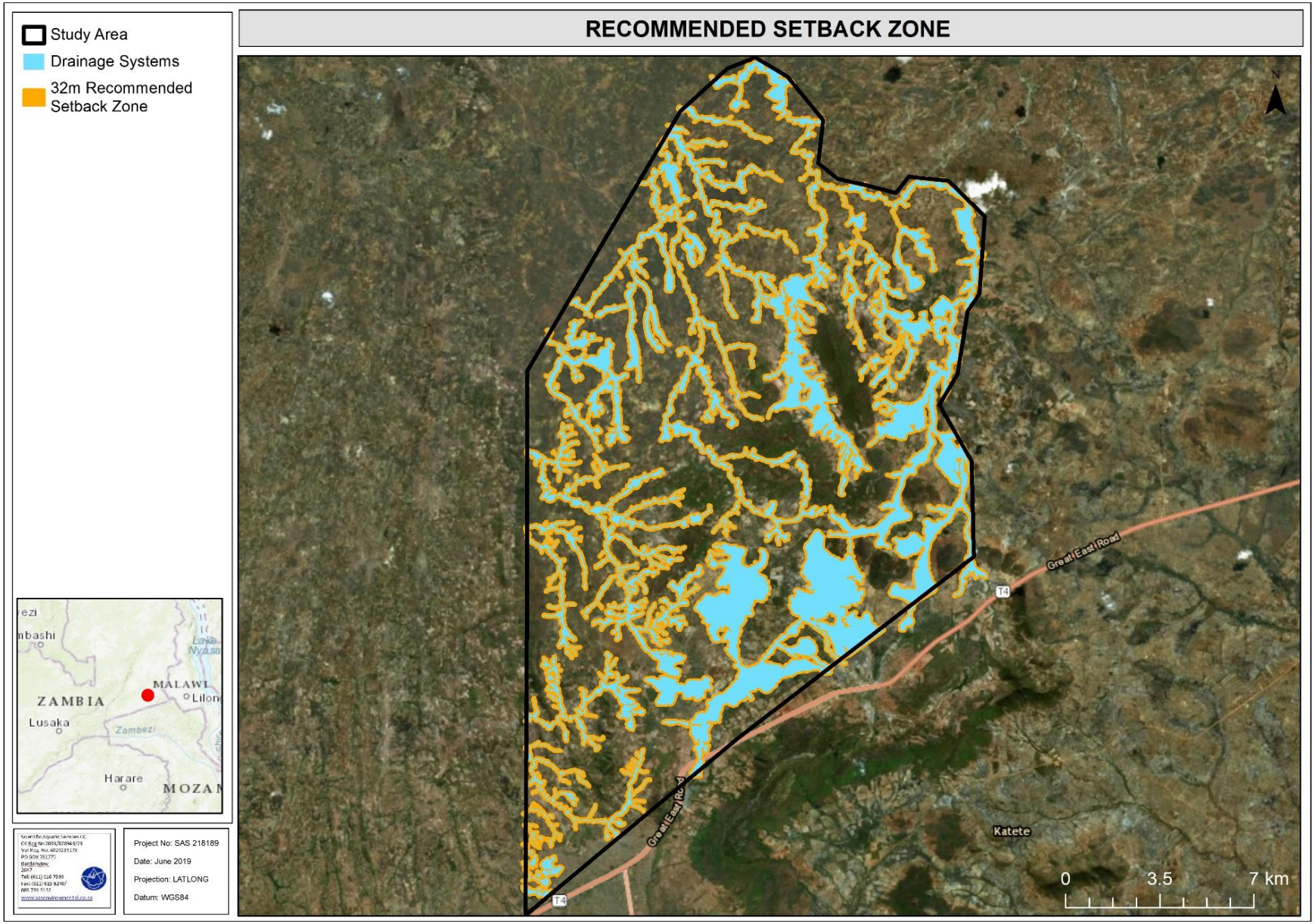


Figure 7: Conceptual depiction of the recommended 32m setback zone (buffer) around the watercourses within the study area.

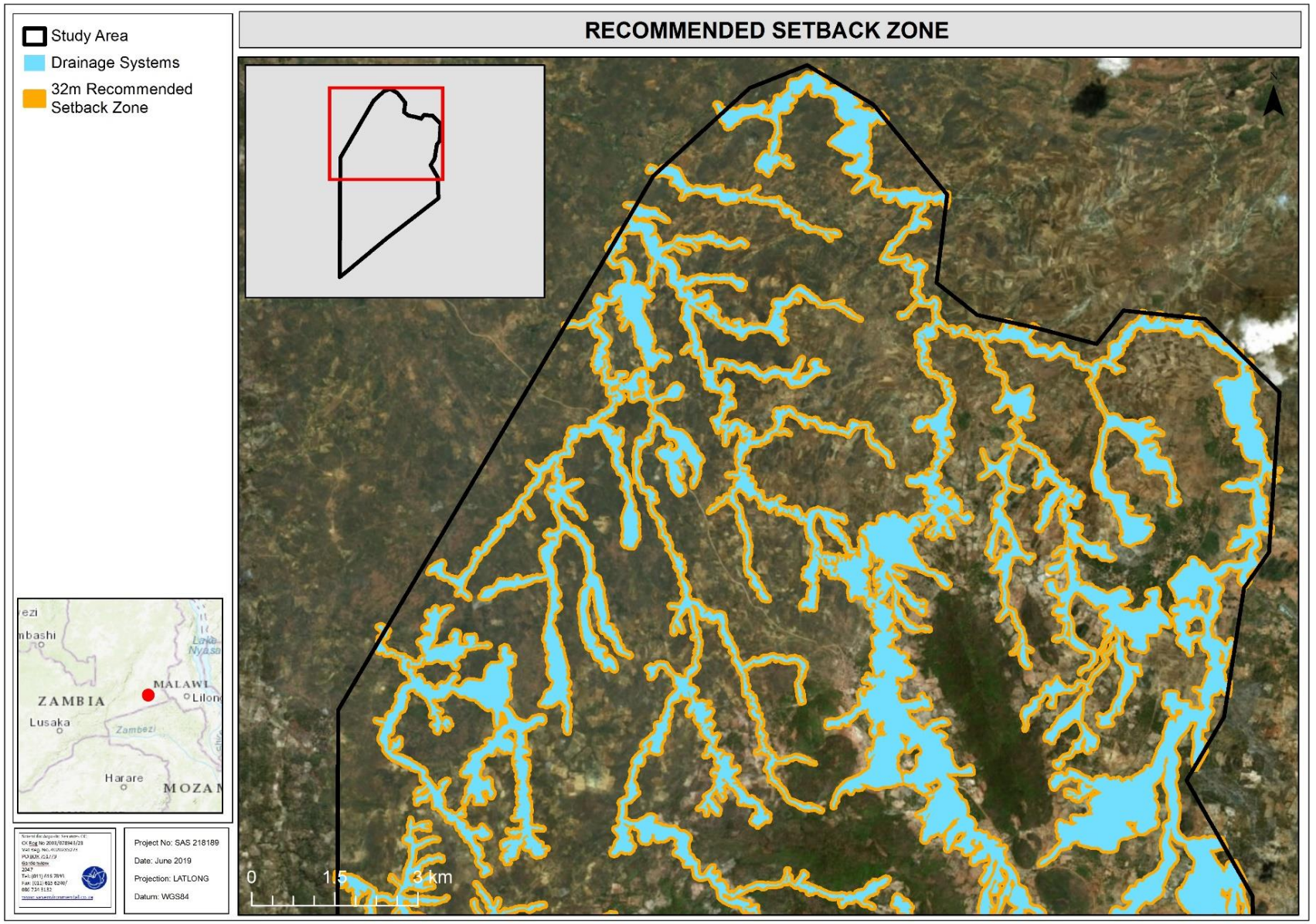


Figure 8: Conceptual depiction of the recommended 32m setback zone (buffer) around the watercourses within the northern portion of the study area.

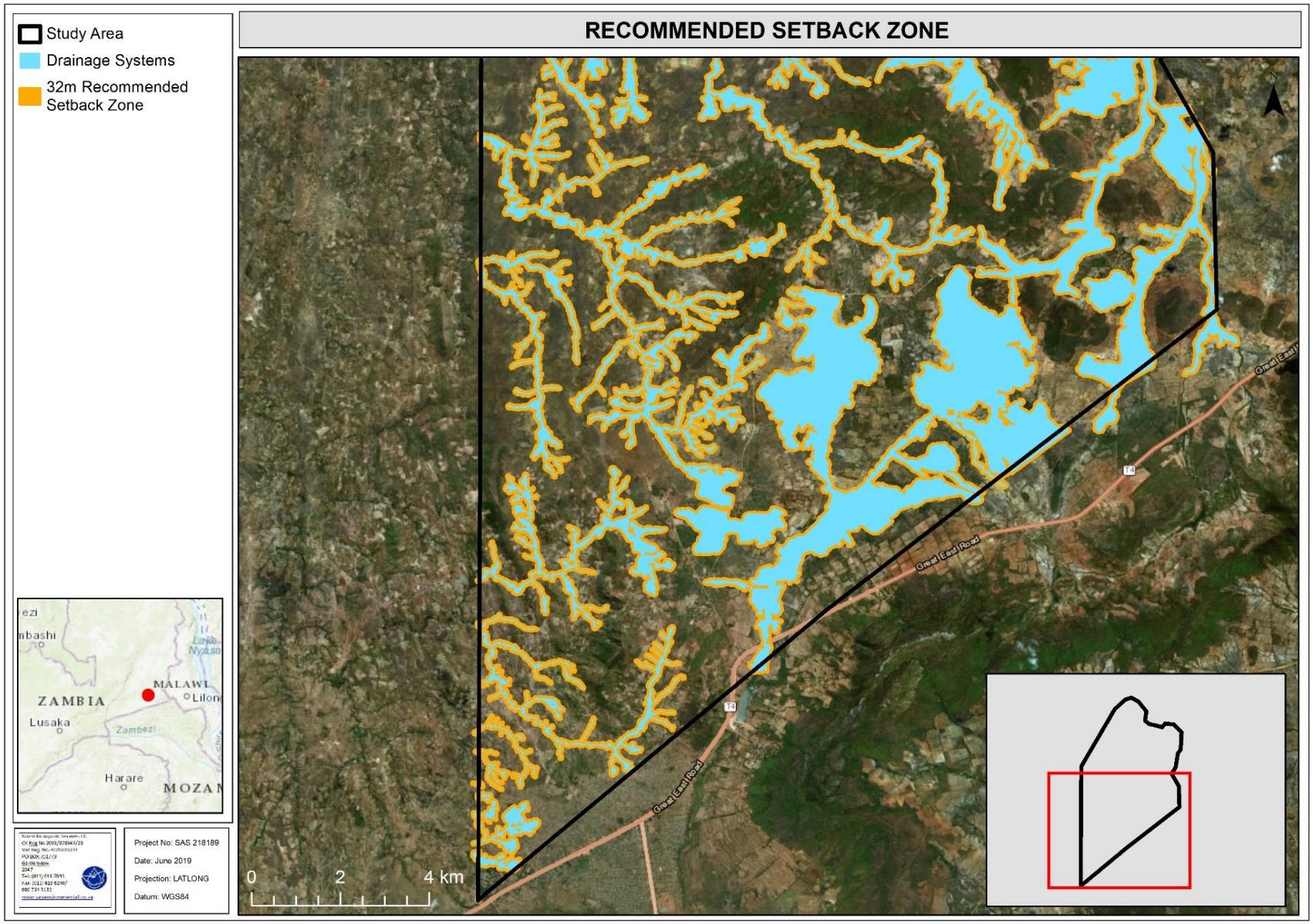


Figure 9: Conceptual depiction of the recommended 32m setback zone (buffer) around the watercourses within the southern portion of the study area.

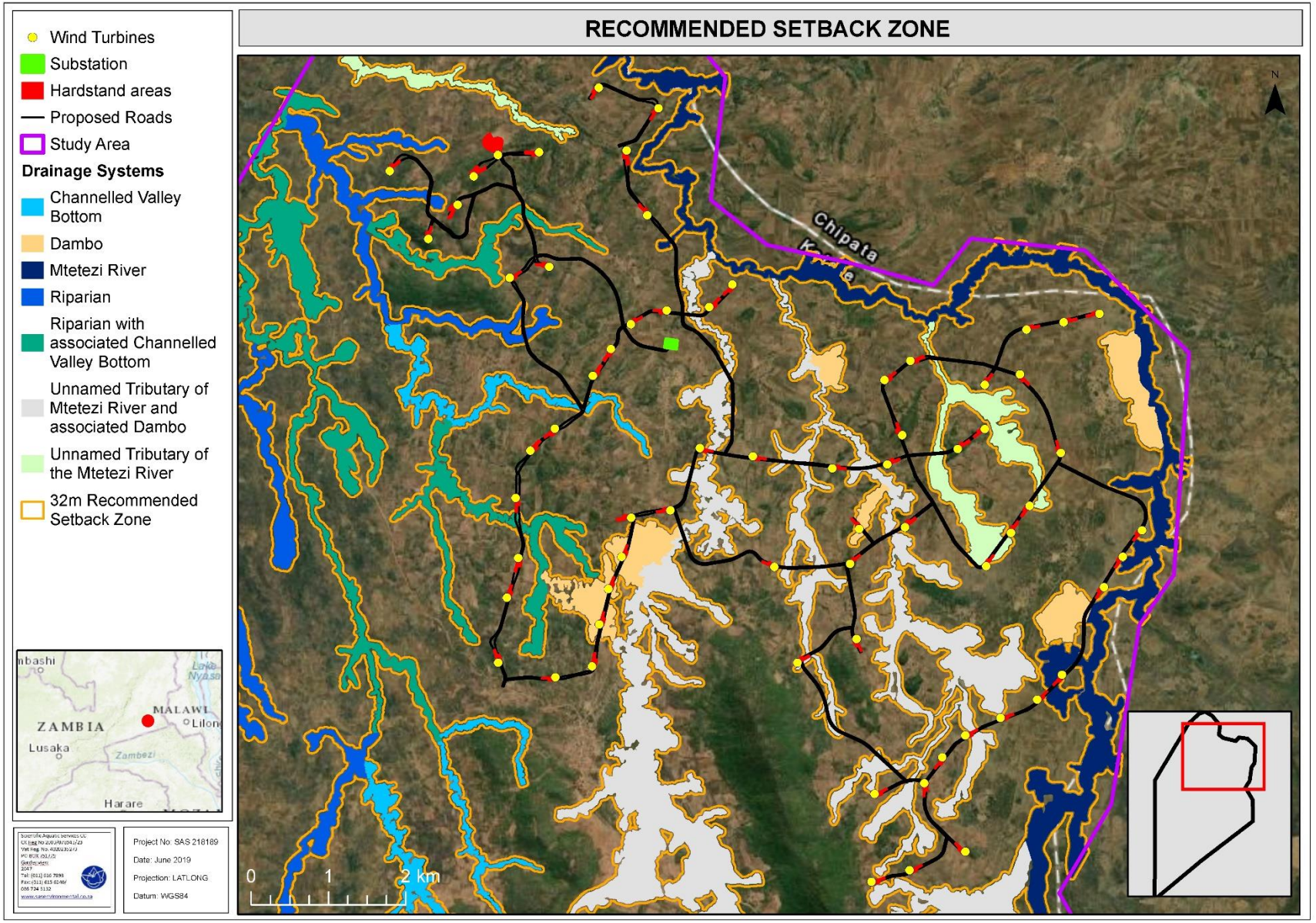


Figure 10: Conceptual depiction of the recommended 32m setback zone (buffer) around the watercourses within the north-eastern portion of the study area, in relation to the proposed turbines and infrastructure as provided in November 2020.

4 IMPACT ASSESSMENT AND PROPOSED MANAGEMENT MEASURES

This section presents the significance of potential impacts on the ecology of the identified freshwater systems associated with the proposed Unika WEF. In addition, it also indicates the recommended mitigatory measures needed to minimise the perceived impacts of the proposed Unika WEF and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures.

4.1 Impact Assessment considerations and outcome

Following the assessment of the freshwater systems associated with the proposed Unika WEF, an impact assessment was applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of these freshwater systems. The impact assessment was undertaken for the proposed layout as provided by the proponent in November 2020 and presented in Figure 10 above. The points below summarise the considerations made when applying the impact assessment:

- The impact assessment was applied considering the risk significance of the various surface infrastructure components, as depicted in Figure 10;
- Although the majority of the proposed wind turbines are placed outside of the delineated boundaries of freshwater systems and their associated 32 m buffer, four turbines (T39, T44, T51 and T53), including associated hardstand areas, are placed within a large dambo wetland;
- A total of 33 road crossings (across freshwater systems) including four across the Mtetzi River were noted. These crossings were not individually assessed as the perceived impact significance of each one is likely to vary minimally;
- Considering the above, the impact assessment was applied separately to the turbines and associated hardstand areas situated within the dambo, the turbines, associated hardstand areas and portions of the access roads located outside of the delineated freshwater systems and associated 32 m buffer zone, and to the road crossings;
- Although no powerlines were included in the layout provided in November 2020 and therefore the impact significance of such infrastructure was not assessed, it is assumed that powerline infrastructure will be required, and therefore mitigation measures were provided to guide the development of powerlines in the vicinity of the freshwater systems;

- The activities relating to the proposed Unika WEF are all considered to be highly site specific, not of a significant extent relative to the area of the freshwater systems assessed, and therefore have a limited spatial extent;
- While the operation of the Unika WEF will be a permanent activity, the construction thereof is envisioned to take between 12 and 24 months. However, the frequency of the construction impacts may be daily during this time;
- Most impacts are considered to be easily detectable, with the exception of contamination of surface and groundwater (which will require some effort); and
- The considered mitigation measures are easily practicable.

Various potential activities and impacts arising from the proposed project and relating to the freshwater systems have been identified. These activities are likely to impact on four aspects of freshwater system functioning and integrity, namely:

- Loss of habitat and ecological structure;
- Changes to ecological and sociocultural service provision;
- Hydrological function and sediment balance; and
- Impacts on water quality.

Various issues and related impacts were identified which may occur throughout all phases of the proposed project, (although impact significance is likely to be higher during the construction phase), and include:

- Site clearing and further removal of vegetation associated with the riverine and wetland habitats;
- Site clearing and the disturbance of soils leading to alien and invasive floral species proliferation;
- Compaction of soils due to construction activities;
- Movement of construction vehicles as well as service road construction within the delineated riparian and wetland zones;
- Topsoil stockpiling adjacent to the watercourses and runoff from stockpiles leading to sedimentation of the system;
- Potential indiscriminate disposal of waste and construction material within watercourses;
- Loss of phosphate, nitrate assimilation and toxicant removal abilities due to vegetation clearing;
- Streamflow diversion and draining water from the watercourses resulting in the alteration of hydrological zones;

- Potential risk of contaminated runoff from the service roads associated with the proposed development, leading to pollution of surface water;
- Disturbance of soils and on-going erosion as part of maintenance activities;
- Potential indiscriminate rehabilitation may lead to habitat transformation and alien vegetation encroachment;
- Potential for insufficient aftercare and maintenance of disturbed areas, leading to ongoing erosion, gully formation and increased sedimentation due to poor management;
- Increased water runoff into watercourses due to unvegetated areas overlooked after construction;
- Vegetation trampling during maintenance activities; and
- Potential indiscriminate movement of vehicles and equipment within the watercourses, particularly within wetland habitat during routine maintenance activities, resulting in soil compaction.

The tables below provide the outcomes of the impact assessments.

Table 6: Results of the impact assessment applied to the proposed turbines and associated hardstand areas, and the portions of access roads located outside of the delineated freshwater systems and associated 32 m buffer zone.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	L	S	L	Pr	H	H	L	L	L
	Managed	L	S	L	Pr	H	H	L	VL	VL
Construction	Unmanaged	M	S	L	Pr	H	H	M	VL	VL
	Managed	L	S	L	Pr	H	H	L	VL	VL
Operations	Unmanaged	M	S	L	Pr	H	H	M	VL	VL
	Managed	L	S	L	Pr	H	H	L	VL	VL
Closure and post closure	Unmanaged	M	S	L	Pr	H	H	M	VL	VL
	Managed	L	S	L	Pr	H	H	L	VL	VL

Table 7: Results of the impact assessment applied to the four proposed turbines and associated hardstand areas roads located within the delineated boundary of a large dambo.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	M	S	L	D	H	H	M	L	L
	Managed	L	S	L	D	H	H	M	VL	VL
Construction	Unmanaged	H	S	L	D	H	M	M	L	M
	Managed	M	S	L	D	H	M	M	VL	VL
Operations	Unmanaged	H	S	L	D	H	M	M	L	M

	Managed	M	S	L	D	H	M	M	VL	VL
Closure and post closure	Unmanaged	H	S	L	D	H	M	M	L	M
	Managed	M	S	L	D	H	M	M	VL	VL

Table 8: Results of the impact assessment applied to the 33 road crossings.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	M	S	L	D	H	H	M	L	L
	Managed	L	S	L	D	H	H	M	VL	VL
Construction	Unmanaged	H	S	L	D	H	M	M	L	M
	Managed	M	S	L	D	H	M	M	VL	VL
Operations	Unmanaged	H	S	L	D	H	M	M	L	M
	Managed	M	S	L	D	H	M	M	VL	VL
Closure and post closure	Unmanaged	H	S	L	D	H	M	M	L	M
	Managed	M	S	L	D	H	M	M	VL	VL

As illustrated in these tables, the impact significance of the majority of the proposed activities ranges from Very-Low to Low, whilst activities located within delineated freshwater systems have the potential for Medium impact significance. Mitigation measures were developed to guide the proposed activities in the vicinity of the freshwater systems. These mitigation measures are presented below.

Table 9: Mitigation measures per anticipated activity.

	Phases	Activity	Aspect	Impact	Control Measures
1	Construction Phase	Site preparation prior to construction activities of surface infrastructure components (including the turbines, hardstand areas and sub-station) located outside the freshwater systems	Vehicular movement (transportation of construction materials)	• Loss of vegetation, associated habitat and ecosystem services; • Transportation of construction materials can result in disturbances to soil, and increased risk of sedimentation/erosion; and • Soil and stormwater contamination from oils and hydrocarbons originating from construction vehicles.	➢ All development footprint areas to remain as small as possible and vegetation clearing to be limited to what is essential; ➢ Retain as much indigenous vegetation as possible; ➢ All vegetation removed as part of the site clearing activities (specifically where large areas need to be cleared) should be transported from the construction site (may not be stockpiled) and disposed of in a safe and appropriate manner; ➢ Freshwater systems, particularly in the vicinity of road crossings, must be regularly inspected and monitored for incision and erosion. Any erosion noted must be proactively managed to prevent further degradation; ➢ During construction, freshwater systems situated downgradient and within 32 m of any construction site must be protected by means of construction of a silt trap, erected along the boundary of the freshwater system. Silt traps must be monitored closely and accumulated sediment removed as regularly as required, by hand; ➢ During construction of the surface infrastructure within close proximity to a freshwater system, regular spraying of non-potable water or the use of chemical dust suppressants must be implemented to reduce dust and to ensure no smothering of vegetation within the freshwater systems occurs from excessive dust settling. It must be noted that specifics as to what type of dust suppressant (grey water vs. chemical dust suppressant) that will be utilised as part of the proposed Unika WEF was not available at the time of assessment. Should this detail become available, it is recommended that the freshwater ecologist provide a statement on the suitability of the use of the proposed dust suppressant; ➢ The freshwater systems outside the construction footprint with approved road crossings must be considered as no-go areas. No construction vehicles, nor construction personnel or vehicles may traverse through these freshwater systems (except on approved road crossings); ➢ As far as possible, existing roads must be utilised to gain access to sites; ➢ Contractor laydown areas, and material storage facilities to remain within the designated contractor camp and batching plant footprint; ➢ All vehicle re-fuelling is to take place outside of the delineated freshwater systems and associated 32m buffer; and ➢ No vegetation may be removed from any delineated freshwater system or directly adjacent thereof where no infrastructure is planned, as this provides a natural buffer zone around the freshwater systems which disperse surface runoff into the freshwater systems, and thus prevents sedimentation and erosion thereof.
2			Removal of vegetation and associated disturbances to soil.	• Earthworks could be potential sources of sediment, which may be transported as runoff into the downstream freshwater system areas; • Exposure of soil, leading to increased runoff, and erosion, and thus increased sedimentation of the freshwater systems; • Increased sedimentation of the freshwater systems, leading to smothering of vegetation associated in the freshwater systems; and • Proliferation of alien and/or invasive vegetation as a result of disturbances.	

	Phases	Activity	Aspect	Impact	Control Measures
3		Site preparation prior to construction activities relating to the upgrading of existing roads, construction of new roads, and culverts.	Removal of vegetation and associated disturbances to soil. Proliferation of alien and/or invasive vegetation as a result of disturbances.	• Earthworks and exposure of soil could result in sedimentation of the freshwater systems, which may be transported as runoff into the downstream freshwater system areas and may smother vegetation associated with the freshwater systems; and • Proliferation of alien and/or invasive vegetation as a result of disturbances.	➢ It is imperative that all construction works upgradient and/or within 32 m of any freshwater system, and especially road crossings over wetlands, be undertaken during the driest period of the year when there is no flow within the freshwater systems, and thus negating the need for diversion of flow; ➢ The reaches of the freshwater systems where no activities are planned to occur must be considered no-go areas. These no-go areas can be marked at a maximum distance of 5 m upstream and downstream of the proposed road upgrade crossing. This 5 m buffer area would allow for construction personal, vehicles (if applicable) to enter the freshwater system crossing where the road is proposed to be upgraded or constructed; ➢ Topsoil removed in preparation for construction of new road crossings must be stored separately and may not be contaminated. Furthermore, the soil layers should be replaced in the same order and the topsoil returned last; ➢ The removed vegetation must be stockpiled outside of the delineated boundary of the freshwater system. The footprint areas of these stockpiles should be kept to a minimum, and may not exceed a height of 2 m. Should the vegetation not be suitable for reinstatement after the construction phase or be alien/invasive vegetation species, all material must be disposed of responsibly. ➢ A suitable AIP control plan must be developed o manage the proliferation of AIPs and ensure that they do not spread as a result of the construction activities.
4		Construction of new roads (including installation of culverts where necessary and bridge crossings) and the upgrading of existing roads traversing freshwater systems.	• Removal of vegetation and associated disturbances to soil. • Compaction of soil in the existing road crossing footprint to increase the width of the roads; and • Importation of materials to construct the roads.	• Earthworks and exposure of soil could result in sedimentation of the freshwater systems, which may be transported as runoff into the downstream freshwater system areas and may smother vegetation associated with the freshwater systems; and • Proliferation of alien and/or invasive vegetation as a result of disturbances.	➢ It was noted that several proposed access roads are located within 100 m to 200 m of existing roads. Where feasible, it is strongly recommended that these existing roads be upgraded, rather than constructing new roads, to minimise the degree of disturbance to and loss of freshwater habitat and to minimise impacts on hydrological and geomorphological processes and balances; ➢ It is considered imperative that road construction works over freshwater systems be undertaken during the driest periods of the year to limit surface water contamination and the need for any surface water diversion during the construction works; ➢ Provided that the road works are undertaken during the driest periods the severity of impact (specifically pertaining to the flow regime) will be significantly reduced as would the frequency of an impact; ➢ Effective and strict erosion control throughout the construction phase is imperative. Erosion berms should be installed to prevent gully formation and further siltation of the freshwater resources. All soil stockpiles should be placed outside of the 32m buffer zone and protected with a suitable geotextile. There is already evidence of excess sediment deposits at some of the assessed sites, and further degradation of the rivers in this regard must be minimised and avoided. Erosion controls must be regularly maintained, at minimum on a fortnightly basis, particularly if rain is forecast or immediately following a rainfall event; ➢ When it is absolutely unavoidable that freshwater systems are affected, especially during bridge construction over the Mtetezi River, disturbance to the riparian zone at each

	Phases	Activity	Aspect	Impact	Control Measures
					crossing point must be minimised and suitably rehabilitated. In this regard, very careful attention to the design criteria and bridge design will need to take place, with special mention of the following: o Disturbances within the river bed/active channel need to be minimised as far as possible. In this regard the following key points are highlighted: • The piers should be located as far above the water level in the active channel as possible in order to reduce the duration in which the piers impede and divert flow, create turbulent flow and create a risk of erosion; • The narrowest point in the river should be identified and potentially used as the crossing point; • The bridge should cross the river at a 90-degree angle to minimise the damage to riparian areas; and • The bridge should not cross the river in any area where the river or active channel makes sharp bends directly upstream of the identified crossing point increasing turbulent flow and erosion potential. ➢ Use of culverts should be made in the area between the active channel bank and to the edge of the macro-channel bank or 1:100 year floodline, whichever is the greater, to ensure that the hydraulic function of the system is maintained and to ensure that wetting frequencies and patterns are maintained in the pre-development condition; ➢ Culvert, causeway and bridge design must ensure that no upstream ponding and no downstream erosion and scouring occur; ➢ Culvert, causeway and bridge design must ensure that no hindrance to terrestrial, wetland/riparian and aquatic fauna occurs; and ➢ Culvert and causeway design should ensure that maximum hydrological connectivity is retained at all times as far as possible. In this regard therefore, box culverts are preferred, since these are less likely to become blocked (in comparison to pipe culverts) and require less maintenance, therefore resulting in fewer disturbances to the surrounding riparian zones during operations.
5		Construction of surface infrastructure (including the turbines and associated hardstand areas) outside of the freshwater systems but within 100 m thereof.	• Removal of vegetation and topsoil and associated stockpiling; • Ground-breaking and earthworks relating to foundations and trenches; • Mixing and casting of concrete for construction purposes;	• Disturbances of soil leading to increased alien vegetation proliferation within the terrestrial buffer zone surrounding the freshwater systems, with the potential to affect the freshwater system habitat; • Altered runoff patterns within the local catchment of the freshwater systems, potentially leading to increased erosion and	➢ During excavation activities, the topsoil and vegetation should be stockpiled separately from other material outside of the delineated freshwater system; ➢ Excavated materials should not be contaminated, and it should be ensured that the minimum surface area is taken up by any stockpiled materials. The mixture of the lower and upper layers of the excavated soil should be kept to a minimum, so as for later use as backfill material after construction has commenced; ➢ All exposed soil must be protected from wind using tarpaulins for the duration of the construction phase to prevent potential erosion and sedimentation of the freshwater systems; ➢ Suitable drainage should be insured along the hardstand areas, in order to ensure that water does not pond on the hardstand or drain in a concentrated manner into the

	Phases	Activity	Aspect	Impact	Control Measures
			• Backfilling of excavated and disturbed areas; and • Miscellaneous activities by construction personnel.	sedimentation of the freshwater systems; • Potential impacts on the water quality of surface water runoff (when present) which may potentially enter the freshwater systems and contamination of soil due to concrete casting; and • Potential of backfill material entering the freshwater systems, increasing the sediment loads therein.	freshwater systems. This must be considered as part of the stormwater management plan and be overseen by a freshwater ecologist; ➢ Construction of the proposed surface infrastructure may result in disturbance to the natural buffer zone surrounding the freshwater systems which may result in the reduction of surface roughness. This can be mitigated by ensuring that no concentrated runoff from the surface infrastructure construction areas enter the freshwater systems by installing silt traps or placing haybales down gradient of the construction footprint (until suitable basal vegetation cover has been restored) to ensure no sediment laden or concentrated runoff generates from the construction footprint; and ➢ It is highly recommended that an alien vegetation management plan be compiled during the planning phase and implemented concurrently with the commencement of construction. With regards to concrete mixing on site: ➢ No mixed concrete may be deposited outside of the designated construction footprint; and ➢ Concrete spilt outside of the demarcated area must be promptly removed and appropriately disposed of. With regards to backfilling of excavated areas: ➢ Stockpiled material should be used as backfill material; ➢ All excavated areas should be backfilled to the natural ground level with excavated material; and ➢ Soil must be suitably compacted, and all construction material must be removed from the site upon the completion of construction or used in the rehabilitation process. Rehabilitation of the construction footprint areas: ➢ All footprint areas which have been compacted should be ripped and revegetated within indigenous vegetation as soon as the construction activities have been completed. This will prevent soil erosion and the creation of gullies within the operational area; and ➢ The operational area should regularly be inspected for alien and invasive vegetation species which might have established due to the construction activity related disturbances.

	Phases	Activity	Aspect	Impact	Control Measures
6		Spanning of the powerlines over the various freshwater systems	• Excavation of pits for the pylons leading to stockpiling of soil; • Potential movement of construction equipment and personnel within the freshwater systems.	• Disturbances of soil leading to potential impacts to the freshwater system vegetation, increased alien vegetation proliferation in the footprint areas, and in turn to altered freshwater system habitat; • Altered runoff patterns, leading to increased erosion and sedimentation of the freshwater systems.	➢ It is imperative that all construction works be undertaken during the drier months when the flow is low in the freshwater systems, and no diversion of flow would be necessary; ➢ It is imperative that all pylons are located at least 10 m from the delineated edge of the freshwater systems to minimise any potential erosion or sedimentation into the freshwater system as a result of construction works. Excavation of pits for the tower foundation within close proximity to a freshwater system may cause excessive sediment to enter into the freshwater systems, specifically if works are undertaken during the rainy months; ➢ Only a 10 m buffer around the pylon footprint area is allowed to be disturbed. This 10 m construction buffer will limit construction vehicles/personnel to disturb the surrounding area to freshwater systems, should the pylons be located in close proximity to a freshwater system; ➢ During excavation of the foundations, soil must be stockpiled upgradient of the excavated pit. Mixture of the lower and upper layers of the excavated soil should be kept to a minimum. This soil must be used to close off the pits, immediately after installation of the pylon; ➢ The bedding layer (such as clean gravel) should be spread evenly and compacted uniformly to the required density using a hand tamper (one man operator) in order to minimise the use of large machinery within the freshwater system or within close proximity to a freshwater system; ➢ When the powerline is spun between the pylons, no vehicles may indiscriminately drive through the freshwater systems, and must make use of the dedicated access roads.

	Phases	Activity	Aspect	Impact	Control Measures
7	OPERATIONAL PHASE	Operation and maintenance of the surface infrastructure outside the freshwater systems but within the 100 m thereof.	• Potential indiscriminate movement of maintenance vehicles within the freshwater systems or within close proximity to the freshwater systems; and • Increased risk of sedimentation and/or hydrocarbons entering the freshwater systems via stormwater runoff from the surface infrastructure (such as from crane pads and the construction camp)	• Disturbance to soil and ongoing erosion as a result of periodic maintenance activities; and • Altered water quality (if surface water is present) as a result of increased availability of pollutants.	➢ No indiscriminate movement of construction equipment through the freshwater systems may be permitted during standard operational activities or maintenance activities. Use must be made of the existing freshwater system crossings only; ➢ Unnecessary disturbances surrounding the perimeter of the surface infrastructure must be avoided; ➢ Ensure that routine inspections and monitoring of any instream infrastructure are undertaken to monitor any build-up of debris that will impact on structure integrity or lead to erosion and sedimentation. Furthermore, monitoring to determine the establishment of indigenous vegetation and the presence of any alien or invasive plant species; ➢ The surface infrastructure areas must be inspected to ensure that no concentrated runoff from these areas form erosion gullies leading to erosion and sedimentation of receiving freshwater systems. Should these impacts be noted, these gullies/preferential flow paths must be infilled with *in situ* material and appropriately stabilised and/or revegetated; and ➢ Monitoring for the establishment for alien and invasive vegetation species must be undertaken, specifically at the road crossings and surface infrastructures. Should alien and invasive plant species be identified, they must be removed and disposed of as per an alien and invasive species control plan and the area must be revegetated with suitable indigenous vegetation.
8		Operation and maintenance of roads (new and existing) traversing freshwater systems.	• Concentrated runoff entering the freshwater systems; and • Disturbance to the vegetation within and surrounding the freshwater systems.	• Concentrated runoff from the road crossings leading to erosion and subsequent sedimentation of the freshwater systems (increase in the sediment load) and turbulent flows when surface water is present; • Changes to pattern flow and timing of water in the landscape due to reduced surface roughness in the freshwater systems.	➢ Routine maintenance of the roads must be undertaken to ensure that no concentration of flow and subsequent erosion occurs due to the road crossings/instream infrastructure. Such maintenance activities must specifically be undertaken after high rainfall events; ➢ Stormwater runoff from the road crossings should be monitored (by the Operation and Maintenance (O&M) Manager), to ensure it does not result in erosion of the freshwater systems. Stormwater should be allowed to diffusely spread across the landscape, by ensuring adequate surface roughness in the freshwater system (through vegetation and rocky areas); ➢ Maintenance vehicles must make use of dedicated access roads and no indiscriminate movement in the freshwater systems may be permitted; ➢ During periodic maintenance activities of the roads/surface infrastructure, monitoring for erosion should be undertaken; and ➢ Should erosion be observed, caused by the road crossings/instream infrastructure, the area must be rehabilitated by infilling the erosion gully and revegetation thereof with suitable indigenous vegetation. Use can also be made of rocks collected from the surrounding area to infill any area prone to erosion, as a natural dispersal mechanism.

5 CONCLUSIONS

Numerous watercourses, comprising four primary HGM types (rivers, channelled and unchannelled valley bottom wetlands and dambos) were identified, delineated and assessed at a high level within the study area. Due to the remote location of the study area, minimal anthropogenic influences on the watercourses were observed and impacts are largely limited to vegetation clearing, soil disturbances and bush encroachment all relating to subsistence agriculture, one of the primary sources of income in the communities, i.e. manufacture of charcoal, and to a lesser extent, domestic uses. Some instream infrastructure – impoundments, weirs and road crossings - were observed within the rivers; however with the exception of the impoundments (which are all located on the Mtetezi River) these are not deemed severe. The undeveloped economy in the area increases the reliance on the wetlands, although during informal discussions with a local *Nduna*, it was revealed that this reliance does not have historical roots and has come about largely due to an increased population and lack of arable land, forcing residents to encroach into the wetlands. Whilst the socio-cultural reliance on wetland systems may be reduced if the economy was further developed, they are nevertheless considered very important for the provision of indirect (ecological) benefits including flood attenuation, erosion control, recharge of downstream systems, trapping of sediment and assimilation of nutrients, and biodiversity maintenance. Thus, a careful approach is required if a sustainable, environmentally sensitive balance between economic growth and protection of the watercourses is to be achieved.

A buffer of 32 m was proposed, to guide the layout of the proposed WEF development. The layout provided by the proponent in November 2020 indicates that the majority of the proposed infrastructure is located outside of the delineated freshwater systems and the associated 32 m buffer, with the exception of four turbines (and their associated hardstand areas) and 33 road crossings. The results of the impact assessment indicated that provided strict adherence to cogent, well-developed mitigation measures takes place, the impact significance of most activities is of very-low to low levels. Nevertheless, it is strongly recommended that the four turbines placed within a dambo wetland be relocated, and if possible, some of the proposed access roads be realigned along existing roads, in order to minimise the cumulative impacts on the freshwater systems.

Based on the findings of the freshwater ecological assessment and the results of the risk assessment, it is the opinion of the ecologist that the proposed Unika WEF poses a negative low risk to the integrity of the identified watercourses provided that adherence to cogent, well-conceived and ecologically sensitive construction plans are implemented and the mitigation measures provided in this report as well as general good construction practice are adhered to, the proposed Unika WEF is considered acceptable.

6 REFERENCES AND BIBLIOGRAPHY

NOTE: Reliable reference material at the required level of detail and accuracy is scant, and thus verified and accurate reference material was utilised. These references are internationally accepted and although many of them do not specifically cover Zambia, the species ranges and distributions overlap. Notes on ecological and biological requirements allowed the specialists to reliably extrapolate data.

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Department of Water Affairs and Forestry (1996), *South African water quality guidelines vol*. 7, Aquatic ecosystems

Gerber, A. and Gabriel, M.J.M. (2002), *Aquatic Invertebrates of South African Rivers*. First Edition. Department of Water Affairs: Pretoria, South Africa.

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APPENDIX A: Ecological Assessment Approach

Visual Assessment

The assessment site was investigated in order to identify visible impacts, with specific reference to impacts from surrounding activities and any effects resulting from activities occurring upstream in the catchment. Both natural constraints placed on ecosystem structure and functions, as well as anthropogenic alterations to the system, were identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual indications of the conditions at the time of assessment. Factors which were noted in the site specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance and pollution of the area; and
- Other life forms reliant on aquatic ecosystems.

APPENDIX B: Wetland Method of Assessment

Wetland Classification System

All areas containing wetland or riparian characteristics that were encountered within the study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the "Classification System" (Ollis *et. al*., 2013). This method encompasses the broad suite of "wetlands" as defined by the Ramsar Convention and includes all ecosystems that the Ramsar Convention is concerned with.

A summary on Levels 1 to 4 of the classification system are presented in the tables below.

Table B1: Classification System for Inland Systems, up to Level 3.

<table>
<tr><th colspan="3">WETLAND / AQUATIC ECOSYSTEM CONTEXT</th></tr>
<tr><th>LEVEL 1:
SYSTEM</th><th>LEVEL 2:
REGIONAL SETTING</th><th>LEVEL 3:
LANDSCAPE UNIT</th></tr>
<tr><td rowspan="4">Inland Systems</td><td rowspan="4">DWA Level 1 Ecoregions
OR
NFEPA WetVeg Groups
OR
Other special framework</td><td>Valley Floor</td></tr>
<tr><td>Slope</td></tr>
<tr><td>Plain</td></tr>
<tr><td>Bench
(Hilltop / Saddle / Shelf)</td></tr>
</table>

Level 1: Inland systems

From the classification system, Inland Systems (Table B1) are defined as **aquatic ecosystems that have no existing connection to the ocean**[3] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but **which are inundated or saturated with water, either permanently or periodically.** It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included in Level 2 of the classification system is that of the aquatic ecoregion (Table B1). Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

[3] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

Table B2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 3: Landscape Setting

At Level 3 of the classification system for Inland Systems, a distinction is made between four Landscape Units (Table B1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et. al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table B2), on the basis of hydrology and geomorphology (Ollis *et. al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et. al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et. al*., 2009).

Wetland delineation

For the purposes of this investigation, wetland habitat was defined according to the factors associated with the Ramsar Commissions’ definition of a wetland. The extent of the wetland was determined by delineating the wetland based upon the Department of Water and Sanitation (DWS) (formerly DWA / DWAF) guidelines ‘A practical field procedure for the identification and delineation of wetlands and riparian areas’ (DWAF, 2008). This method is regarded as regional best practice adapted from the Ramsar Commissions guidelines and stipulates that consideration be given to four specific wetland indicators to determine the boundary of the wetland. Whilst not developed in the region in which the investigation area is located, this method is

regarded as applicable, relevant and provides an accurate rationale in watercourse mapping in support of the International Finance Corporation standards for rigorous characterisation of watercourses.

These indicators are:

- Densification of riparian vegetation;
- Changes in hue of vegetation;
- Linear connectivity of features to drainage systems;
- Position in the landscape, for example valley floors; and
- Presence of surface water showing up either as black areas or white areas reflecting cloud cover.

By observing the evidence of these features, in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF 2005).

The presence of hydric soils as a soil wetness indicator (i.e. examination of redoximorphic features within the soil) are one of the most important factors for identifying wetlands boundaries. The reason being that vegetation (considered to be the primary determining factor) can easily respond to changes in hydrology (e.g. the draining of a wetland), while the soil morphological signatures remain even if the wetland hydrology is altered.

A number of soil forms associated with the permanent zone of the wetland or the seasonal / temporary zones are provided in the guidelines of this method.

One of these are the redoximorphic features, which are the result of the reduction, translocation and oxidation (precipitation) of Fe (iron) and Mn (manganese) oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Only once soils within 500mm of the surface display these redoximorphic features can the soils be considered to be hydric (wetland) soils, and it can then be considered a wetland. Redoximorphic features typically occur in three types:

- A reduced matrix – i.e. an *in situ* low chroma (soil colour), resulting from the absence of Fe_3^+ ions which are characterised by “grey” colours of the soil matrix.
- Redox depletions - the “grey” (low chroma) bodies within the soil where Fe-Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur; and
- Redox concentrations - Accumulation of iron and manganese oxides (also called mottles).

Once the presence or absence of redoximorphic features within the upper 500mm of the soil profile is identified, that alone is sufficient to identify the soil as being hydric (a wetland soil) or non-hydric (non-wetland soil) (Collins, 2005; DWAF, 2005).

Riparian and wetland zones can be divided into three zones (DWAF 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation.

Since wetlands has a wetness gradient from the middle of the wetland to the adjacent terrestrial area, vegetation in an untransformed state can be used to support the delineation of a wetland, due to plant community adapting to the gradient. Plant communities are assessed, rather than individual indicator species, but the dominant species (hydrophytes or not) in the area are assessed to determine the presence of a wetland.

APPENDIX C: IMPACT ASSESSMENT METHOD

METHOD OF ASSESSING IMPACT SIGNIFICANCE

The identification and assessment of environmental impacts is a multi-faceted process, using a combination of quantitative and qualitative descriptions and evaluations. It involves applying scientific measurements and professional judgement to determine the significance of environmental impacts associated with the proposed project. The process involves consideration of, *inter alia*: the purpose and need for the project; views and concerns of interested and affected parties (I&APs); social and political norms, and general public interest.

IDENTIFICATION AND DESCRIPTION OF IMPACTS

Identified impacts are described in terms of the nature of the impact, compliance with legislation and accepted standards, receptor sensitivity and the significance of the predicted environmental change (before and after mitigation). Mitigation measures may be existing measures or additional measures that were identified through the impact assessment and associated specialist input. The impact rating system considers the confidence level that can be placed on the successful implementation of mitigation.

EVALUATION OF IMPACTS AND MITIGATION MEASURES

INTRODUCTION

Impacts are assessed using SLR's standard convention for assessing the significance of impacts, a summary of which is provided below.

In assigning significance ratings to potential impacts before and after mitigation the approach presented below is to be followed.

1. **Determine the impact consequence rating:** This is a function of the "intensity", "duration" and "extent" of the impact (see Section 2.2). The consequence ratings for combinations of these three criteria are given in Section 0.

2. **Determine impact significance rating:** The significance of an impact is a function of the consequence of the impact occurring and the probability of occurrence (see Section 2.2). Significance is determined using the table in Section 2.4.

3. **Modify significance rating (if necessary):** Significance ratings are based on largely professional judgement and transparent defined criteria. In some instances, therefore, whilst the significance rating of potential impacts might be "low", the importance of these impacts to local communities or individuals might be extremely high. The importance/value which interested and affected parties attach to impacts will be highlighted, and recommendations should be made as to ways of avoiding or minimising these perceived negative impacts through project design, selection of appropriate alternatives and / or management.

4. **Determine degree of confidence of the significance assessment:** Once the significance of the impact has been determined, the degree of confidence in the assessment will be qualified (see Section 2.2).

Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact.

CRITERIA FOR IMPACT ASSESSMENT

The criteria for impact assessment are provided below.

Criteria	Rating	Description
Criteria for ranking of the INTENSITY (SEVERITY) of environmental impacts	**ZERO TO VERY LOW**	Negligible change, disturbance or nuisance. The impact affects the environment in such a way that natural functions and processes are not affected. People / communities are able to adapt with relative ease and maintain pre-impact livelihoods.
	LOW	Minor (Slight) change, disturbance or nuisance. The impact on the environment is not detectable or there is no perceptible change to people's livelihood.
	MEDIUM	Moderate change, disturbance or discomfort. Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way. People/communities are able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.
	HIGH	Prominent change, disturbance or degradation. Where natural functions or processes are altered to the extent that they will temporarily or permanently cease. Affected people/communities will not be able to adapt to changes or continue to maintain-pre impact livelihoods.
Criteria for ranking the DURATION of impacts	**SHORT TERM**	< 5 years.
	MEDIUM TERM	5 to < 15 years.
	LONG TERM	> 15 years, but where the impact will eventually cease either because of natural processes or by human intervention.
	PERMANENT	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such time span that the impact can be considered transient.
Criteria for ranking the EXTENT / SPATIAL SCALE of impacts	**LOCAL**	Impact is confined to project or study area or part thereof, e.g. limited to the area of interest and its immediate surroundings.
	REGIONAL	Impact is confined to the region, e.g. coast, basin, catchment, municipal region, etc.
	NATIONAL	Impact is confined to the country as a whole, e.g. South Africa, etc.
	INTERNATIONAL	Impact extends beyond the national scale.
Criteria for determining the PROBABILITY of impacts	**IMPROBABLE**	Where the possibility of the impact to materialise is very low either because of design or historic experience, i.e. ≤ 30% chance of occurring.
	POSSIBLE	Where there is a distinct possibility that the impact would occur, i.e. > 30 to ≤ 60% chance of occurring.
	PROBABLE	Where it is most likely that the impact would occur, i.e. > 60 to ≤ 80% chance of occurring.
	DEFINITE	Where the impact would occur regardless of any prevention measures, i.e. > 80% chance of occurring.

Criteria	Rating	Description
Criteria for determining the DEGREE OF CONFIDENCE of the assessment	**LOW**	≤ 35% sure of impact prediction.
	MEDIUM	> 35% and ≤ 70% sure of impact prediction.
	HIGH	> 70% sure of impact prediction.
Criteria for the DEGREE TO WHICH IMPACT CAN BE MITIGATED - the degree to which an impact can be reduced / enhanced	**NONE**	No change in impact after mitigation.
	VERY LOW	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
	LOW	Where the significance rating drops by one level, after mitigation.
	MEDIUM	Where the significance rating drops by two to three levels, after mitigation.
	HIGH	Where the significance rating drops by more than three levels, after mitigation.
Criteria for LOSS OF RESOURCES - the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable	**LOW**	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
	MEDIUM	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
	HIGH	Where the activity results in an irreplaceable loss of a resource.

DETERMINING CONSEQUENCE

Consequence attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity. The ratings and description for determining consequence are provided below.

Rating	Description
VERY HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***long term***; OR of ***high intensity*** at a ***national level*** in the ***medium term***; OR of ***medium intensity*** at a ***national level*** in the ***long term.***
HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***high intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***national level*** in the ***long term***; OR of ***high intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***regional level*** in the ***long term.***
MEDIUM	Impacts could be EITHER: of ***high intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***medium intensity*** at a ***regional level*** in the ***medium term***; OR of ***high intensity*** at a ***regional level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***local level*** in the ***long term***; OR of ***low intensity*** at a ***national level*** in the ***medium term;***
Rating	**Description**
	OR of ***low intensity*** at a ***regional level*** in the ***long term.***

LOW	Impacts could be EITHER of ***low intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***national level*** in the ***short term***; OR of ***high intensity*** at a ***local level*** and endure in the ***short term***; OR of ***medium intensity*** at a ***regional level*** in the ***short term***; OR of ***low intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.***
VERY LOW	Impacts could be EITHER of ***low intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***; OR of ***low to medium intensity*** at a ***local level*** and endure in the ***short term.*** OR **Zero to very low intensity** with any combination of extent and duration.

DETERMINING SIGNIFICANCE

The consequence rating is considered together with the probability of occurrence in order to determine the overall significance using the table below.

		PROBABILITY			
		IMPROBABLE	POSSIBLE	PROBABLE	DEFINITE
CONSEQUENCE	VERY LOW	INSIGNIFICANT	INSIGNIFICANT	VERY LOW	VERY LOW
	LOW	VERY LOW	VERY LOW	LOW	LOW
	MEDIUM	LOW	LOW	MEDIUM	MEDIUM
	HIGH	MEDIUM	MEDIUM	HIGH	HIGH
	VERY HIGH	HIGH	HIGH	VERY HIGH	VERY HIGH

In certain cases it may not be possible to determine the significance of an impact. In these instances the significance is **UNKNOWN**.

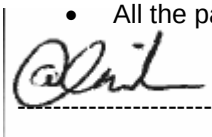
APPENDIX D: SPECIALISTS DETAILS

Details, Expertise and Curriculum Vitae of Company and Author

Declaration that the specialist is independent in a form as may be specified by the competent authority

I, Amanda Mileson, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF AMANDA MILESON

PERSONAL DETAILS

Position in Company	Ecologist
Date of Birth	15 February 1978
Nationality	Zimbabwean
Languages	English
Joined SAS	2013

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member South African Wetland Society

Member Gauteng Wetland Forum

EDUCATION

Qualifications

Advanced Diploma: Nature Conservation (UNISA)	2020
N.Dip Nature Conservation (UNISA)	2017
Wetland Management: Introduction and Delineation (University of the Free State)	2018
Tools for Wetland Assessment (Rhodes University)	2017
Wetland Rehabilitation (University of the Free State)	2015

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Free State, North West, Limpopo, Northern Cape, Eastern Cape

Zimbabwe, Zambia

SELECTED PROJECT EXAMPLES

Wetland Assessments

- Baseline Aquatic and Freshwater Assessment as part of the Environmental Assessment and Authorisation Process for the N11 Ring Road, Mokopane, Limpopo Province.
- Freshwater Resource Ecological Assessment as part of the Water Use License Application Requirements for the Proposed Upgrades to the Klippan Pump Station Near Welkom, Free State Province.
- Freshwater Resource Ecological Assessment as part of the Water Use License Application Requirements for the Proposed Urania-Bronville 11kv and 132kv Powerline Corridor Near Welkom, Free State Province.
- Freshwater Assessment for the Proposed Rietrug, Distribution Line: Basic Assessment for the proposed Construction of Electrical Grid Infrastructure to support the proposed (split) Rietrug Wind Energy Facility, near Sutherland, in the Northern Cape and Western Cape Provinces.
- Freshwater Assessment for the Proposed Sutherland 2 Distribution Line: Basic Assessment for the proposed Construction of Electrical Grid Infrastructure to support the proposed (split) Sutherland 2 Wind Energy Facility, near Sutherland, in the Northern Cape and Western Cape Provinces.

- Freshwater Assessment for the Proposed Sutherland Distribution Line: Basic Assessment for the proposed Construction of Electrical Grid Infrastructure to support the proposed (split) Sutherland Wind Energy Facility, near Sutherland, in the Northern Cape and Western Cape Provinces.
- Freshwater resource delineation and ecological assessment as part of the proposed expansion of the Kudumane Mining Project, Northern Cape Province.
- Freshwater assessment as part of the environmental assessment and authorisation process for associate electrical infrastructure and a proposed pipeline for the Rooipunt Solar Thermal Power Park Project near Upington, Northern Cape.
- Present Ecological State of the Wetlands Report: Jukskei and Klip River Catchments: Monitoring and Managing the Ecological State of the Wetlands in the City of Johannesburg Metropolitan Area.
- Wetland assessment as part of the environmental assessment and authorisation process for the proposed Leandra underground coal mine.
- Freshwater ecological assessment as part of the water use licence application process for the proposed waste rock dump expansion for Impala Platinum Mine in Rustenburg, North-West Province.
- Wetland assessment as part of the water use licence application process for the Marula Platinum Mine, Limpopo Province.
- Wetland assessment as part of the environmental authorisation process for the Anglo Platinum Der Brochen Project, Limpopo Province.
- Wetland assessment as part of the environmental authorisation process for the proposed Yzermyn Coal Mining Project near Dirkiesdorp, Mpumalanga.
- Wetland assessment as part of the environmental authorisation process for the Mzimvubu Water Project, Eastern Cape.
- Wetland assessment as part of the proposed water management process at the Assmang Chrome Machadodorp Works, Mpumalanga.
- Wetland ecological assessment as part of the Section 24G application process for the Temba Water Purification Plant.

Terrestrial Assessments

- Investigation of specialist biodiversity aspects required by GDARD in the vicinity of the Apies River, downstream of the proposed construction of new outlet works at the Kudube (Leeuwkraal) Dam in Temba, Gauteng
- Terrestrial Ecological Scan as part of the environmental authorisation process for three proposed bridge upgrades near Edenvale, Gauteng
- Terrestrial Ecological Scan as part of the environmental authorisation process for the proposed Dalpark Ext 3 filling station development, Gauteng

Rehabilitation Projects

- Freshwater Resource Rehabilitation and Management Plan as part of the Environmental Authorisation Process for the Proposed Urania-Bronville 11kv and 132kv Powerline Corridor Near Welkom, Free State Province.
- Rehabilitation Plan as part of the Water Use License Application Requirements for the Proposed Upgrade of the Thabazimbi Wastewater Treatment Works (WWTW) Sewer Line, Limpopo Province.
- Wetland rehabilitation and management plan for The Hills EcoEstate, Midrand, Gauteng.
- Riparian rehabilitation and management plan for The Diepsloot River, Riversands, Gauteng.
- Riparian rehabilitation and management plan for the Apies River in the vicinity of the proposed construction of new outlet works at the Kudube (Leeuwkraal) Dam in Temba, Gauteng.

Environmental Control Officer

- Monthly specialist Environmental Control Officer (ECO) function for the monitoring of riparian crossings at Riversands Country Estate Development, Gauteng province.
- Weekly specialist Environmental Control Officer (ECO) function for the monitoring of emergency desilting and rehabilitation of existing stormwater retention dams on ERF 836 Kosmosdal ext 1, and portion 5 of ERF 115 Kosmosdal ext 4, near Centurion, Gauteng Province.