Baseline assessment of the bat species on the proposed Spitsvale opencast mining project, Steelpoort, Limpopo Province.

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1 Introduction

Habitat destruction and global climate change are impacting the earth on a major scale and monitoring such without studying the response of specific taxa to these changes is insufficient to understand the reaching effects of these factors on complex biological communities (Jones *et al.* 2009). Specific taxa that show a measurable response to climate change and habitat destruction are extremely important as bioindicators, particularly in an environment prior to the land being transformed (Jones *et al.* 2009). Bats have enormous potential as bioindicators since they are taxonomically stable, one can monitor trends in their populations, short and long-term effects on their populations can be measured, and they are distributed on a global scale making the effects of habitat change comparable on a global scale (Jones *et al.* 2009, Jones *et al.* 2003).

In addition to climate change (extremes in drought, heat, cold and precipitation), agricultural intensification, disease, fatalities induced by wind turbines, overhunting (in some regions bats are important food items for humans) and the loss of habitats, human-introduced toxins present in an ecosystem influence bat populations. Occupying higher trophic levels, insectivorous bats are sensitive to toxin accumulations in ecosystems and are likely to show consequences of pollutants faster than lower trophic level organisms such as herbivorous insects and birds (Jones *et al.* 2009, Griffiths *et al.* 2014, Korine *et al*. 2016). In particular reference to the opencast mining, loss of habitat, suitable roosting sites, deterioration in water quality and pollution caused by mining activities are of particular concern and may cause result in a change of the bat activity and species composition over the proposed Spitsvale opencast mining area.

Bats are slow reproducers and take a longer time to recover from declines in population numbers, although declines in population numbers takes longer to identify, it is thus necessary to monitor populations in areas where habitats are to be transformed dramatically.

The purpose of this study conducted on the proposed Spitsvale opencast mining site is to identify bats species that occur on the site, bat activity over the site and to determine potential impacts on those species as part of the Environmental Impact Assessment (EIA).

2 Spitsvale Open Cast Mining Site Vegetation, Climate & Topography.

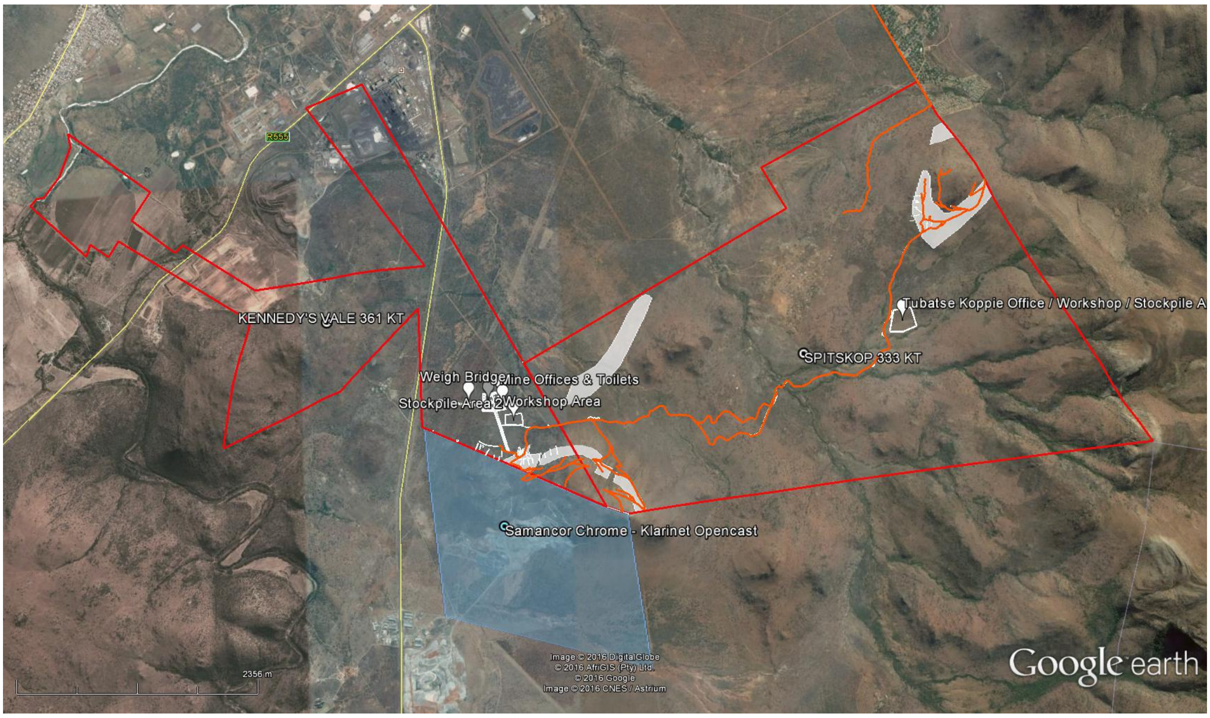

Image 1. The position and layout of the proposed Spitsvale open cast mining site. The mining right area is highlighted by the red border, with proposed opencast mining sites in grey, infrastructure in white and main access roads highlighted in orange.

The mining site lies within the Savanna biome of the Sekhukhune Plains Bushveld which extends from Burgersfort and the Steelpooort River basin, through the Motse River basin to Jobskop and Legwareng (Mucina & Rutherford 2011).

The topography of the Sekhukhune Plains Bushveld comprises mainly of semi-arid plains and open valleys with mountains running parallel to the escarpment. The proposed Spitsvale opencast mining area lies within this mountainous terrain of the Transvaal Super Group, dominated by the Klarient Koppie 1237m above mean sea level (Spitskop PR EMP). The Tubatse Village borders the mining area in the North East. Several tributaries and an intermittent stream runs through the proposed mining area and flows into the Steelpoort River to the North West (~9km) (**Image 1**).

The vegetation is predominantly short thornveld comprising of *Acacia spp., Combretum spp., Albizia spp.,* and *Boscia spp.* with an abundance of *Aloe* and succulent species (Mucina & Rutherford 2011). For the most part, the vegetation between the two main mining areas is still intact (**Image 2**).

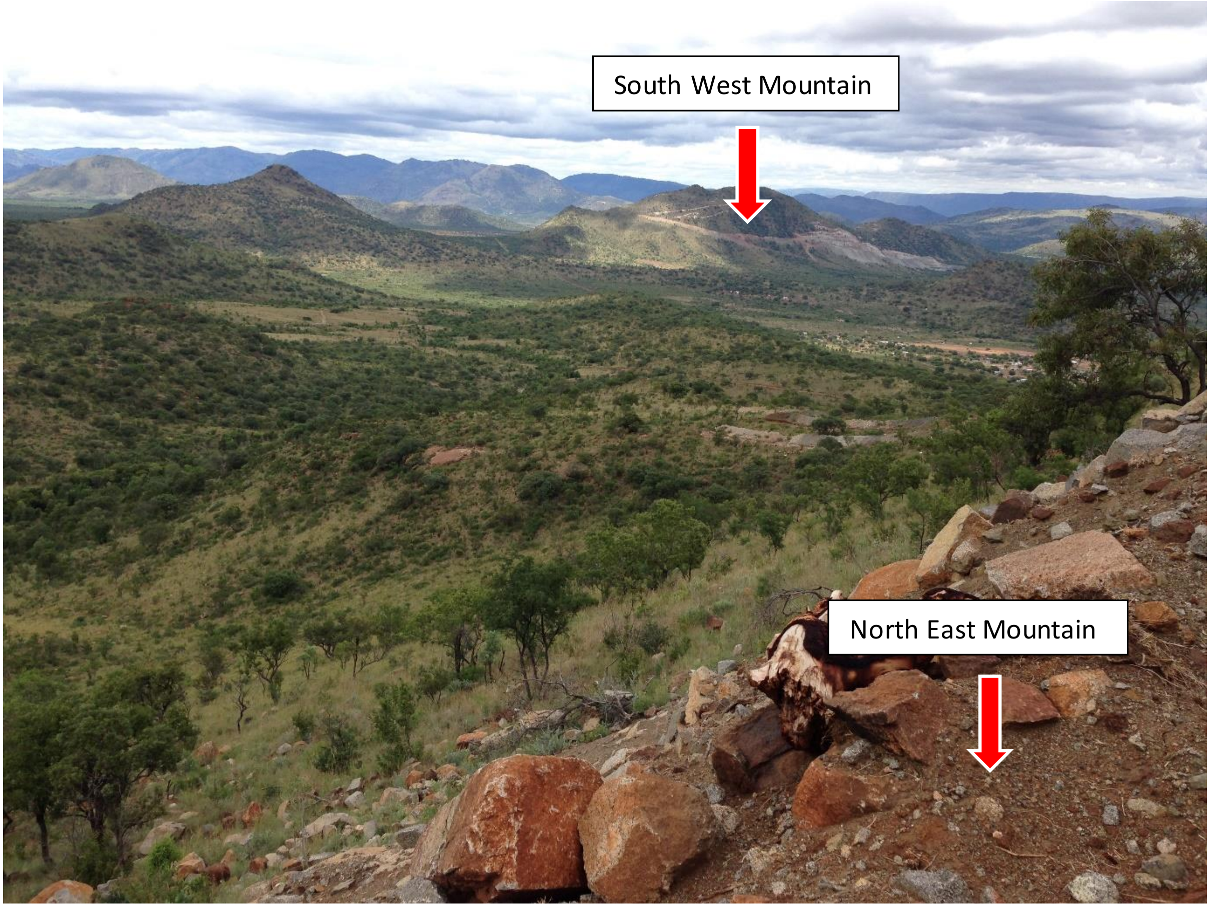

Image 2. Vegetation structure and undulating terrain between the mining sites of the North East and South West mountains.

The area receives summer rainfalls of 400-600mm and winters are very dry. Daily temperatures vary considerably with mean minimum winter temperatures from -0.9°C to mean summer temperatures of 37.3°C (Mucina & Rutherford 2011).

3 Sample Methods and Data Analyses

The warmer and wetter summer months is the ideal time to survey bats as the moisture and warm ambient night temperatures result in more abundant insect prey species and surface water for bats to drink and forage over is available. Due to the short timeframe during which the study could be conducted**,** five nights were surveyed comprising of four nights of acoustic monitoring and one night of active trapping with mist nets.

3.1 Desktop Study

Prior to acoustic monitoring and active trapping on the Spitsvale mining site, a desktop study was conducted to determine which bat species may occur in the mining and surrounding area. A list of probable species was generated (**Table 1**).

3.2 Data collection

Roost Sites

The North East mountain was traversed on foot moving from one rocky outcrop to the next actively searching for occupied and potential roosting sites on 16 January 2016.

Acoustic monitoring

Acoustic monitoring of bats for activity over the site and species composition was conducted on 14-18 January 2016. Four transects were driven with a SMM-U1 ultrasonic microphone connected to a SM3BAT Bioacoustics Recorder (Wildlife Acoustics, Inc.). Transects began at sunset and terminated between 21:30-22:00 when the available roads on the site had been covered. It is important to note that very few roads covered the full extent of the mining rights area and many were not accessible. Most of the roads created on the North East and South West mountain mining areas were too steep and unstable for transects to be conducted. On the final two nights, community members became suspicious of the bat monitoring activity and built a fire on the road. For safety reasons, the North East mountain was approached as close as possible before turning around and mirroring the transect track back to the starting point in order to cover the full time period.

Active Trapping

Together with a desktop and visual inspection of the landscape, three areas were identified for mist netting (**Image 3**). Mist nets were placed in the natural water courses (two dry and one with a standing pool) as bats are known to use such structures in the landscape to commute, forage and drink. Active trapping was conducted on 16 January 2016 to verify species identification and record release calls to compare to the acoustic monitoring data recorded during transects. 16 January 2016 was chosen as an active trapping night as no wind or rain was forecast and the night was anticipated to be completely overcast based on weather predictions which would 'shade' the mist nets from the moonlight. However, this was not the case, the clouds dissipated and the moonlight illuminated the landscape and the nets which made the capture of bats very difficult.

The SM3BAT bat detector (Wildlife Acoustics) was positioned between the three trapping areas to record echolocation calls as bats commuted and foraged in the immediate area.

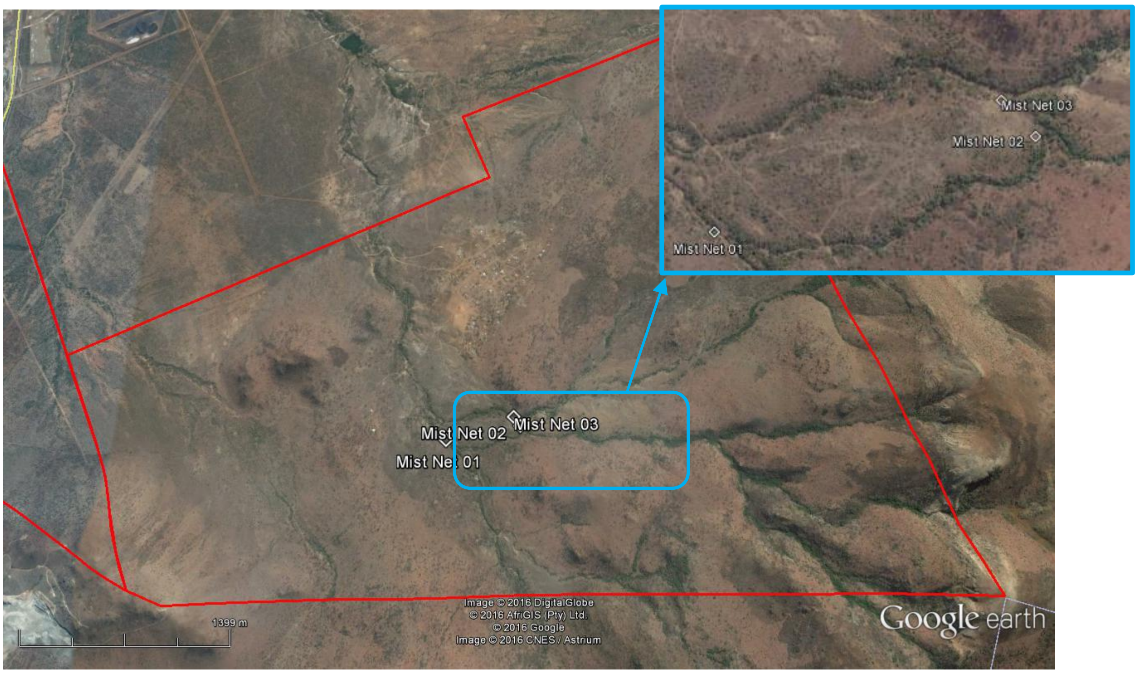

Image 3. Positions of the mist nets within tributaries (dry) for active trapping of bats.

3.3 Data Analysis

All calls recorded by the SM3BAT were converted into zero-crossing (ZC) and sound (WAV) files for identification purposes. BatSound (Pettersson Elektronik AB) and AnalookW (Chris Corben) programmes were used to identify individual bat echolocation calls. Species were identified based on peak frequency, call duration and bandwidth.

During transects, echolocation calls spaced a minute apart were considered as individual bats to lessen the possibility of replication of calls by the same individual. Each species was then mapped onto each transect using MapSource (Garmin) and Google Maps to indicate areas where bats may be most active across the site.

To determine time periods of main activity (foraging, commuting and/or social), transect times were divided into time categories of 30min.

4 Results

Roosting Sites

Active searching for potential and occupied roosting sites was conducted during the day on 16 January 2016 focusing predominantly on the North East mountain as the South West mountain was already being mined (**Image 4**). Upon close inspection of the rock faces and boulders, four potential roosting sites were identified and one occupied roost was located (**Image 5-6**). A vertical crack in a boulder was positively identified as an active roost occupied by a Molossid bat species (**Image 6B**).

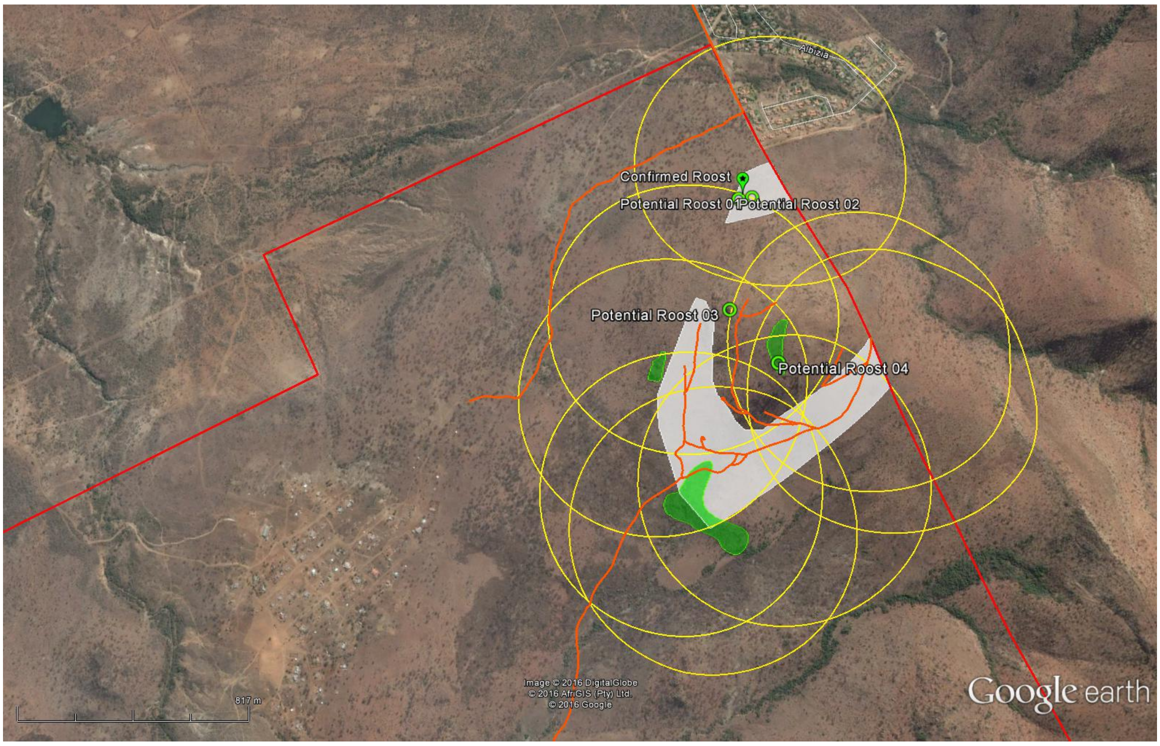

Image 4. North East mountain that was investigated for roosting sites. Several main roosting sites were identified (green circles) and one confirmed roost was located (green star symbol). The 500m blasting radius is indicated in yellow.

Image 5. Examples of potential roosting sites located on the North East mountain.

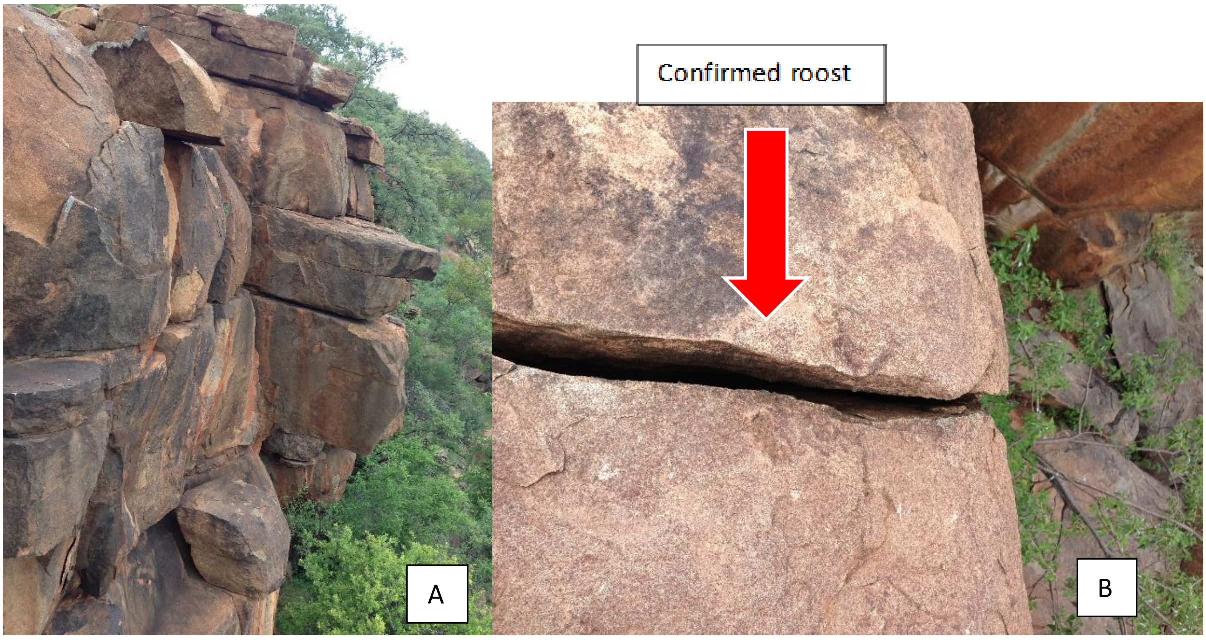

Image 6. A: Confirmed roosting site which may have yielded additional roosts of other species/colonies who did not betray their location with audible squeaks as the roost was approached. B: The actual roost used by a Molossid bat species located on the northern edge of the rock outcrop.

Desktop Study

Prior to conducting the baseline study, a species list was composed of potential bat species that may occur in the Spitsvale opencast mining area including their conservation status (**Table 1**). One vulnerable bat species, Percival's short eared trident bat (*Cloeotis percivali*) could occur in the area however, its echolocation call was not recorded and no caves were identified as potential roosting sites. Three near threatened species may occur in the area, with only the Natal long-fingered bat recorded during transects. All other species are considered "Least Concern" in accordance with the IUCN Red data list (IUCN 2015).

Table 1. Desktop study of species that may occur in the Spitsvale opencast mining area according to available literature (Monadjem *et al.* 2010).

Scientific name	**Common name**	**Conservation Status**
Cloeotis percivali	Percival's short eared trident bat	Vulnerable
Hipposideros caffer	Sundevall's leaf-nosed bat	Least Concern
Rhinolophus blasii	Blasius horseshoe bat	Near Threatened
R. clivosus	Geoffroy's horseshoe bat	Least Concern
R. darlingi	Darlings horseshoe bat	Least Concern

R. cohenii	Cohen's (previously Hildebrandt's) horseshoe bat	Least Concern
R. Simulator	Bushveld horseshoe bat	Least Concern
R. swinnyi	Swinny's horseshoe bat	Near Threatened
Taphozous mauritianus	Mauritian tomb bat	Least Concern
N. thebaica	Egyptian slit-faced bat	Least Concern
C. pumilus	Little free-tailed bat	Least Concern
Mops condylurus	Angolan free-tailed bat	Least Concern
M. midas	Midas free-tailed bat	Least Concern
Tadarida aegyptiaca	Egyptian Free-tailed bat	Least Concern
Miniopterus fraterculus	Lesser long-fingered bat	Least Concern
M. natalensis	Natal long-fingered bat	Least Concern
Eptesicus hottentotus	Long tailed serotine	Least Concern
Hypsugo anchietae	Anchieta's pipistrelle	Least Concern
Kerivoula lanosa	Lesser woolly bat	Least Concern
Myotis tricolor	Temminck's myotis	Least Concern
M. welwitschii	Welwitsch's myotis	Least Concern
Neoromicia capensis	Cape serotine	Least Concern
N. nana	Banana bat	Least Concern
N. zuluensis	Zulu serotine	Least Concern
Nycticeinops schlieffeni	Schlieffen's twilight bat	Least Concern
Pipistrellus hesperidus	Dusky pipistrelle	Least Concern
P. rusticus	Rusty pipistrelle	Least Concern
Scotophilus dinganii	Yellow-bellied house bat	Least Concern
S. leucogaster	White bellied house bat	Least Concern

Acoustic monitoring & Active trapping

Four night transects were driven on the 14, 15, 17 and 18 January 2016. Bat echolocation calls provided a species list of nine bat species with a potential tenth species (Zulu Serotine-*Neoromicia zuluensis*).

Table 2. Species identified according to echolocation calls detailing conservation status (IUCN), habitat preference, foraging ecology, roost type (Monadjem *et al.* 2010) and profile.

Species Name & Conservation Status	Distribution & Habitat Preference	Foraging Ecology	Roost Type	Profile
Family VESPERTILIONIDAE				
Cape Serotine – *Neoromicia capensis* **Least Concern**	Widespread throughout southern and central Africa. Tolerant of a wide range of habitat types: arid semi-desert, forest, montane grasslands and savanna.	Clutter-edge forager.	Roofs of houses, under bark of trees, at bases of aloes and thatch roofs.	
Long-tailed Serotine – *Eptesicus hottentotus* **Least Concern**	Widespread but distributed sparsely as a function of roost preference. Appears to have a preference for areas with rocky outcrops (e.g. Zimbabwe: Gorges in Miombo woodland and granitic hills).	Clutter-edge forager.	Caves and rock crevices in rocky outcrops.	

Rusty Pipistrelle – *Pipistrellus rusticus* **Least Concern**	Occurs from northern South Africa to Namibia, Botswana, Zimbabwe, Zambia and Malawi. Associated with open water bodies in savanna woodland. Absent from arid savanna and moist miombo woodland.	Clutter-edge forager.	Crevices in trees and in Limpopo Valley it is locally common in mopane woodland with rocky outcrops.	
Banana Bat? – *Neoromicia nana* **Least Concern**	Occurs widely in the wetter parts of the eastern and northern Sothern African region. Well-wooded habitats in proximity to water: Riparian vegetation and forest patches.	Clutter-edge forager.	Unfurling banana leaves, thatch roofs, leaves of other plants (e.g. Strelitzia plants).	
Yellow-bellied House Bat – *Scotophilus dinganii* **Least Concern**	Widespread over central and Southern Africa but absent from open habitats such as Kalahari, plateau grassland and Karoo. Distribution appears to be associated with presence of trees throughout savanna biome.	Clutter-edge forager.	Typically roosts in roofs of houses and holes in trees.	

Schlieffen's Twilight bat – *Nycticeinops schlieffeni* **Least Concern**	Widespread in the northern region from Kwa-Zulu Natal and Swaziland to central and northern Mozambique, Zimbabwe, Botswana and an isolated population in Namibia. Absent from tropical forests and arid west. Associated with low-lying savannas and riparian vegetation.	Houses and crevices of trees.	Clutter-edge forager.	
Zulu Serotine? – *Neoromicia zuluensis** **Least Concern**	Widespread in the northern region from Kwa-Zulu Natal and Swaziland to northern Namibia, Botswana, Zimbabwe, Mozambique, Zambia and southern Malawi. Appears to be associated with riparian habitats in woodland savanna.	Unknown. Has been recorded from an aloe.	Clutter-edge forager.	No picture available.
Family MINIOPERIDAE				
Natal Long-fingered bat – *Miniopterus natalensis* **Least Concern**	Widespread and more common in the southern and eastern parts of South Africa than the arid west. Distributed widely across Zimbabwe, central Mozambique, Zambia and Malawi. Core of distribution in savannas and grasslands of Southern Africa. Cave-dependent thus availability of roosts may be more crucial in determining its presence that the vegetation.	Cave dweller.	Clutter-edge forager.	

Family MOLOSSIDAE				
Egyptian Free-tailed bat – *Tadarida aegyptiaca* **Least Concern**	Widespread and abundant throughout southern Africa but restricted distribution in western Botswana and western Namibia. Absent from most of Mozambique and Malawi. Vegetation type appears to have little influence on distribution. Occurs in most habitat types but avoids forests.	Rock crevices, caves, hollow trees, under bark and under exfoliating rocks. Have been recorded roosting in large colonies in roofs of anthropogenic structures.	Open air forager.	
Angolan Free-tailed bat – *Mops condylurus* **Least Concern**	Abundant and widespread in eastern South Africa. Distribution extends into Mozambique, Zimbabwe, northern Botswana, Zambia, DRC, Malawi and Angola. Can tolerate a wide range of climatic conditions thus occur in mesic and semi-arid habitats.	Tree hollows and narrow crevices in caves and rocks. Particularly fond of roosting in anthropogenic structures such as houses and bridges with expanding joints.	Open air forager.	

***A single call identified closest to a Zulu Serotine was recorded, however it may have been a variation in the call if the Natal Long-fingered bat.**

Active trapping was not as successful as anticipated. Three individuals were captured and were positively identified as two Cape Serotine bats (one male and one female) and a Yellow House bat (male).

Bat Activity across the proposed Spitsvale opencast mining site

Image 7 incorporates bat activity over all four transect nights driven. It was evident that bat activity was highest in two main areas, 1. near the office buildings and 2. in the low-laying area between the North East and South West mountains. In addition to the acoustic monitoring, bats were visually observed foraging around the spot lights near the offices during transects as insects were attracted to the light source. There appeared to be high bat activity over the low-lying area where the tributaries (although predominantly dry at the time of the survey) joined to flow into the Steelpoort River. Out of the 9 species identified, 7 species were recorded in the low-lying area. This may be due to more time spent traversing the small network of accessible roads. It is interesting to note that very little bat activity was reordered over the Ditamaga Trust community lands (**Image 7**).

Bat activity and species richness increased as Tubatse Village was approached to the North of the mining area, possibly in response to the urbanisation providing favourable roosting sites (in houses and large trees present in the Village), increased availability of surface water (swimming pools), and higher insect activity due to irrigation of gardens providing insects with breeding grounds and food sources as well as the presence of a wet area visually observed as the mining area was entered from the Tubatse access point.

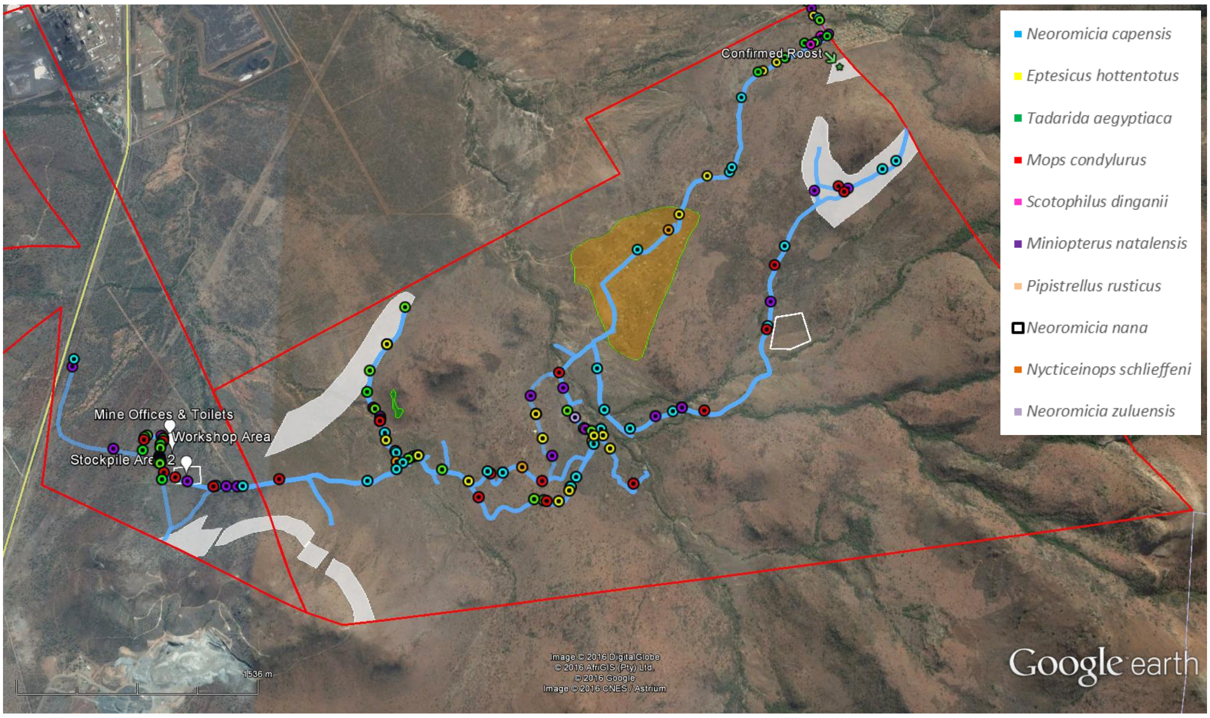

Image 7. Bat activity over four nights of acoustic monitoring indicating areas of activity in relation to surface infrastructure.

Including the data from the static bat detector night, a total of 303 calls were recorded over the five nights (**Figure 1**). The highest night of bat calls was on 18 January 2016 which may have been in relation to more favourable weather conditions. Number of calls ranged from 44-58 over the first four nights. **Figure 2** shows the temporal distribution of bat activity per species recorded during transects over the Spitsvale site. The most active time of the night for bat activity was between 20:00-21:30. During this time period the most common species were; Egyptian Free-tailed bat (*T. aegyptiaca*), followed by the Natal Long-fingered bat (*M. natalensis*) and the Cape Serotine (*Neoromicia capensis*). The late activity period could be in relation to adverse weather conditions present during the first portion of the transects.

Overall, the Egyptian Free-tailed bat (*T. aegyptiaca*) was most common on the site accounting for 34.39% of all bat calls recorded, followed by the Cape Serotine (*N. capensis*-20.16%), Natal Long-fingered bat (*M. natalensis*-20.16%), Angolan Free-tailed bat (*M. condylurus*-9.88%), Long-tailed Serotine (*E. hottentotus*-9.88%), Yellow House bat (*S. dinganii*-2.77%), Rusty Pipistrelle (*P. rusticus*-0.79%), Banana bat (*N. nana*-0.79%), Schlieffen's Twilight bat (*N. schlieffeni*-0.79%) and Zulu Serotine (*N. zuluensis*-0.40%) (**Figure3**).

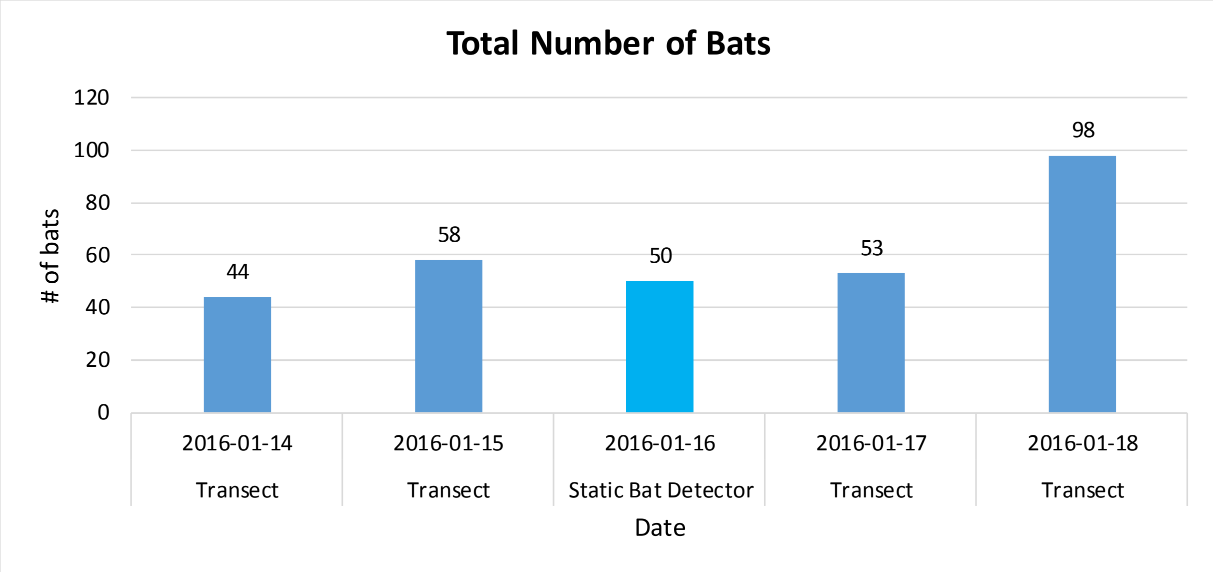

Figure 1. Total bat activity recorded over the four transects and the bat passes recorded by the static SM3BAT.

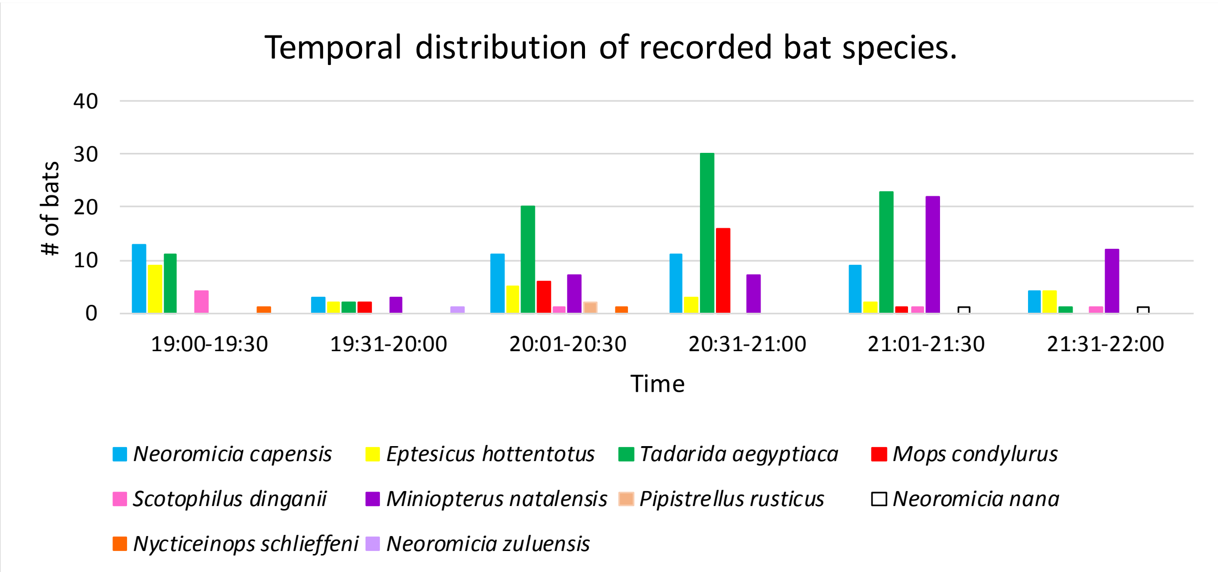

Figure 2. Temporal distribution of bat activity recorded over all four transect nights.

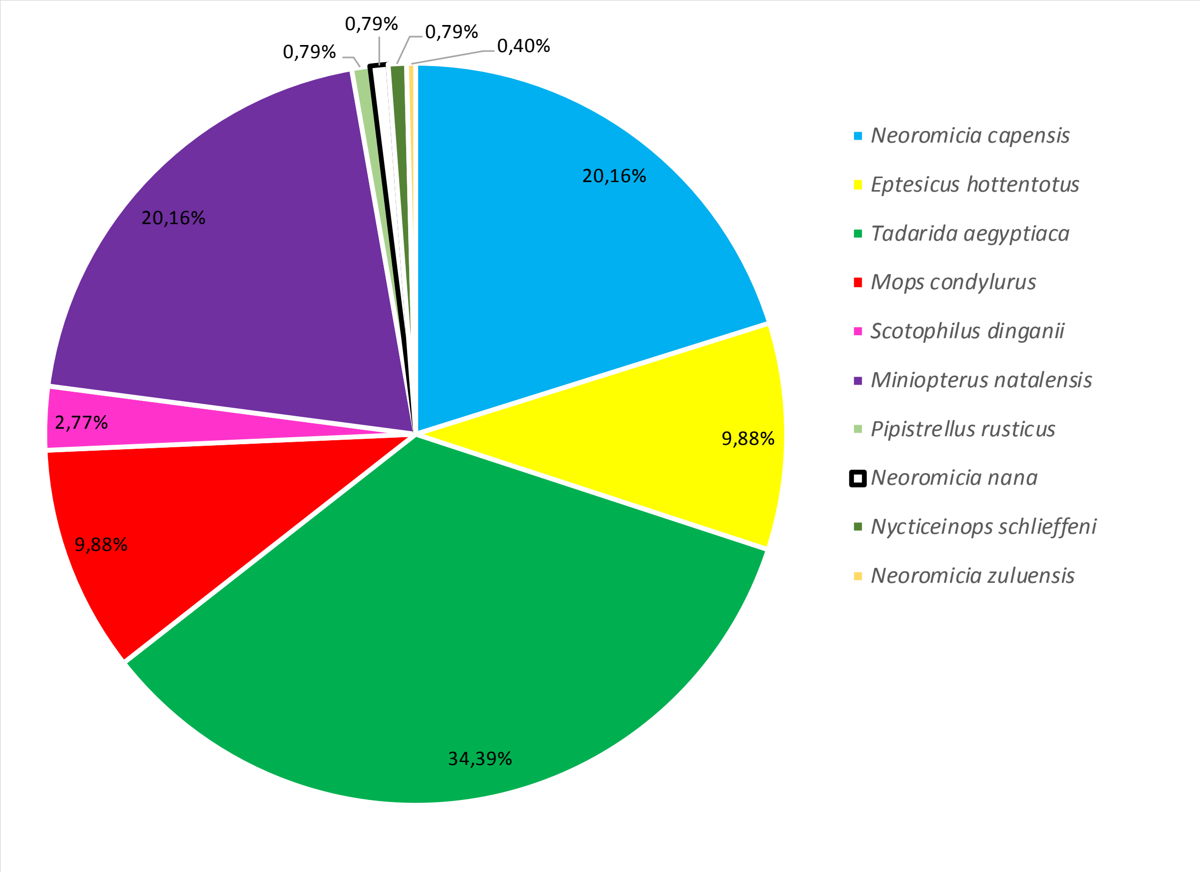

Figure 3. Percentage of species recorded during acoustic monitoring.

5 Potential Impacts and Mitigation Measures

IUCN Conservation Categories of Vulnerability

No species identified in the baseline assessment were classified higher than "Least Concern" which means that they are widespread and abundant species (IUCN 2015). In Monadjem *et al.* 2010, the Natal Long-fingered bat is classified as "Near Threatened" meaning that it does not qualify for "Critically Endangered, Endangered or Vulnerable" but it may qualify in the future, particularly as it has a high risk of collisions with the blades of wind turbines (Sowler & Stoffberg 2014).

Roosting sites: Blasting & Vibrations

The only bat species that uses a specific roost type is the Natal Long-fingered bat. During the active search for roosts, no caves had been located. It is my suspicion that the Natal Long-fingered bats recorded over the Spitsvale opencast site are roosting else-where in the surrounding environment and not on Spitsvale itself. Even though few, the potential roosting sites that are available to bats are within the opencast mining area and the 500m blasting radius. Bats are known to use a variety of roost types from rock cavities, exfoliating rock, tree foliage, under tree bark, tree cavities, aardvark burrows, natural and man-made caves and numerous man-made structures (Jones *et al* 2009, Monadjem *et al* 2010, Voight *et al.* 2016). The few roosting sites that were identified and will be lost and/or disturbed by mining activities may not impact directly on the populations of the identified bat species as they will seek shelter elsewhere in the landscape. There is the possibility that displaced bats may seek shelter in anthropogenic structures in the surrounding area as suitable roosting and even foraging sites. Alternatively, artificial roosts (bat boxes) can be provided, however, bats do not often accept alternative roosts (Voight *et al.* 2016).

Vegetation Removal/Habitat Degradation

Changes in landscape and habitat conversion can affect bat populations and assemblages on a local and regional scale (Jones *et al*. 2009, Jones *et al*. 2003, Jung & Kalko 2011).

Overall, the Sekhukhune Plains Bushveld is heavily degraded by anthropogenic activities such as cultivation, urbanisation and mining, with the addition of natural and man-made erosion dongas (Mucina & Rutherford 2011). The majority of the species recorded on the Spitsvale site are clutter-edge foragers meaning that they forage at the interface between open areas and vegetation and extensive clearing of the natural vegetation may result in bats activity decreasing as they forage elsewhere.

The removal of vegetation and degradation of habitats impact bats on in the following manner:

- Bats are sensitive to urbanisation although some species readily make use of man-made structures. They are sensitive to lighting, traffic noise and natural roost loss.
- Changes in water quality such as eutrophication, sewage treatment or mining activities, will result in bats avoiding drinking from such water bodies.
- Intensification of agriculture results in the loss of boundaries and an increase in pesticide use which will impact directly on insect abundance and availability.

Open water in arid and semi-arid environments (such as the Sekhukhune Plains Bushveld) may be an important resource influencing survival, resource use, distribution and activity of insectivorous bats (Korine *et al.* 2016). Several studies on water quality have shown that a deterioration in water quality reduced bat activity and foraging (Griffiths *et al.* 2014), whereas other studies show an increase in foraging activity over water bodies of poor quality that increased the availability of certain prey groups that are tolerant to poor water quality (Jones *et al.* 2009, Korine *et al*. 2016). It has been shown that toxins are ingested by bats directly and indirectly when they drink and forage on prey (that have bio-accumulated toxins in them) over polluted water bodies (Korine *et al.* 2016). In relation to mining activities, any heavy metals used or released into the environment during mining operations bio-accumulate in the bats themselves and can have detrimental effects on bat populations (Korine *et al.* 2016)

The focus for mitigation measures in relation to vegetation removal/habitat degradation would be;

- Conserve as much of the natural vegetation as possible. Only create haul roads that are absolutely necessary.
- Discourage vehicles from driving through the natural vegetation were mining activities are not taking place.
- Prohibit mining plant and trucks from washing or dumping material near a water course (wet or dry) to prevent the pollution of natural water bodies.
- Prohibit any chemical and/or heavy metal from being released into the environment.
- Manage all waste water and stormwater to prevent pollution to water bodies.

Light and Noise Pollution

Light pollution impacts both negatively and positively on bats. Research has shown that there are open-area foraging bat populations that may benefit from feeding on insects attracted to artificial light sources (Jones *et al.* 2009, Voigt *et al.* 2016). The negative effects of artificial light pollution include delayed emergence times for foraging. From the baseline study on Spitsvale opencast mine, it was evident that the Egyptian Free-tailed bat was present in higher numbers around the artificial light source than any other species. If excessive lighting is erected, the species composition may shift to an increase in Egyptian Free-tail activity and the species that do not favour foraging under artificial lights may move out of the area to non-illuminated areas to forage.

Opencast mining produces high sound pressure levels during blasting, handling of materials, exploratory and production drilling, crushing material and transporting material (Duarte *et al.* 2016). An increase in opencast mining activity related noise and road traffic noise may also alter foraging times of bats as is has been suggested that as a result of increased noise, the sounds of moving insects that bats usually detect are in fact masked by traffic noise (Jones *et al.* 2009), however, no studies have been done specifically in relation to opencast mining and bat foraging activity in South Africa.

The focus for mitigation measures in relation to light and noise pollution would be;

- To erect security lights/spot lights only near infrastructure/where absolutely necessary.
- Mitigate night time noise to as low as possible, particularly during peak foraging times.
- Restrict blasting activities to daytime hours.

6 General Conclusion

No specialist species of bats were identified during the field study, nonetheless, with additional deterioration to the landscape and the loss of habitat due to vegetation clearing may cause a shift in the species composition within the bat community to a bias towards more hardy species such as the Egyptian free-tailed bat.

Due to the prevailing weather conditions and lunar cycle which were not conducive to active trapping and may not have been favourable to all species foraging (windy, overcast with potential rain and a waxing crescent – gibbous), the transects and trapping night can only provide a baseline indication of the bat species and activity over the site. This baseline report should be followed by annual/biannual surveys to monitor bat activity, species compositions and population trends as mining activities proceed.

In my opinion, based on the data collected during the bat baseline survey and available literature, there is little reason from a chiropteran perspective for the proposed Spitsvale Project opencast mine to be prohibited.

Bat activity and trends in population numbers are of particular interest to determine the long-term effects of opencast mining of Spitsvale, it is suggested that a passive recording monitoring system be put in place and maintained by a specialist to determine the impacts of active opencast mining on bat populations in relation to landscape changes, noise pollution, light pollution and water quality.

7 Credentials of the Author

Dawn Cory-Toussaint has had an interest in bats from a young age and has been involved with the Gauteng and Northern Regions Bat Interest Group since 2004 which developed her interest in Chiropterans further. Her post graduate studies were focused on heterothermy in bats producing three publications from her work:

Cory Toussaint, D., McKechnie, A. E., & van der Merwe, M. 2010. Heterothermy in free-ranging male Egyptian free-tailed bats (*Tadarida aegyptiaca*) in a subtropical climate. *Mammalian Biology* **75**: 466–470.

Cory Toussaint, D., & McKechnie A. E. 2012. Interspecific variation in thermoregulation among three sympatric bats inhabiting a hot, semi-arid environment. *Journal of Comparative Physiology B.* **182**: 1129-1140.

Cory Toussaint, D., Brigham, R. M., & McKEchnie, A. E. *In Press.* Thermoregulation in free-ranging *Nycteris thebaica* (Nycteridae) during winter: No evidence of torpor. *Mammalian Biology* **78**: 365–368.

From August 2013-August 2014 she held a position as a Junior Environmental Consultant for Animalia: Zoological and Ecological Consultation CC. as a bat specialist for pre-construction surveys of Wind Energy Farms across the country.

Dawn Cory Toussaint has been involved in bat surveys for North West Nature Conservation, biodiversity projects and assisting in the study of reproduction in *Tadarida aegyptiaca* (University of Pretoria).

8 References

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10 Declaration of Independence

Appendix 1.

11 Compliance to Appendix 6 of GNR 982 (EIA 2014 regulations)

Appendix 2