National Forest Act. A number of Shepherd's Bush Trees *(Boscia foetida*) were identified on all sites, as well as a few Camel Thorn (*Acacia erioloba)*. These species and the details regarding their location, rescue, relocation and permit requirements in compliance with National Legislation; National Forest Act has been completed in support of permits required from the Department of Forestry and Fisheries.

### 6.5.2 Fauna

Due to the nature of land use – Game farming, fauna which exists in the area can be described to be modified from the natural state, as a result of stocking an introduction of species which were not originally specific to the area.

#### 6.5.2.1 Mammals

Areas adjacent to the project areas, which are not actively engaged in the wildlife industry, do not have the same mammal diversity or richness as the area of concern. This is due to the area being actively stocked with game. Game numbers have been controlled according to management measures. All mammal species are actively protected and managed primarily for the economic gains, but indirectly the area serves as a refuge for a variety of small and large mammal species, which would not occur in the area otherwise. The variety of vegetation types occurring in the area of interest ensures an ecologically diverse assemblage of plant species which in turn supports a variety of mammals.

During field investigations mammal species present within the area of concern were noted. The prominent abundance of wild ungulates (hooved animals) and small mammals was apparent while there was a definite absence of large predators. The game farm was previously stocked with wild herbivores, and small carnivores/scavengers and large predators were purposefully excluded. Animal numbers were artificially controlled by hunting. Species identified during the survey, at the various sites are listed in Table 6-1 and illustrated in Figure 6-16.

Honey Badger (*Mellivora capensis*), has been identified on previous studies in the area, this species is listed as Near Threatened. Other near threatened species Sable Antelope (*Hippotragus niger niger*) identified during the field survey, is listed as threatented (according to IUCN Red Data Listing). Sable has been re-introduced into the area while honey badger naturally occurs in the area.

The remaining species all fall within the Lower Risk IUCN Red Data category and are not threatened.

**Table 6-1: Mammals recorded during the field survey**

| Species | Common name | Status | Vischpan | Kruishout |
|---|---|---|---|---|
| *Aepyceros melampus* | Impala | | * | * |
| *Alcelaphus buselaphus* | Red Hartebeest | | * | |
| *Canis mesomelas* | Black Backed Jackal | | | |
| *Ceratotherium simum* | White Rhinoceros | | * | |
| *Cercopithecus aethiops pygerythrus* | Vervet Monkey | | * | * |
| *Connochaetes taurinus taurinus* | Blue Wildebeest | | * | |
| *Damaliscus dorcas* | Blesbuck | | * | |
| *Equus burchellii* | Plains Zebra | | * | |
| *Camelopardalis* | Giraffe | | * | |
| *Hippotragus niger niger* | Sable Antelope | T | * | * |
| *Hystrix africeaustralis* | Porcupine | | * | * |
| *Lepus saxatilis* | Scrub/Savannah Hare | | * | |
| *Mungos mungo* | Banded Mongoose | | * | |
| *Oryx gazelle* | Gemsbok | | * | |
| *Paraxerus cepapi* | Tree Squirrel | | * | |
| *Pedetes capensis* | Springhare | | | |
| *Phacochoerus africanus* | Warthog | | * | * |
| *Raphicerus campestris* | Steenbok | | * | |
| *Sylvicapra grimmia* | Grey /Common Duiker | | * | |

| Species | Common name | Status | Vischpan | Kruishout |
|---|---|---|---|---|
| *Syncerus caffer* | Cape Buffalo | | * | |
| *Taurotragus oryx* | Eland | | * | |
| *Tragelaphus strepsiceros* | Kudu | | * | * |
| *Tragelaphus angasi* | Nyala | | | |
| *Xerus inauris* | Cape Ground Squirrel | | * | * |

: denotes species protected within the Limpopo Province (Limpopo Environmental act of 2003)

* : denotes species identified within the farm.

**Figure 6-16: Fauna and Avifauna identified during the survey; (Right to left, Top to bottom) Gemsbok, Sable, Black backed Jackal, Pied Babbler, Little beater, Lilac breasted Roller, Burchells Sandgrouse, Shaft Tailed Widow**

#### 6.5.2.2 Birds

Birds have been viewed as good ecological indicators, as their presence or absence tends to represent conditions pertaining to the proper functioning of an ecosystem. Bird communities and ecological condition are linked to land cover. As the land cover of an area changes, so do the types of birds in that area (The Bird Community Index, 2007). Land cover is directly linked to habitats within the study area. The diversity of these habitats should give rise to many different species.

The bird species observed in the study area and surrounds totalled 133 species. These are listed in Appendix D. Included in these findings were three Vulnerable and two Near Threatened species, the remaining species all fall within the Least Concerned IUCN categories and are not threatened species. The Red-billed Oxpecker (*Buphagus erythrorhynchus*) and the Yellow billed Stork (*Mycteria ibis*) are currently classified as Near Threatened according to the IUCN, with the Kori Bustard (*Ardeotis kori*), White-backed Vulture *(Gyps africanus*) and the Cape Vulture (*Gyps coprotheres*) being designated as Vulnerable.

Birds observed outside the project area, yet within the general area, were also noted as the likelihood of these species occurring within the project area is high due to the transient nature of birds.

According to Roberts (2006), almost 400 species of birds have been identified in the area; the majority of these birds are comprised of bushveld species.

An avifauna study was further completed by WildSkies Ecological Services, the specialist report is attached in Appendix E. The findings of the study were in line with that of Digby Wells. With regards to the five alternative sites which were proposed for the power station, due to the uniformity of the habitat in this area, there is no little preference between these sites in terms of avifauna. A slight differentiating factor is that the two westernmost sites are closer to a pan and as such may be slightly more sensitive. It is therefore recommended that one of the eastern three sites be selected. It must be noted though that none of the five sites are fatally flawed. The project can therefore be constructed on any of these sites.

#### 6.5.2.3 Bats

A specialist bat study was completed by WildSkies Ecological Services, the specialist report is attached in Appendix F.

The potential bat species that could occur in the area are presented below in Table 6-2, along with the bats' habitat requirement and conservation status. A likelihood of occurrence has also been presented.

### Table 6-2: Potential bat species in the study area (Monadjem *et al,* 2010.)

| Species | Habitat | Conservation Status | Likelihood of occurrence |
|---|---|---|---|
| *Cloeotis percivali* | Woodland | Vulnerable | possible |
| *Hipposideras gigas* | Arid Savanna | Near-Threatened | possible |
| *Rhinolophus blasii* | Savanna/woodland | Near-Threatened | possible |
| *Miniopterus natalensis* | Savanna/grassland | Near-Threatened | possible |
| *Eidolan helvum* | Fruit producing woodlands | Least Concern | unlikely |
| *Epomophorus crypturus* | Forests | Least Concern | unlikely |
| *Epomophorus wahlbergi* | Forests/peri-urban | Least Concern | unlikely |
| *Rousettus aegyptiacus* | caves | Least Concern | unlikely |
| *Hipposideras caffer* | Savanna/woodland | Least Concern | possible |
| *Hipposideras vittatus* | Savanna/woodland | Least Concern | possible |
| *Rhinolophus clivosus* | Savanna/woodland/riparian forest | Least Concern | possible |
| *Rhinolophus darlingi* | Savanna/woodland | Least Concern | possible |
| *Rhinolophus hildebrandtii* | Savanna | Least Concern | possible |
| *Rhinolophus landeri* | Riparian woodland | Least Concern | unlikely |
| *Rhinolophus simulator* | Savanna/ woodland/wodded drainage lines | Least Concern | possible |
| *Taphozous mauritianus* | Savanna/ woodland | Least Concern | possible |
| *Nycteris thebaica* | Savanna/karoo | Least Concern | possible |
| *Chaerephon pumilus* | unknown | Least Concern | possible |
| *Chaerephon ansorgei* | Dry woodland/Savanna/Near mountains | Least Concern | unlikely |
| *Mops midas* | Savanna/ woodland | Least Concern | possible |
| *Tadarida aegyptiaca* | wide tolerance | Least Concern | possible |
| *Eptesicus hottentotus* | Rocky outcrops | Least Concern | unlikely |
| *Glaucanycteris variegata* | Savanna/woodland | Least Concern | possible |
| *Hypsugo anchietae* | Riparian forest | Least Concern | unlikely |
| *Kerivoula lanosa* | unknown | Least Concern | possible |
| *Laephatis botswanae* | Savanna/Open woodland | Least Concern | possible |
| *Myotis tricolar* | Moutainous | Least Concern | unlikely |
| *Neoromicia capensis* | wide tolerance | Least Concern | possible |
| *Neoromicia nana* | Riparian vegetation/ forest patches | Least Concern | unlikely |
| *Neoromicia zuluensis* | Woodland savanna/riparian | Least Concern | possible |
| *Nycticeinops schlieffeni* | Savanna/riparian | Least Concern | possible |
| *Pipistrellus hesperidus* | Riparian/ forest patches | Least Concern | unlikely |
| *Pipistrellus pipistrelle* | Large rivers and wetlands in Savanna | Least Concern | unlikely |
| *Pipistrellus rusticus* | Savanna/woodland/near water | Least Concern | possible |
| *Scotophilus dinganii* | Savanna/near trees | Least Concern | possible |
| *Scotophilus leucogaster* | Mopane woodland | Least Concern | unlikely |

As can be seen in Table 6-2 only one Vulnerable species occurs in the area, followed by three Near-threatened. All four of these could possibly occur on site and indeed one was confirmed by the identification of calls. The rest of the 32 species are all classified as being of Least Concern. 23 species have the possibility of occurring in the region considering their range and habitat requirements.

An EM3 bat detector was used to record bat calls during vehicle based transects. The species were then identified using various sources and the following bats were established as present in the study area with the following counts.

**Table 6-3: Bat counts**

| Day | Label | Number |
|---|---|---|
| 15/06/2012 | M. natalensis | 14 |
| 15/06/2012 | N. capensis | 3 |
| 16/06/2012 | M. bocagii | 2 |
| 16/06/2012 | M. natalensis | 9 |
| 16/06/2012 | N. capensis | 6 |
| 16/06/2012 | Unknown | 2 |

Each call was plotted with its position on Google earth and the following map was created, showing where each species was recorded (Figure 6-17).

It is clear to see from the above data, as well as the map below, that bats are utilizing the entire study site. It must be kept in mind that the calls were recorded in winter and it is highly likely that many more species, and greater abundances, would be recorded in the summer months.

It must also be noted that while it is possible to identify bats from calls, the only completely reliable method is to identify species in the hand from morphological features and measurements. This is not practical for a study such as this as it would be very unlikely to catch a representative sample of bats over the total study area. Calls are therefore relied upon to give an idea of what species are in the area. It is also useful to get an idea of areas in which bats are congregating. This explains why two calls could not be identified with confidence and they have thus been presented as “unsure”.

It must also be noted that some species have very similar calls. Where there was doubt, the more sensitive species was used in the identification in keeping with the precautionary principle.

That being said the data is of sufficient quality to make an assessment on the project and the impact it will have on bat species.

*Neoromicia capensis* was found throughout the site. This was expected because this species has a wide tolerance of habitat and is quite common throughout the region. This bat is a clutter edge forager and gives birth during the wet summer months in Limpopo. This species of bat roosts in houses and under the bark of trees. The abundance of trees in the broader area means that the removal of trees on the exact power station sites will not be that critical.

*Miniopterus natalensis* was also found on the site, it was mainly associated with the eastern and southern sides of the site. This bat species also occurs widely but is associated with caves. While no caves were visible on the site visit, this does not preclude the bat from occurring here as caves may be present in the near vicinity. This species is also a clutter edge forager and also gives birth in the wet season. The females congregate in maternity roosts. These areas would be critical to avoid during the project. This was the species with a very similar call to *Pipistrellus rusticus* and as mentioned above it was presented instead of *Pipistrellus rusticus* as it has the higher conservation status and the precautionary principle was thus used. The fact that it is a cave rooster also means it is more sensitive to habitat destruction than *Pipistrellus rusticus* which roosts in trees.

*Myotis bocagii* was identified from its echolocation call. It is not a species identified from the distribution data but Monadjem *et al (* 2010) suggest it is more widely distributed than the maps show. Only 2 calls were recorded and identified and these both occurred on the western side of the study site. Its roosting behavior is not known and it seems to be associated with water. It is a clutter edge and clutter forager. No reproductive data is known for this species.

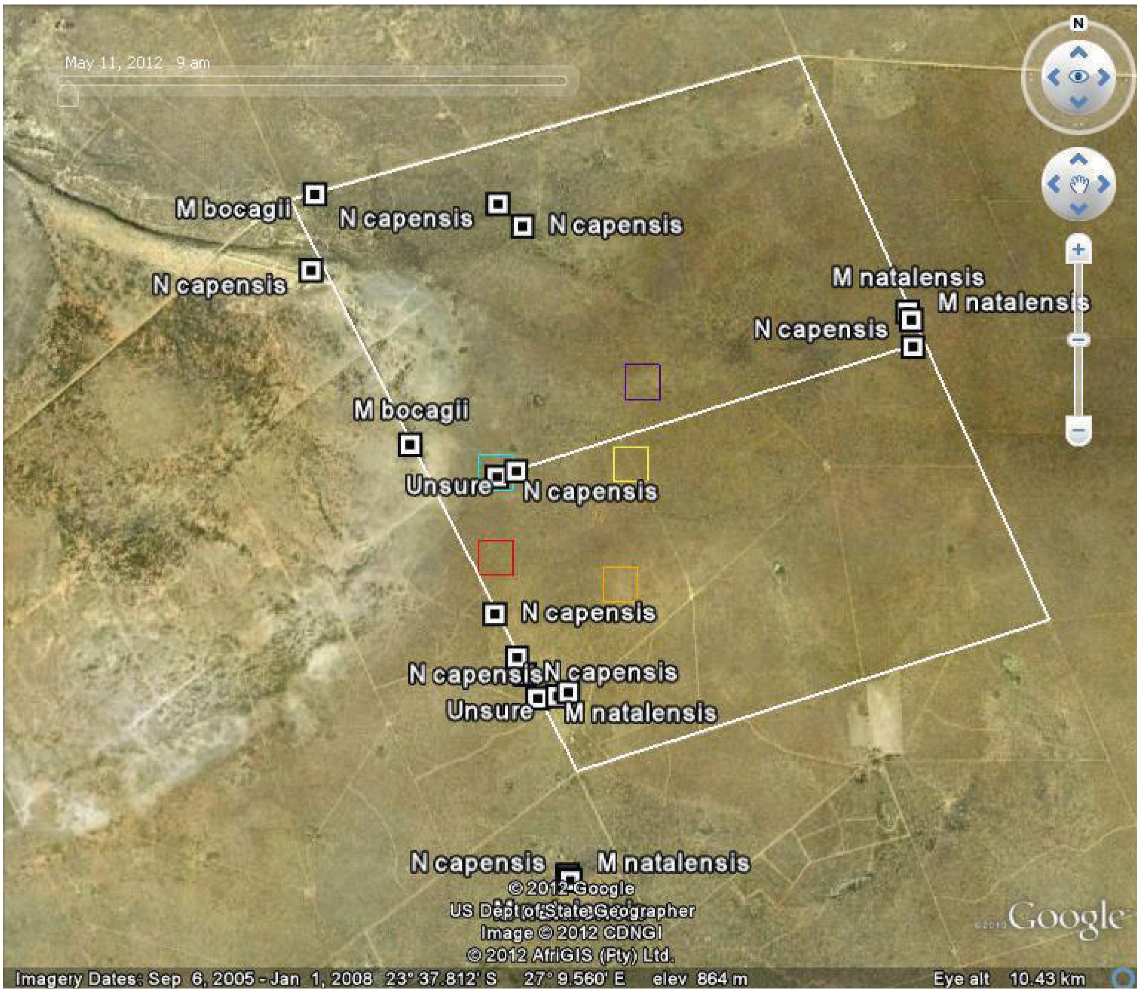



**Figure 6-17: Bat calls and locations from vehicle transects.**

### 6.5.2.4 Reptiles

The reptile species listed in Appendix D were all recorded during the field survey, confirming reports from local residents of their presence.

According to literature, the majority of the reptiles expected to occur within the study area are not expected to occur in areas where overgrazing has diminished the grass layer. This is particular to snakes, as the small mammals which exist in the grassland habitat are not present. This grass layer is essential for invertebrates and most rodents to survive; without this grass layer these fauna species do not have shelter or food and thus have a negative impact on their abundance.

A vulnerable reptile which could potentially occur in the area is the Southern African Python (*Python natalensis*). The Aurora House Snake (*Lamprophis aurora*) might also potentially occur in the area, it is listed as rare.

Two reptile species identified on site are not listed under IUCN, however they are endemic to the Waterberg area; the Waterberg dwarf gecko (*Lygodactylus waterbergensis*) and the Waterberg Flat Lizard (*Platysaurus minor).*

### 6.5.2.5 Amphibians

Amphibians are viewed to be good indicators of changes to the whole ecosystem because they are sensitive to changes in the aquatic and terrestrial environments (Waddle, 2006).

There are a collection of amphibians associated with the Savanna Biome. The distribution of frogs in the Savanna bushveld, is closely linked to their physiological adaptations to not only survive but thrive in certain climatic conditions. The summer rainfall gradient from the west (300 mm) of the Savanna range of South Africa to the east coast (1000 mm) provides a range of biotic and abiotic factors. These factors create niche environments to which different species are adapted. Owing to this, few frog species are distributed evenly across the region. All the frog and toad species encountered during the field survey are listed in Appendix D.

No species of frogs with Red Data Status were observed during the field survey.

### 6.5.2.6 Terrestrial invertebrates

A number of butterflies were identified during the field survey; none of these are listed as Red Data. Various other insects were similarly identified and are illustrated in Figure 6-18 as well as listed in Appendix D.

**Figure 6-18: Terrestrial Invertebrates; Ox Eye Pansy Butterfly (Top Left), Grasshopper (top right). Spiller's Sulphur Yellow Butterfly (bottom left), Dung Beetle (bottom right)**

Butterflies and dragonflies are currently the main Red Data invertebrates due to the greater awareness of butterflies by the public and the fact they are caught for various collectors globally. Many Odonata species have been recognised as specialist habitat users and bio-indicators, hence the Red Data listing of some of these species.

### 6.5.3 Discussion

The results obtained from the field study revealed natural habitat that has been greatly influenced by management decisions in the past. From data gathered it was obvious that the areas were stocked with ungulates, in certain circumstances overstocked, this was seen in the lack of available graze and the substantial bush encroachment that resulted from overstocking. The effect of overstocking reduces the vigour of plants by means of repeated defoliation of palatable species, thereby creating favourable habitat for bush encroaching species. Furthermore it also reduces the water infiltration capabilities of soil due to trampling, which indirectly affects plant growth.

Management decision for the farms required the artificial stocking of game for both hunting and game viewing purposes. The wild herbivore population cannot be seen as natural for the area, and can therefore not be indicative of high levels of biodiversity. Predatory animals on the other hand move freely between the farms and are naturally occurring.

In conclusion the proposed development has obvious negative repercussions of loss of biodiversity due to habitat loss. This will however will be minimal due to the development of the surrounding coal mine and infustructure.

There are potentially some positive repercussions too; from a floral perspective the natural habitat that exists on the area of concern is experiencing negative effects due to overstocking.

Relocation of mammals should occur in conjunction with relocation for the greater Boikarabelo mining right area.

Bird species are expected to move to alternative habitats, due to fact that they take flight.

## 6.6 Wetlands

A desktop investigation whereby aerial imagery was considered for the presence of wetland areas was conducted. In addition to this, findings from the soil investigation were also considered to determine the presence of any wetland soils associated with the project area. Findings from the desktop study did not indicate the presence of any wetland systems in the project area, and this conclusion was supported by the soil investigation. No wetland soils were identified for the soil investigation.

## 6.7 Hydrology

Due to the small footprint of the power station and supporting infrastructure the hydrology of the greater project area is discussed. No drainage lines, streams or rivers exist within the proposed power station area. A surface water report was completed for the Boikarabelo

Coal Mine and as the surface water environment is the same this report has be utilised. This report is attached in Appendix G together with the water monitoring reports.

### 6.7.1 Description of the surface water environment

The proposed site falls along the boundary of Botswana and South Africa in the A41E quaternary catchment of the Matlabas catchment within the Limpopo River Water Management Area (WMA 01). The water resources in the vicinity of the proposed site include: a stretch of the Limpopo River which forms the border of the A41E catchment in the west, three non-perennial streams draining the part of the area into the Limpopo River, and two marshes in the area. The greater project site including the mine and power station area is 1.6% (13.713 $km^2$) of the net A41E catchment area (816 $km^2$).

### 6.7.2 Water uses

According to the DWA water use database, the main use of water in the catchment area is for agricultural irrigation, with annual volumes ranging from 10 360 to 540 000 $m^3$ being abstracted. There are no significant dams, and a significant quantity of the water use is from groundwater (DWAF, 2004). Most of these abstractions occur on the Limpopo River, as it is the major water resources in the catchment area.

Water uses on the project site for the power station is mainly groundwater abstraction for game watering and potable use.

### 6.7.3 Mean annual runoff

The MAR refers to the amount of water that essentially runs off on a catchment area after rainfall, evaporation, infiltration and friction caused by land cover have been taken into account. The value for the A41E quaternary catchment is 5.9 mm which is equivalent to 11.4 million $m^3$ (WRC, 1994). The MAP (average amount of rainfall that is received by a specific catchment over a period of one year) and MAE (average amount of water that evaporates over a specific catchment over a measuring period of one year) for the A41E quaternary catchment is represented by 438 and 1 950 mm respectively (WRC, 1994). The rainfall zone within which the site falls is A4B while the evaporation zone is 1D.

### 6.7.4 Surface water quality

Sampling points were identified up- and downstream of the site. The number of sampled points fell short of the requirements for surface water quality assessment due to lack of access to downstream points (W1SP1, W1SP2, and WSP8) and the continuously dry non-perennial streams (WSSP3, WSSP4 and WSSP5). Additional water quality data sourced from the DWA indicated that there were no monitoring points within the A41E catchment.

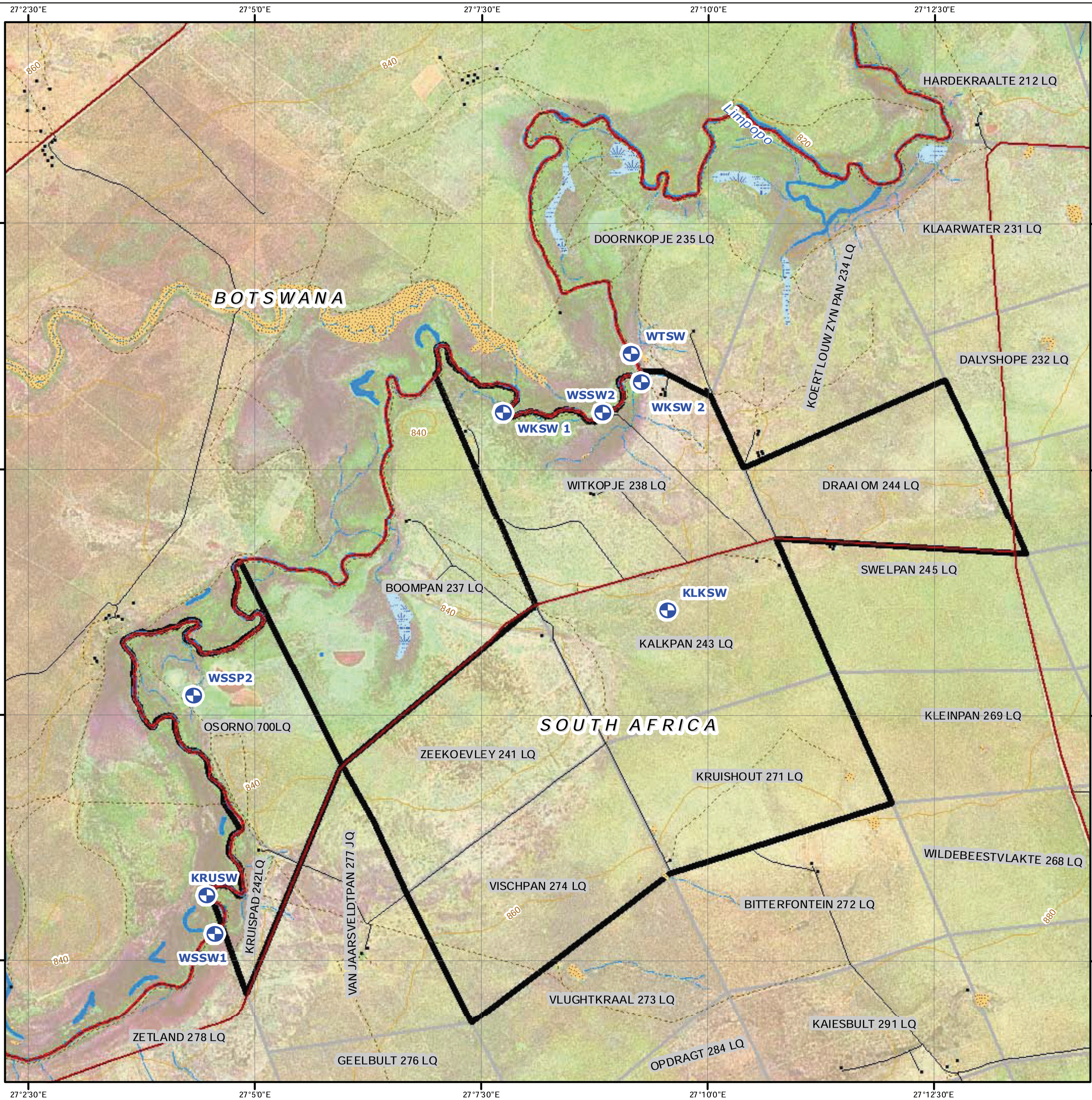
The chemical analysis results from the sampled sites indicated that the quality of the surface water resources fell within Classes I and II level when benchmarked against the SANS 241 (2005) drinking water standards. Thirteen parametres of the five water samples fell within Class 0, which is the ideal quality of drinking water. Table 6-4 is a colour coded summary of the data benchmarked against the SANS standard. Current monitoring data has also been included in the table

There is no indication in the results of any mining related impacts to the surface water resources sampled. The Sulphate (SO4), pH, Electrical Conductivity (EC) and Manganese (Mn) values all fell within the ideal category (Class I). Sample WKSW2 contained elevated levels of Iron (Fe) that fell within Class II. This was attributed to possible natural geological influence from the area.

Plan 10

# Boikarabelo Coal Mine

## Surface Water Sampling Points




### Legend

- Surface Water Sampling Points
- Project Area
- House
- Main Road
- Secondary Road
- Minor Road
- Track
- Contour (20m)
- Non-Perennial Stream
- Perennial Stream
- Farm Boundaries
- Dam / Lake
- Perennial Pan
- Non-Perennial Pan / Stream
- Wetland
- International Boundary

resource generation

DIGBY WELLS ENVIRONMENTAL

www.digbywells.com

Projection: Transverse Mercator
Datum: Hartebeesthoek 1994
Central Meridian: 27°E

Ref #: bjt.ISI543.201001.107
Revision Number: 3
Date: 06/08/2012

N

0 0.5 1 2 3 4
Kilometres
1:75 000

**Table 6-4: Chemical analysis for the surface water samples taken at the proposed mining site and benchmarked with SANS 241 standards.**

| Sample ID | Total Dissolved Solids | Nitrate $NO_3$ (N) | Chlorides (Cl) | Total Alkalinity (as $CaCO_3$) | Sulphate ($SO_4$) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Iron (Fe) | Manganese (Mn) | Conductivity at 25° C in mS/m | pH-Value at 25° C | Aluminum (Al) | Free and Saline Ammonia (as N) | Fluoride (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class I (Recommended) | <1000 | <10 | <200 | N/S | <400 | <150 | <70 | <200 | <50 | <0.2 | <0.1 | <150 | 5-9.5 | <0.3 | <1 | |
| Class II (Max. Allowable) | 2400 | 20 | 600 | N/S | 600 | 300 | 100 | 400 | 100 | 2 | 1 | 370 | 4-5 or 9.5-10 | 0.3-0.5 | 2 | |
| Duration (years) | 7 | 7 | 7 | N/S | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | No Limit | 1 | None | |
| WKSW 1 | 370 | 0.13 | 91 | 144 | 62.6 | 26.2 | 25.4 | 65.4 | 7.85 | 0.01 | 0.01 | 65.9 | 7.56 | 0.07 | 0.37 | |
| WKSW 2 | 394 | 0.17 | 98 | 150 | 68.1 | 27.9 | 27.7 | 69.3 | 7.86 | 0.23 | 0.01 | 70.1 | 7.51 | 0.08 | 0.42 | |
| WSSP2 | 372 | 0.05 | 71 | 186 | 47.7 | 32.1 | 25.4 | 61.2 | 9.21 | 0.005 | 0.01 | 60.3 | 7.37 | 0.03 | 0.1 | |
| WSSW 1 | 482 | -0.1 | 95 | 186 | 69.9 | 36 | 30 | 69.7 | 6.57 | -0.01 | -0.01 | 73.5 | 8.68 | -0.01 | -0.2 | |
| WSSW2 | 498 | 0.05 | 96 | 199 | 69.9 | 37.9 | 30.7 | 71.6 | 7.18 | 0.005 | 0.005 | 76.2 | 7.27 | 0.01 | 0.2 | |
| **September 2009** | | | | | | | | | | | | | | | | |
| WKSW 2 | 384 | 1.3 | 66 | 151 | 58.1 | 40.4 | 20.7 | 51.5 | 6.42 | 0.01 | 0.01 | 60.4 | 8.37 | 0.1 | 0.2 | |
| WSSW 1 | 380 | 0.79 | 65 | 151 | 53.3 | 39.7 | 20.3 | 50.5 | 6.33 | 0.01 | 0.01 | 59.9 | 8.38 | 0.1 | 0.2 | |

| Sample ID | Total Dissolved Solids | Nitrate $NO_3$ (N) | Chlorides (Cl) | Total Alkalinity (as $CaCO_3$) | Sulphate ($SO_4$) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Iron (Fe) | Manganese (Mn) | Conductivity at 25° C in mS/m | pH-Value at 25° C | Aluminum (Al) | Free and Saline Ammonia (as N) | Fluoride (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class I (Recommended) | <1000 | <10 | <200 | N/S | <400 | <150 | <70 | <200 | <50 | <0.2 | <0.1 | <150 | 5-9.5 | <0.3 | <1 | |
| Class II (Max. Allowable) | 2400 | 20 | 600 | N/S | 600 | 300 | 100 | 400 | 100 | 2 | 1 | 370 | 4-5 or 9.5-10 | 0.3-0.5 | 2 | |
| Duration (years) | 7 | 7 | 7 | N/S | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | No Limit | 1 | None | |
| WSSW 2 | 412 | 1.3 | 60 | 158 | 88.8 | 41.1 | 20.9 | 51.3 | 6.38 | 0.01 | 0.01 | 60.6 | 8.35 | 0.05 | 0.2 | |
| **December 2009** | | | | | | | | | | | | | | | | |
| WKSW 1 | 370 | 0.13 | 91 | 144 | 62.6 | 26.2 | 25.4 | 65.4 | 7.85 | 0.01 | 0.01 | 65.9 | 7.56 | 0.07 | 0.37 | 0.47 |
| WKSW 2 | 394 | 0.17 | 98 | 150 | 68.1 | 27.9 | 27.7 | 69.3 | 7.86 | 0.23 | 0.01 | 70.1 | 7.51 | 0.08 | 0.42 | 0.44 |
| **April 2010** | | | | | | | | | | | | | | | | |
| WSSW 2 | 280 | 0.1 | 44 | 122 | 39.8 | 30.8 | 15.9 | 41.4 | 7.31 | 0.01 | 0.01 | 46.9 | 8.01 | 0.12 | 0.2 | 0.42 |
| WSSW1 | 318 | 0.1 | 47 | 122 | 39.7 | 31.3 | 15.9 | 41.7 | 7.24 | 0.09 | 0.01 | 48.6 | 8.19 | 0.2 | 0.2 | 0.37 |
| WKSW 2 | 306 | 0.1 | 44 | 124 | 38.1 | 31 | 15.8 | 40.7 | 7.25 | 0.22 | 0.01 | 47.3 | 8.06 | 0.26 | 0.2 | 0.35 |
| **December 2010** | | | | | | | | | | | | | | | | |
| WKSW 2 | 384 | 1.3 | 66 | 151 | 58.1 | 40.4 | 20.7 | 51.1 | 6.42 | 0.01 | 0.01 | 60.4 | 8.37 | 0.1 | 0.2 | |
| WSSW 1 | 380 | 0.79 | 65 | 151 | 53.3 | 39.7 | 20.3 | 50.5 | 6.33 | 0.01 | 0.01 | 59.9 | 8.38 | 0.1 | 0.2 | |

| Sample ID | Total Dissolved Solids | Nitrate $NO_3$ (N) | Chlorides (Cl) | Total Alkalinity (as $CaCO_3$) | Sulphate ($SO_4$) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Iron (Fe) | Manganese (Mn) | Conductivity at 25° C in mS/m | pH-Value at 25° C | Aluminum (Al) | Free and Saline Ammonia (as N) | Fluoride (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class I (Recommended) | <1000 | <10 | <200 | N/S | <400 | <150 | <70 | <200 | <50 | <0.2 | <0.1 | <150 | 5-9.5 | <0.3 | <1 | |
| Class II (Max. Allowable) | 2400 | 20 | 600 | N/S | 600 | 300 | 100 | 400 | 100 | 2 | 1 | 370 | 4-5 or 9.5-10 | 0.3-0.5 | 2 | |
| Duration (years) | 7 | 7 | 7 | N/S | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | No Limit | 1 | None | |
| WSSW 2 | 412 | 1.3 | 60 | 158 | 88.8 | 41.1 | 20.9 | 51.3 | 6.38 | 0.01 | 0.01 | 60.6 | 8.35 | 0.05 | 0.2 | |
| **January 2012** | | | | | | | | | | | | | | | | |
| KRUSW | 297 | 0.2 | 69.3 | 117 | 49.5 | 28.8 | 20.8 | 51.1 | 7.4 | -0.01 | 0 | 54 | 8.4 | -0.01 | -0.02 | 0.2 |
| WTSW | 301 | 0.3 | 68.2 | 117.6 | 54 | 27.9 | 21 | 51.7 | 7.5 | -0.01 | 0 | 54 | 8.2 | -0.01 | 0.03 | 0.2 |
| **May 2012** | | | | | | | | | | | | | | | | |
| KLKSW1 | 1087 | -0.06 | 404.8 | 266.5 | 125.5 | 108.4 | 45.02 | 235.3 | 8.03 | 0.7 | 0.04 | 152.5 | 6.93 | 0.04 | 0.73 | 0.56 |
| KRUSW | 456 | -0.06 | 107.9 | 105.5 | 125.6 | 37.4 | 27.68 | 87.03 | 6.98 | -0.01 | 0 | 76.5 | 8.57 | -0.01 | 0.07 | 0.45 |
| WTSW | 461 | -0.06 | 110.8 | 102 | 128.2 | 38.92 | 27.68 | 87.28 | 6.92 | -0.01 | 0 | 76.1 | 8.57 | -0.1 | 0.08 | 0.43 |

### 6.7.5 Overall water quality status

The surface water quality results fell predominantly within the ideal level (Class 0). The current use of fertilizers for agricultural activities in the surrounding areas of the proposed mining does not seem to impact negatively on the quality of the sampled water resources as seen by the low levels of nitrates ($NO_3$) and Potassium (K). The marginally high Fe (WSSW2) may be attributed to the geology of the surrounding area. The high level of these metals could therefore manifest as a high EC measures in samples (WSSW1 and WSSW2).

Overall water quality upstream (WSSW1 and WSSP2) of the project site is ideal (Class 0) with the exception of Total dissolved solids (TDS) and EC (WSSW2) that fell in Class 1. Downstream of the project site (WKSW2) the water quality is ideal except for the Fe concentration which fell in the maximum allowable class (II) while conductivity fell in Class 1. At another downstream surface water point (WSSW2), the TDS, Mg, and conductivity all fell in Class 1.

Bearing in mind that South Africa is a water-scarce country (DEAT, 2005) and the available surface fresh water resources are being heavily utilized, the management of water quality in the Limpopo River and surrounding surface water systems should be directed towards preventing the deterioration of this baseline quality.

### 6.7.6 Concluding statement

Based on the chemical surface water results, the following conclusions can be reached:

- The surface water resources of the proposed mining site are of good quality and are in line with the ideal drinking water standards (SANS 241);
- Sample WKSW2 had maximum allowable Fe concentrations which could be associated with the geology of the site; and
- The current agricultural activities around the site are not impacting on the water resources.

No surface water bodies will be directly impacted on by the development of the proposed power station.

## 6.8 Hydrogeology

The complete Hydrogeological Report for the power station is attached in Appendix H. The water monitoring reports are attached in Appendix G, which includes groundwater monitoring results.

### 6.8.1 Potential Sources of Contamination

A conceptual site model, describing the dynamics of groundwater flow and contaminant transport in the groundwater pathway, is already developed as part of the groundwater flow model (Digby Wells, 2011). The conceptual model describes the interaction between natural groundwater flow and recharge and induced activities such as open pit mine dewatering.

The conceptual model is updated in this study to incorporate the infiltration of contaminants from the ash and discard dumps, power station and associated infrastructures during the construction, operation, closure and post-closure phases of the site. The contaminant migration rates, gradients and directions from the site are expected to be influenced by the dewatering at the open pit, and therefore the pit is also incorporated into the conceptual and numerical models.

The main activities at the proposed Boikarabelo mine and power station that could result in a deterioration of groundwater quality are:

- The ash dump;
- The coal stockyard;
- The discard dump;
- The pollution control dams, and;
- The power plant.

The mine intends to utilise good engineering practices to ensure good water management on site

### 6.8.2 Mass transport modelling

The numerical model for the Boikarabelo project was updated and contaminant transport simulated for the proposed power station infrastructure. The operational as well as post closure phases were simulated.

#### 6.8.2.1 Particle Tracking

The PMPATH software was used to estimate the advective transport of potential contaminants from the power station (ash and discard dumps). This was done to simulate the likely flow-path of the groundwater and particles (contaminants) during and after operation. The migration pathways of the particles at the end of the operation and 100 years after closure are shown in Plan 11 and Plan 12, respectively.

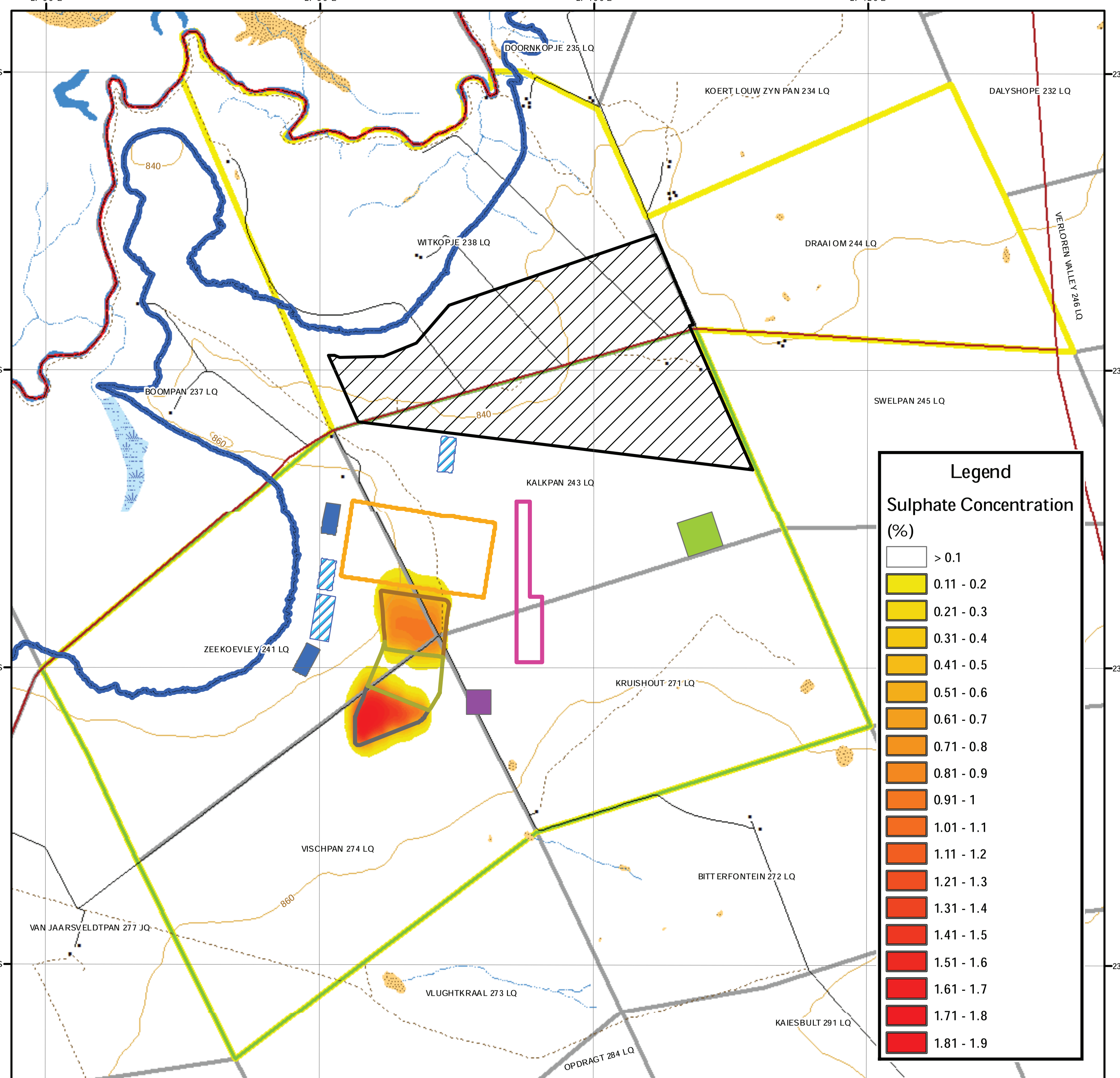
Plan 12 shows that the groundwater beneath the power station area is likely to flow towards the open pit during operation. This pattern is also expected to continue after closure until the groundwater recovers to near its pre-mining water level condition. Thereafter, groundwater flow is towards the Limpopo River

The particle tracking is also used as a tool to locate the proposed monitoring boreholes for the contamination monitoring, recommended for the water management plan.

Plan 11

# Boikarabelo Power Station

## Estimated Sulphate Plume at the End of Operation




### Legend

- Project Area
- Mining Right Boundary
- Predicted Floodline 1:100
- House
- Main Road
- Secondary Road
- Minor Road
- Track
- Contour (20m)
- Non-Perennial Stream
- Perennial Stream
- Dam / Lake
- Perennial Pan
- Non-Perennial Pan / Stream
- Wetland
- Farm Boundaries
- International Boundary
- Ash Dump
- Clean Water Dam
- Discard Dump
- Future Discard Dump
- Opencast Pit
- Overburden Stockpile
- PCD
- Plant Area
- Power Station
- Temporary Construction Village

resource generator

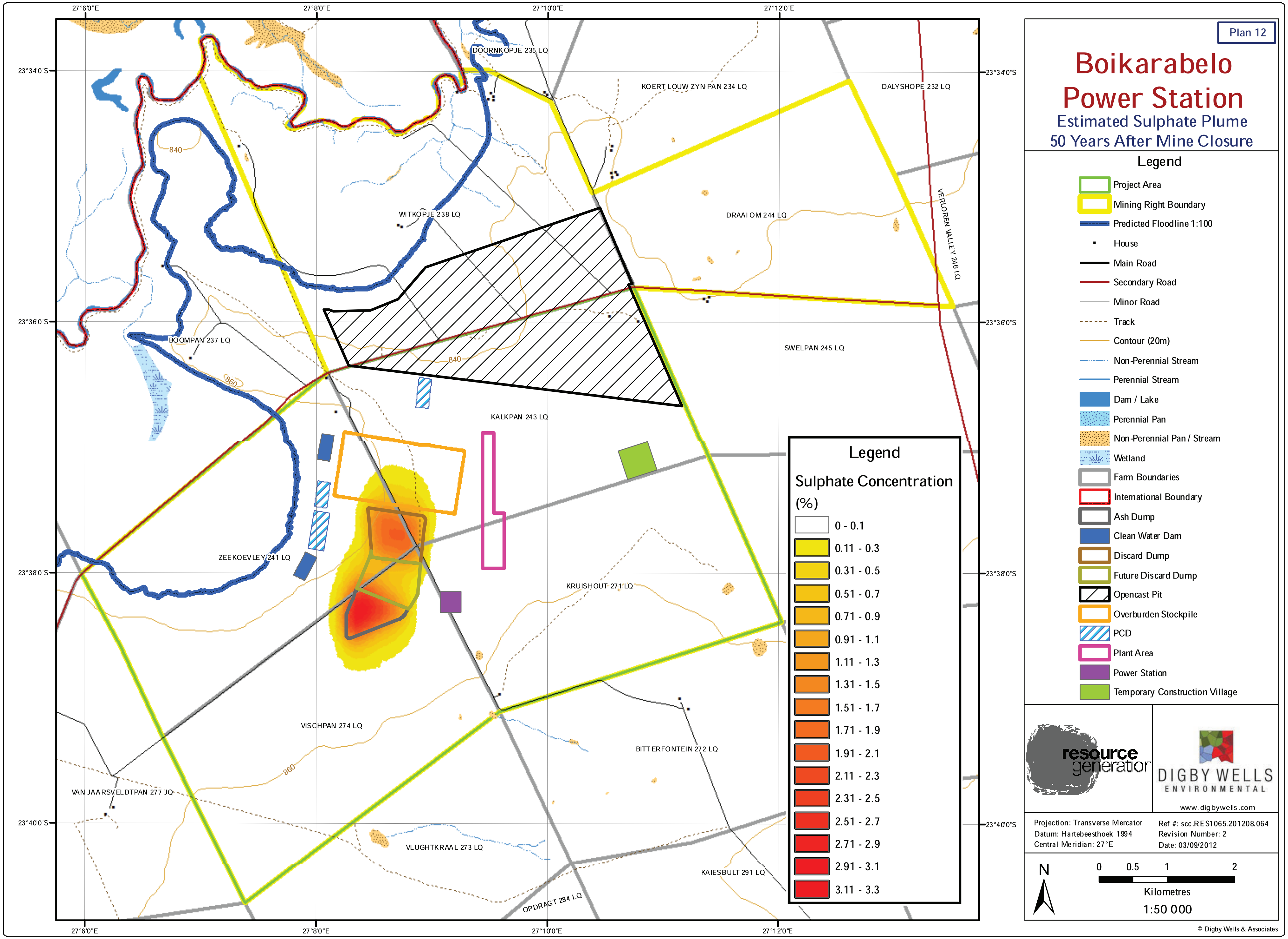
DIGBY WELLS ENVIRONMENTAL
www.digbywells.com

Projection: Transverse Mercator
Datum: Hartebeesthoek 1994
Central Meridian: 27°E

Ref #: scc.RES1065.201208.063
Revision Number: 2
Date: 03/09/2012

N

0 0.5 1 2
Kilometres
1:50 000



Plan 12
Boikarabelo Power Station
Estimated Sulphate Plume
50 Years After Mine Closure
Legend
Project Area
Mining Right Boundary
Predicted Floodline 1:100
House
Main Road
Secondary Road
Minor Road
Track
Contour (20m)
Non-Perennial Stream
Perennial Stream
Dam / Lake
Perennial Pan
Non-Perennial Pan / Stream
Wetland
Farm Boundaries
International Boundary
Ash Dump
Clean Water Dam
Discard Dump
Future Discard Dump
Opencast Pit
Overburden Stockpile
PCD
Plant Area
Power Station
Temporary Construction Village
resource generation
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Ref #: scc.RES1065.201208.064
Revision Number: 2
Date: 03/09/2012
N
0 0.5 1 2
Kilometres
1:50 000
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Legend
Sulphate Concentration (%)
0 - 0.1
0.11 - 0.3
0.31 - 0.5
0.51 - 0.7
0.71 - 0.9
0.91 - 1.1
1.11 - 1.3
1.31 - 1.5
1.51 - 1.7
1.71 - 1.9
1.91 - 2.1
2.11 - 2.3
2.31 - 2.5
2.51 - 2.7
2.71 - 2.9
2.91 - 3.1
3.11 - 3.3
27°6'0"E
27°8'0"E
27°10'0"E
27°12'0"E
23°34'0"S
23°36'0"S
23°38'0"S
23°40'0"S
DOORNKOPJE 235 LQ
KOERT LOUW ZYN PAN 234 LQ
DALYSHOPE 232 LQ
VERLOREN VALLEY 246 LQ
WITKOPJE 238 LQ
DRAAI OM 244 LQ
SWELPAN 245 LQ
BOOMPAN 237 LQ
KALKPAN 243 LQ
ZEEKOEVLEY 241 LQ
KRUISHOUT 271 LQ
VISCHPAN 274 LQ
BITTERFONTEIN 272 LQ
VAN JAARSVELDTPAN 277 JQ
VLUGHTKRAAL 273 LQ
KAIESBULT 291 LQ
OPDRAGT 284 LQ
840
860

#### 6.8.2.2 Contamination Plumes

The simulated contamination plumes at the end of operation (Plan 13), 50 years after closure (Plan 14) and 100 years after closure (Plan 15) show that the plumes will be contained within the mine footprint areas.

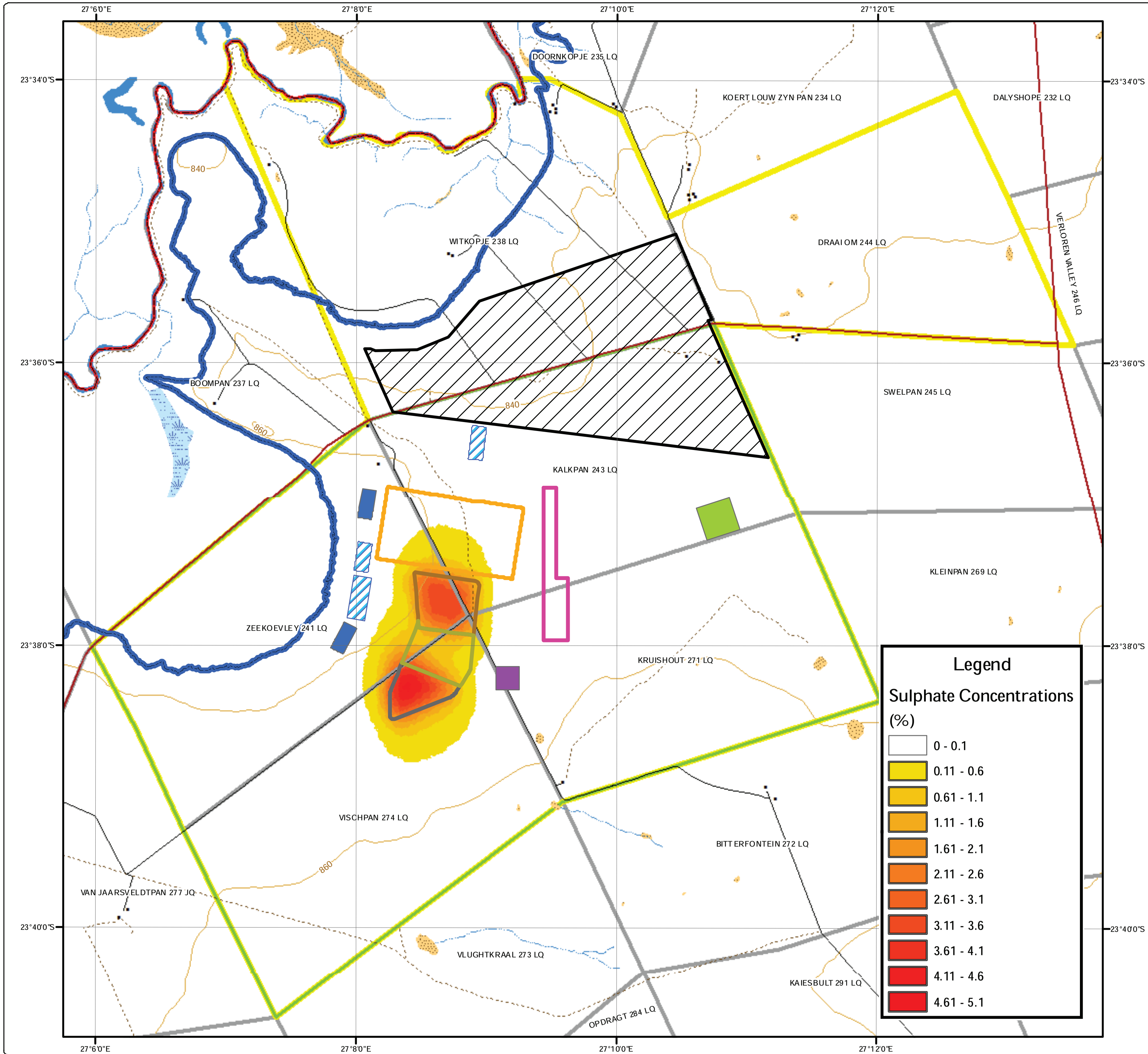
During mine operation, the contaminant migration is expected to be directed towards the pit in response to the cone of depression that will be created by the mine dewatering. Even after mine closure this trend will be maintained until full groundwater recovery is obtained.

Following mine closure and full water level recovery, the groundwater conditions will be similar to the pre-mining conditions and the flow will be directed towards the Limpopo River. The contaminants are also likely to migrate in the same direction towards the river. Due to natural processes (such as dispersion, dilution and sorption) however it is unlikely for the contaminants to reach the river at concentrations of concern.

Plan 13

# Boikarabelo Power Station

## Estimated Sulphate Plume 100 Years After Mine Closure




### Legend

- Project Area
- Mining Right Boundary
- Predicted Floodline 1:100
- House
- Main Road
- Secondary Road
- Minor Road
- Track
- Contour (20m)
- Non-Perennial Stream
- Perennial Stream
- Dam / Lake
- Perennial Pan
- Non-Perennial Pan / Stream
- Wetland
- Farm Boundaries
- International Boundary
- Ash Dump
- Clean Water Dam
- Discard Dump
- Future Discard Dump
- Opencast Pit
- Overburden Stockpile
- PCD
- Plant Area
- Power Station
- Temporary Construction Village

resource generation

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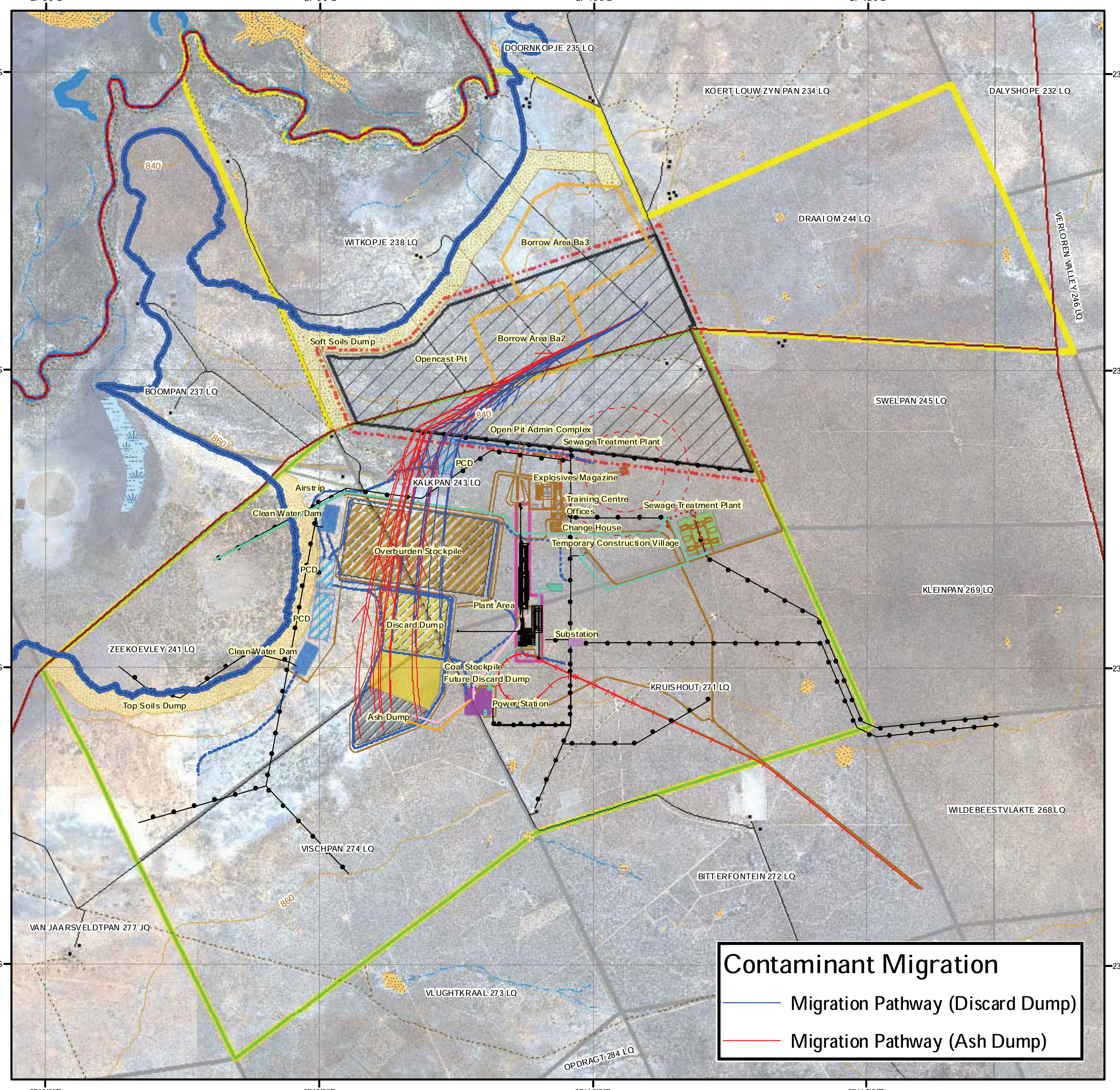
N

0 0.5 1 2
Kilometres
1:50 000

Plan 14

# Boikarabelo Power Station

## Contaminant Migration Pathway at the End of Operation




Legend

| | |
|---|---|
| Project Area | **Mine Plan** |
| Mining Right Boundary | Conveyor |
| Predicted Floodline 1:100 | Drain |
| House | Explosives Magazine Blastline |
| Main Road | Pipeline |
| Secondary Road | Power Line |
| Minor Road | Railway Line |
| Track | Road |
| Contour (20m) | Sewage |
| Non-Perennial Stream | Slurry Line |
| Perennial Stream | Plant |
| Dam / Lake | Airstrip |
| Perennial Pan | Ash Dump |
| Non-Perennial Pan / Stream | Blast Line |
| Wetland | Borrow Area |
| Farm Boundaries | Buildings |
| International Boundary | Clean Water Dam |
| | Coal Stockpile |
| | Discard Dump |
| | Explosives Magazine |
| | Future Discard Dump |
| | Offices |
| | Opencast Pit |
| | Overburden Stockpile |
| | PCD |
| | Plant Area |
| | Power Station |
| | Sewage Treatment Plant |
| | Substation |
| | Temporary Construction Village |
| | Water Storage Tanks |
| | Soft Soils Dump |
| | Top Soils Dump |

resource generation

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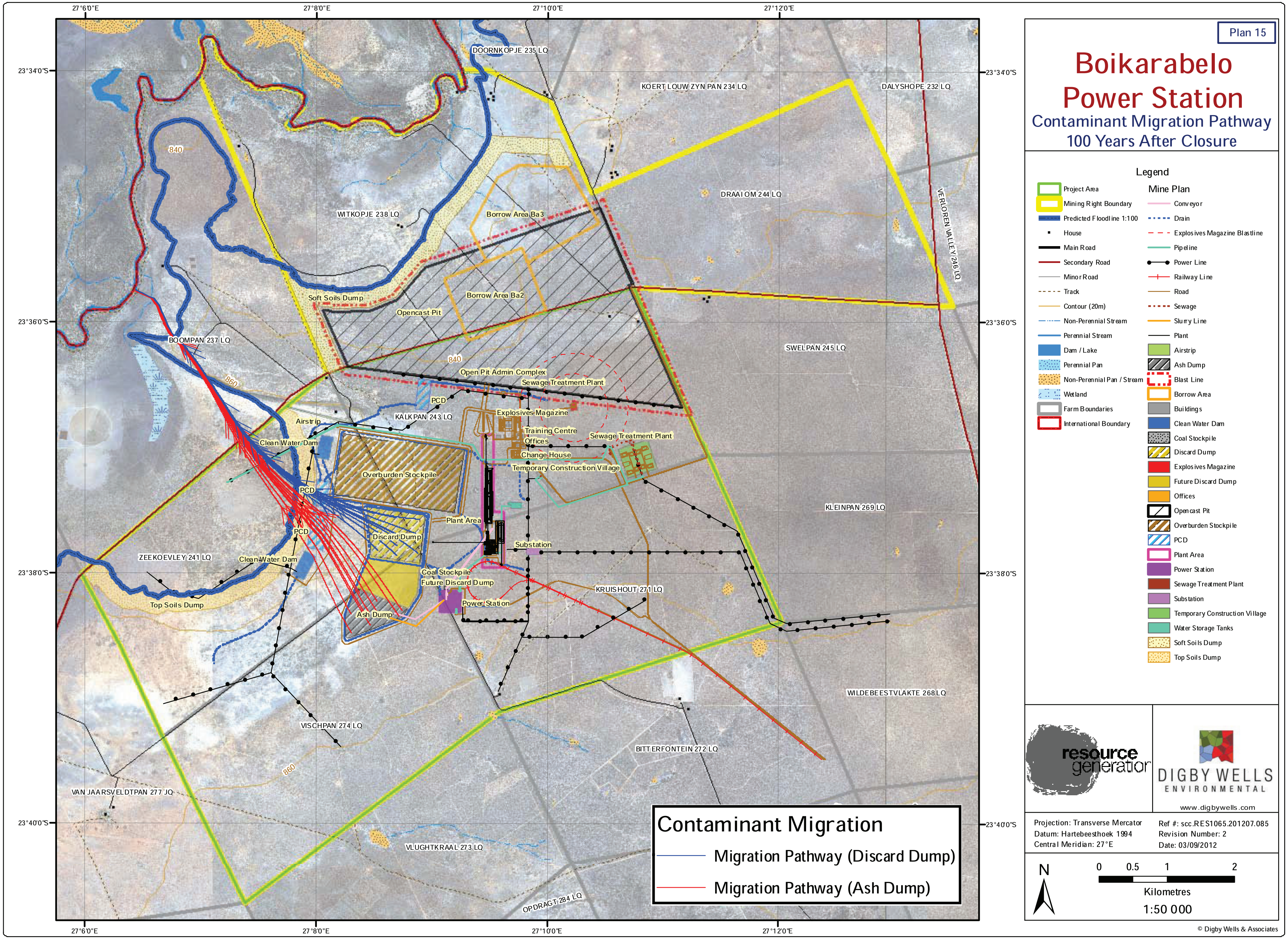
Revision Number: 2
Date: 03/09/2012

N

0 0.5 1 2
Kilometres
1:50 000



Plan 15
Boikarabelo Power Station
Contaminant Migration Pathway 100 Years After Closure
Legend
Project Area
Mining Right Boundary
Predicted Floodline 1:100
House
Main Road
Secondary Road
Minor Road
Track
Contour (20m)
Non-Perennial Stream
Perennial Stream
Dam / Lake
Perennial Pan
Non-Perennial Pan / Stream
Wetland
Farm Boundaries
International Boundary
Mine Plan
Conveyor
Drain
Explosives Magazine Blastline
Pipeline
Power Line
Railway Line
Road
Sewage
Slurry Line
Plant
Airstrip
Ash Dump
Blast Line
Borrow Area
Buildings
Clean Water Dam
Coal Stockpile
Discard Dump
Explosives Magazine
Future Discard Dump
Offices
Opencast Pit
Overburden Stockpile
PCD
Plant Area
Power Station
Sewage Treatment Plant
Substation
Temporary Construction Village
Water Storage Tanks
Soft Soils Dump
Top Soils Dump
resource generation
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Revision Number: 2
Date: 03/09/2012
N
0 0.5 1 2
Kilometres
1:50 000
© Digby Wells & Associates
Contaminant Migration
Migration Pathway (Discard Dump)
Migration Pathway (Ash Dump)
DOORNKOPJE 235 LQ
KOERT LOUW ZYN PAN 234 LQ
DALYSHOPE 232 LQ
VERLOREN VALLEY 246 LQ
DRAAI OM 244 LQ
WITKOPJE 238 LQ
BOOMPAN 237 LQ
SWELPAN 245 LQ
KALKPAN 243 LQ
KLEINPAN 269 LQ
ZEEKOEVLEY 241 LQ
KRUISHOUT 271 LQ
WILDEBEESTVLAKTE 268 LQ
VISCHPAN 274 LQ
BITTERFONTEIN 272 LQ
VAN JAARSVELDTPAN 277 JQ
VLUGHTKRAAL 273 LQ
OPDRAGT 284 LQ
Borrow Area Ba3
Borrow Area Ba2
Soft Soils Dump
Opencast Pit
Open Pit Admin Complex
Sewage Treatment Plant
PCD
Airstrip
Explosives Magazine
Training Centre
Offices
Change House
Temporary Construction Village
Clean Water Dam
Overburden Stockpile
Plant Area
Discard Dump
Substation
Coal Stockpile
Future Discard Dump
Power Station
Ash Dump
Top Soils Dump
840
860
27°6'0"E
27°8'0"E
27°10'0"E
27°12'0"E
23°34'0"S
23°36'0"S
23°38'0"S
23°40'0"S

## 6.9 Noise Assessment

The detailed Noise Assessment Report is attached in Appendix I.

Baseline noise measurements were taken at various farmsteads, within a radius of two kilometres from the proposed activities. The two kilometre buffer zone has been selected in accordance to the Concawe method (SANS 10357) for calculating noise propagation.

According to the SANS 10103:2008 guidelines 'daytime' is defined as anytime between 06:00 to 22:00, and 'night time' between 22:00 to 06:00. As a result of these guidelines, measurements were taken once during the daytime and once during night time at each identified noise receptor. Monitoring was taken at a measurement of 1.5 metres above ground level, and for a minimum period of 30 minutes (SANS 10103:2008).

A Quest (Model 1900), Type 1, impulse and precision integrating sound level meter was used for the measurements. The instrument was field calibrated with a Quest QC-10, sound level calibrator. Meteorological conditions at the time of the measurements were measured with a Kestrel 3500 pocket weather meter. Certificates of calibration for these instruments are available on request.

A list of relevant receptors, which may be impacted by the power generating activities is presented in Table 6-5 and illustrated on Plan 16 below.

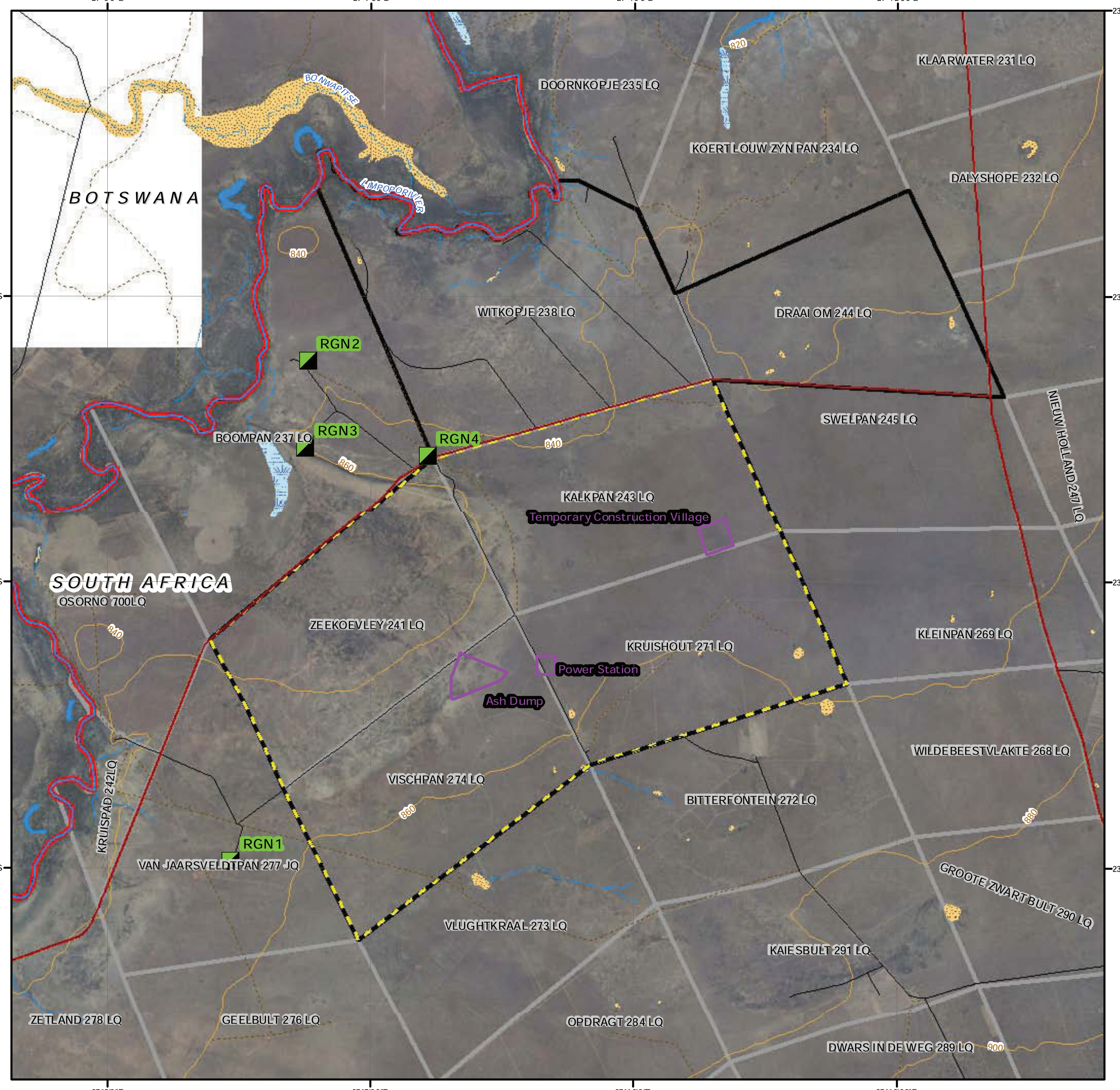
**Table 6-5: Relevant receptors that might be impacted on by the proposed Boikarabelo Power Station**

| Site ID | Farm | Owner | Type of receptor | GPS coordinates |
|---|---|---|---|---|
| RGN1 | Van Jaarsveldtpan 277 JQ | Maluma Lodge cc. | Maluma Lodge | 23°39'56.62"S & 27° 6'10.06"E |
| RGN2 | Boompan 237 LQ | Haygon Safaris (Pty) Ltd | Permanent residence | 23°35' 34.19"S & 27° 6' 51.66"E |
| RGN3 | Boompan 237 LQ | Haygon Safaris (Pty) Ltd | Lodge | 23°36'19.57"S & 27° 6'52.48"E |
| RGN4 | Boompan 237 LQ | Haygon Safaris (Pty) Ltd | Labourer's housing | 23°36'23.93"S & 27° 8'1.95"E |

Plan 16

# Boikarabelo Power Station

## Noise Receptors




### Legend

- Noise Receptors
- Project Area
- Mining Right Boundary
- Power Station Infrastructure
- Main Road
- Secondary Road
- Minor Road
- Track
- Contour (20m)
- Non-perennial Stream
- Perennial Stream
- Dam / Lake
- Perennial Pan
- Non-Perennial Pan / Stream
- Wetland
- Farm Boundaries
- International Boundary

resource generation

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Revision Number: 2
Date: 30/08/2012

N

0 0.5 1 2 3
Kilometres
1:65 000

The results of the ambient noise measurements taken at various locations around the proposed site indicated that the sound power levels were all relatively similar. The same baseline day and night time levels will therefore be applied to receptors RGN1 – RGN4. The results from the noise meter recordings for all the sampled points as well as the rating limits according to the SANS 10103:2008 guidelines are presented in Table 6-6. Additionally this table also presents the recorded date and time periods as well as the in situ meteorological conditions.

**Table 6-6: Results of the baseline noise measurements taken at receptors located around the proposed power generating activities**

| Sample ID | SANS rating limit | | | Measurement details | | | |
|---|---|---|---|---|---|---|---|
| | Type of district | Period | Acceptable rating level dBA | $L_{Areq,T}$ dBA | Maximum/Minimum dBA | Date/Time | Meteorological conditions |
| RGN1 | Rural | Daytime | 45 | 40 | 50 / 29 | 08/09/2009 12:00 | Temp: 35°C<br>Wind: NW @ 0.8 m/s<br>Humidity: 12% |
| | | Night time | 35 | 30 | 50 / 27 | 08/09/2009 22:00 | Temp: 22°C<br>Wind: NW @ 0.3 m/s<br>Humidity: 24% |
| RGN2 | Rural | Daytime | 45 | 40 | 50 / 29 | 08/09/2009 12:00 | Temp: 35°C<br>Wind: NW @ 0.8 m/s<br>Humidity: 12% |
| | | Night time | 35 | 30 | 50 / 27 | 08/09/2009 22:00 | Temp: 22°C<br>Wind: NW @ 0.3 m/s<br>Humidity: 24% |
| RGN3 | Rural | Daytime | 45 | 40 | 50 / 29 | 08/09/2009 | Temp: 35°C |

| Sample ID | SANS rating limit | | | Measurement details | | | |
|---|---|---|---|---|---|---|---|
| | Type of district | Period | Acceptable rating level dBA | $L_{Areq,T}$ dBA | Maximum/Minimum dBA | Date/Time | Meteorological conditions |
| | | | | | | 12:00 | Wind: NW @ 0.8 m/s<br>Humidity: 12% |
| | | Night time | 35 | 30 | 50 / 27 | 08/09/2009<br>22:00 | Temp: 22°C<br>Wind: NW @ 0.3 m/s<br>Humidity: 24% |
| RGN4 | Rural | Daytime | 45 | 40 | 50 / 29 | 08/09/2009<br>12:00 | Temp: 35°C<br>Wind: NW @ 0.8 m/s<br>Humidity: 12% |
| | | Night time | 35 | 30 | 50 / 27 | 08/09/2009<br>22:00 | Temp: 22°C<br>Wind: NW @ 0.3 m/s<br>Humidity: 24% |
| (red) | Indicates $L_{Aeq,T}$ levels above either the daytime rating limit or the night time rating limit | | | | | | |

Note: LAeq,T is the equivalent continuous A-weighted sound pressure level, in decibels, determined over a time period of not less then 30 minutes (the average noise level over the specified time period). The Maximum/Minimum is the highest/lowest reading during the specified time period over which the measurement was taken. 'A-weighted' is a standard weighting of the audible frequencies designed to reflect the response of the human ear to noise

Based on the daytime results from the baseline environmental noise measurements it is noted that the Leq levels measured below the SANS guidelines for the maximum allowable outdoor daytime limit for ambient noise in rural districts. The night time ambient Leq levels measured below the SANS guidelines for the maximum allowable outdoor limit for night time ambient noise in rural districts.

The noise sources that were influencing the baseline measurements at the time of the noise survey and that were responsible for the day/night time measurements are summarised in Table 6-7.

**Table 6-7: Summary of noise sources influencing baseline measurements around the proposed site**

| Noise source description | | | |
|---|---|---|---|
| **Day** | **Duration** | **Night** | **Duration** |
| Birdsong | Continuous | Crickets | Continuous |

The main noise sources during the construction and operational phase have been identified as:

- Construction activities; and
- The equipment during the operational phase such as:
  - The steam turbine generators;
  - The turbine fan coolers; and
  - Electricity transformers.
  - it should be borne in mind that other construction and operational developments will have taken place at the stage of commencement of the Boikarabelo Power Station Project.

## 6.10 Air Quality

An Air Quality Impact Assessment was undertaken by EScience Associates (Pty) Ltd. The complete report is attached in Appendix J.

The purpose of the Atmospheric Impact assessment is to allow an informed evaluation of the air quality impact resulting from emissions of potentially significant pollutants associated with the proposed CFB plant. The CALPUFF suite of modelling tools was used to model both the emissions from the proposed project as well as significant industrial sources within the surrounding Waterberg area. The proposed plant is close to the RSA-Botswana border, thus transboundary emissions from power stations in Botswana were also accounted for. Emissions inventorying and modelling focussed on the following pollutants:

- Oxides of nitrogen ($NO_x$);
- Sulphur Dioxide ($SO_2$); and
- Particulate Matter (specifically $PM_{10}$).

The proposed plant meets the definition of a solid fuel combustion installation as per subcategory 1.1 of GN248:2010 and thus the AQIA also serves to inform an application for an Atmospheric Emissions Licence in terms of chapter 5 of NEMAQA.

### 6.10.1 Significant background emitters

There are various industrial, mining and agricultural sources in proximity to the site and in the proposed Waterberg Priority Area (WPA) overall (Figure 6-19). For the purposes of this assessment only long range sources were accounted i.e. industrial point sources. These sources have elevated release heights (i.e. tall stacks) and emissions are buoyant (i.e. significantly warmer than ambient temperatures) and thus have propensity to contribute to background pollutant levels at the proposed site.

Significant background industrial sources of significance were identified as those sources with APPA registration certificates. Smaller industrial sources in urban conurbations were not considered, due to the relatively small emissions therefrom as well as the impracticality of identifying quantifying these sources.

Low level, non-buoyant emissions (mostly fugitive emissions from mines, agriculture, and derelict land) are primarily particulate in nature and are expected to fallout relatively quickly, they are thus excluded from the assessment.

There are large existing and future power stations in the surrounding area:

- Matimba Power Station – RSA, existing.
- Medupi Power Station – RSA, future.
- Moropule – Bostwana, existing and expanding power output.
- Mookone – Bostwana, future.
- Mmamabula - Bostwana, future

These facilities have been considered as part of the background emitters. The plants that are yet to come in to operation have been included as if they are already in operation as it is assumed that they will commence operations as planned.

Background industrial sources of significance were identified as those sources with APPA registration certificates. Smaller industrial sources in urban conurbations were not considered, due to the relatively small emissions therefrom as well as the impracticality of identifying and quantifying these sources.

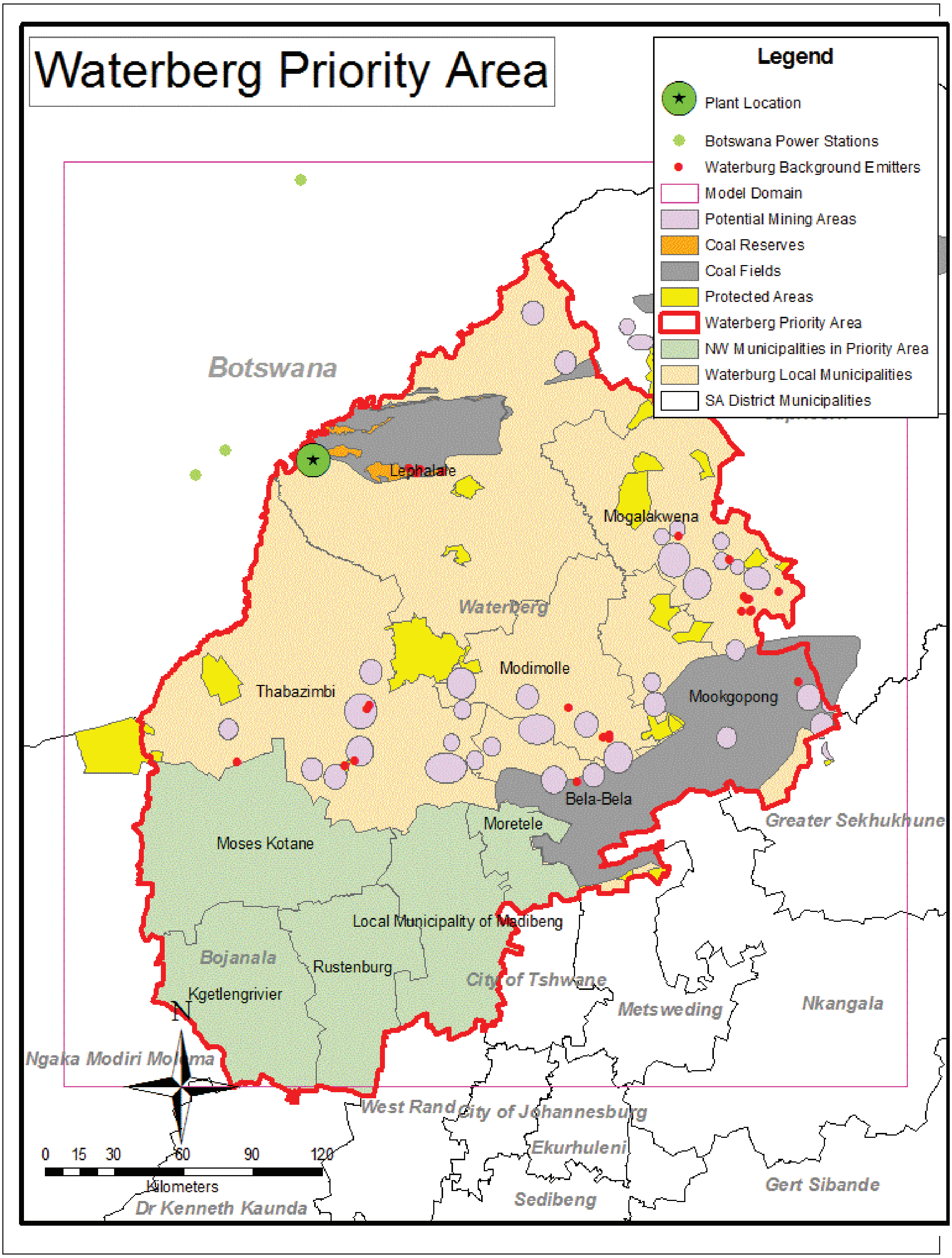


**Figure 6-19: Major emissions contributors in the proposed Waterberg Priority Area**

### 6.10.2 Potential significant emissions

The importance and impact of airborne pollutants on human health is constituted by two principal issues: concentration of the pollutant and the duration of exposure. The effects associated with short exposure duration (typically less than 24h) are referred to as acute effects, and those associated with exposure over long periods (several years) are termed chronic effects.

South Africa has national ambient air quality standards for the priority pollutants which are derived in accordance with international standards and regulation with the specific intent to protect human health. These are:

- Carbon monoxide (CO);
- Nitrogen dioxide ($NO_2$);
- Sulphur dioxide ($SO_2$);
- Ozone ($O_3$);
- Particulate matter ($PM_{10}$);
- Lead (Pb); and
- Benzene ($C_6H_6$).

Of particular concern for the proposed plant are:

- Nitrogen dioxide ($NO_2$);
- Sulphur dioxide ($SO_2$);
- Particulate matter ($PM_{10}$);

#### 6.10.2.1 Particulate matter

Particulate matter (PM) composition and emission levels are a complex function of boiler firing configuration, boiler operation, pollution control equipment and coal properties. Uncontrolled PM emissions from coal-fired boilers include the ash from combustion of the fuel as well as unburned carbon resulting from incomplete combustion. CFB boilers also release particulate matter as gypsum and lime. Correspondingly there is gypsum and free lime in the CFB ash. When low enough carbon is present this ash is well suited for blending into cement and other construction material. Due to its basicity and hydraulic characteristics, CFB ash can be utilised in a broad range of applications.

The distribution of ash between the bottom ash and fly ash fractions directly affects the PM emission rate and depends on the boiler firing method and furnace type (wet or dry bottom). Boiler load also affects the PM emissions as decreasing load tends to reduce PM emissions. However, the magnitude of the reduction varies considerably depending on boiler type, fuel, and boiler operation. The flue gases are cleaned of particulates in a downstream electrostatic precipitator or baghouse filter; in the instance of this CFB, it was assumed the ratio of PM to $PM_{10}$ is in accordance with values reported in US EPA (1998) AP42.

6.10.2.1.1 Health and Environmental Effects

The impact of particles on human health is largely depended on

- particle characteristics, particularly particle size and chemical composition, and,
- The duration, frequency and magnitude of exposure.

The potential of particles to be inhaled and deposited in the lung is a function of the aerodynamic characteristics of particles in flow streams. The aerodynamic properties of particles are related to their size, shape and density. The deposition of particles in different regions of the respiratory system depends on their size.

The nasal openings permit very large dust particles to enter the nasal region, along with much finer airborne particulates. Larger particles are deposited in the nasal region by impaction on the hairs of the nose or at the bends of the nasal passages. Smaller particles ($PM_{10}$) pass through the nasal region and are deposited in the tracheobronchial and pulmonary regions. Particles are removed by impacting the wall of the bronchi when they are unable to follow the gaseous streamline flow through subsequent bifurcations of the bronchial tree. As the airflow decreases near the terminal bronchi, the smallest particles are removed by Brownian motion, which pushes them to the alveolar membrane (CEPA/FPAC Working Group, 1998; Dockery and Pope, 1994).

Air quality guidelines for particulates are given for various particle size fractions, including total suspended particulates (TSP), inhalable particulates or $PM_{10}$ (i.e. particulates with an aerodynamic diameter of less than 10 m), and inhalable particulates of PM2.5 (i.e. particulates with an aerodynamic diameter of less than 2.5 μg/m³). Although TSP is defined as all particulates with an aerodynamic diameter of less than 100 μg/m³, an effective upper limit of 30 μg/m³ aerodynamic diameter is frequently assigned. PMI0 and PM2.5 are of concern due to their health impact potentials. As indicated previously, such fine particles are able to be deposited in, and damaging to, the lower airways and gas-exchanging portions of the lung.

6.10.2.1.2 Particulate Matter Abatement

PM entrained in flue gas should generally be captured by high efficiency dust collectors. There are several options available such as bag filters, electrostatic precipitators and scrubbers. All of these options, and more, are viable for CFB PM control. The selection of abatement equipment to be used thus becomes a function of detailed engineering design considerations and cost.

### 6.10.2.2 Sulphur dioxide

Gaseous $SO_x$ from coal combustion is primarily sulphur dioxide ($SO_2$), with a much lower quantity of sulphur trioxide ($SO_3$) and sulphates. These compounds form as the organic and pyritic sulphur in the coal are oxidized during the combustion process.

The more alkaline nature of the ash in some sub-bituminous coals causes the sulphur to react in the furnace to form various sulphate salts that end up in the bottoms ash or in the fly ash. The crushed limestone required for desulphurisation is fed into the process near the bottom of the combustor to initiate desulphurisation directly in the combustion zone. The gypsum formed as a result of this process is discharged together with the bottom ash and fly ash.

###### 6.10.2.2.1 Health and Environmental Effects

The primary health concerns associated with exposure to high concentrations of $SO_2$ include effects on breathing, respiratory illness, alterations in pulmonary defences, and aggravation of existing cardiovascular disease. Major sub-groups of the population that are most sensitive to $SO_2$ include asthmatics and individuals with cardiovascular disease or chronic lung disease (such as bronchitis or emphysema) as well as children and the elderly. Emissions of $SO_2$ can also damage the foliage of trees and agricultural crops. Together, $SO_2$ and $NO_x$ are the major precursors to acid rain, which is associated with the acidification of lakes and streams, accelerated corrosion of buildings and monuments and reduced visibility.

###### 6.10.2.2.2 $SO_2$ Abatement

Sulphur contained in the combusted fuel is oxidized to $SO_2$ and it is possible to capture this acidic gas component using limestone as sorbent, whereby surface reaction results in gypsum formation and reduces the $SO_2$ emitted in the flue gas. As much as 95% of the sulphur can be retained by such abatement methods, although the limestone utilization is low, approximately 40%.

Limestone is calcined in order to be of use in $SO_2$ abatement and adds to process carbon dioxide output, as follows:

The calcium oxide reacts to capture $SO_2$ as follows:

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(s)$$

The limestone becomes porous as a result of the calcinations and additional surface area is exposed for reaction with $SO_2$.

$$CaO\,(S) + SO_2(g) + \frac{1}{2}O_2(g) \rightarrow CaSO_4(s)$$

The internal surface area available for reaction diminishes as conversion to gypsum increases. The relative volume of the gypsum formed on the limestone particle surface is responsible for blocking of the internal pores and this is the principle reason for poor limestone utilization and rapidly decaying reaction rate. Therefore particle size of the limestone is of significance in the abatement of $SO_2$ as finer particles are likely to have a greater fraction of their surface area utilized before being blocked. The disadvantage of having smaller particle sizes is that they are more likely to be entrained from the reaction vessel before being fully sulphated.

The lime undergoes structural changes during this process and attrition of particles results in creation of finer particles that are removed by the flue gases. Porosity of the original limestone is significant for effectiveness of $CO_2$ release and the ensuing gypsum formation.

Particle porosity is believed to be the dominant kinetic factor in gypsum formation in this type of application.

The ideal particle size distribution for a CFB power plant is site specific. That is, it depends on the manufacturer and specifications of the combustor and dust collection, the economics of producing and feeding fines, the ash content of the fuel and the propensity for the stone to attrition.

Bed temperature has a significant effect on the reaction kinetics and thermodynamics of calcinations and subsequent gypsum formation. The uniformity of bed temperature is also important. Optimal temperatures are evident for each particular choice of sorbent, particle size, calcination conditions and pressure.

The residence time of the sorbent particles in a CFB boiler is a function of the particle size together with the combustion gas velocity. Residence time is an important limiting factor because the rate of sulphation is proportional to surface area which in turn is inversely proportional to particle diameter. Smaller particles with higher sulphation rates have shorter residence times due to their low terminal velocities. Conversely, larger particles may have slower rates of sulphation, but are contained in the system for a much longer residence time.

For abatement, the bed quality is evaluated by limestone distribution where mixing and fluidization has direct impact on effectiveness of $SO_2$ abatement with increased contact resulting in better capture. Increased fluid velocity will however reduce residence time and effective phase contact and likely reaction.

Availability of oxygen for sulphation is an important aspect of the surface reaction – oxygen must be present sufficiently in excess to enable unhindered gypsum formation.

Because of low limestone utilization, the chemical composition and purity of the limestone is not of particular significance to the abatement of $SO_2$, but may have an impact on eventual ash and flue gas composition. (Miller & Miller, 2008: 289–295)

$SO_2$ may also be removed from the flue gas stream via scrubbing. Scrubbers are separation equipment that use absorption as the primary mechanism to remove air pollutants. Scrubber systems are typically divided into three main groups depending on their usage of water called dry-, semi-dry- and wet-scrubbers.

Dry-scrubber designs can either be of a fixed or fluidised bed of sorbent material where the flue gas is blown through the material for contact or the sorbent can be injected in powder or particulate form into the flue gas. Semi-dry-scrubbing adds a small amount of moisture to the sorbent particles to assist in the removal of pollutants. Wet-scrubbing uses either water or slurry with a sorbent added to the water.

#### 6.10.2.3 Nitrogen oxides

$NO_x$ emissions from coal combustion are primarily nitric oxide (NO), with only a small volume per cent present as nitrogen dioxide ($NO_2$) and nitrous oxide ($N_2O$) is also emitted at a few parts per million. $NO_x$ formation results from thermal fixation of atmospheric nitrogen in the combustion flame (thermal $NO_x$) and from oxidation of nitrogen bound in the coal (fuel $NO_x$).

The CFB combustion temperature (840-900 °C) decreases the likelihood of significant oxidation of nitrogen contained in the combustion air and the fuel. This allows for low $NO_x$ emission levels in CFB flue gas. The low combustor temperatures are maintained by controlling operation of the fluid bed heat exchanger.

Experimental measurements of thermal $NO_x$ formation have shown that the $NO_x$ concentration is exponentially dependent on temperature and is also proportional to nitrogen concentration, oxygen concentration and the gas residence time in combustion flame. When fuel contains large quantities of organically bound nitrogen (as do most coals) the contribution of fuel bound nitrogen to $NO_x$ emissions may become significant. Small variations in temperature do not appear to significantly affect the production of fuel $NO_x$. (Cooper 2002).

#### 6.10.2.3.1 Health, and Environmental Effects

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza. The effects of short-term exposure are still unclear, but continued or frequent exposure to concentrations that are typically much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children. Nitrogen oxides are important in forming ozone and may affect both terrestrial and aquatic ecosystems. Nitrogen oxides in the air are a potentially significant contributor to a number of environmental effects such as acid rain and eutrophication.

Extensive measurements in Australian Coal mines have shown very low concentration of such oxides as a result of blasting for very short periods (we can discuss if this adds value to the narrative)

#### 6.10.2.3.2 $NO_x$ Capture and Mitigation

Nitrogenous compounds are formed by oxidation of nitrogen found in the fuel as well as the combustion air, as noted previously. At the reduced operating temperatures of the CFB, formation of $NO_x$ from the combustion air is not the major contributor but the nitrogen content of the fuel is still directly related to the likely $NO_x$ formation in the flue gas.

Present techniques for reducing $NO_x$ emissions are:

- peak temperature reduction,
- fuel re-burning, air-staging,
- low excess air and
- reduced air preheating.

Post-combustion abatement may be achieved by selective non-catalytic (SNCR) and catalytic (SCR) contact. Air-staging reduces the available oxygen for $NO_x$ formation. SNCR utilizes ammonia or urea (nitrogen containing compounds) to react as follows, respectively:

$$4NO + 4NH_2 + O_2 \rightarrow 4N_2 + 6H_2O$$

$$4NO + 2CO(NH_2)_2 + O_2 \rightarrow 4N_2 + 2CO_2 + 2H_2O$$

(Miller & Miller, 2008)

#### 6.10.2.4 Carbon Monoxide

During combustion, carbon in the fuel is oxidized through a series of reactions to form first carbon monoxide (CO) and then carbon dioxide ($CO_2$). The extent, or completion, of the combustion process is measured by the extent of carbon transformation to carbon monoxide and the following depletion of carbon monoxide to form carbon dioxide in the flue gas. High levels of carbon monoxide output are due to incomplete combustion, likely due to incorrect air-to-fuel ratio, poor burner design or poor operation and maintenance (Cleaver Brooks, 1998).

##### 6.10.2.4.1 Health, and Environmental Effects

At low concentration CO exposure results in fatigue in healthy persons and chest pain in persons with heart disease. At higher concentrations it may lead to impaired vision and coordination, headaches, dizziness, confusion and nausea. It may cause flu-like symptoms which may disappear after exposure ends. It is shown to be fatal at very high concentrations. Acute effects are due to the formation of carboxyhaemoglobin in the blood, which inhibits oxygen intake by formation of oxyhaemoglobin. (EPA, 2009)

##### 6.10.2.4.2 Carbon Monoxide and Hydrocarbons Control

CO and hydrocarbons are formed by incomplete combustion of the carbon content of the fuel. Control is accomplished by air-staging (Miller & Miller, 2008). Proper burner maintenance, inspections, operation, or utilizing an oxygen control package are additional methods for the control of carbon monoxide formation (Cleaver Brooks, 1998).

#### 6.10.2.5 Metals and trace elements

##### 6.10.2.5.1 Metals and Trace Elements Control

Trace elements are introduced by the fuel to be combusted and are collected in the bottom ash and in the dust collectors, but may also exit the system with the flue gas (as a vapour (volatile metals), or as particulate matter (non-volatile metals, and volatile metals adsorbed to PM). The point of capture or emission is dependent on various factors, such as volatility, system temperature, operating conditions and pollution control devices (Figure 6-20).

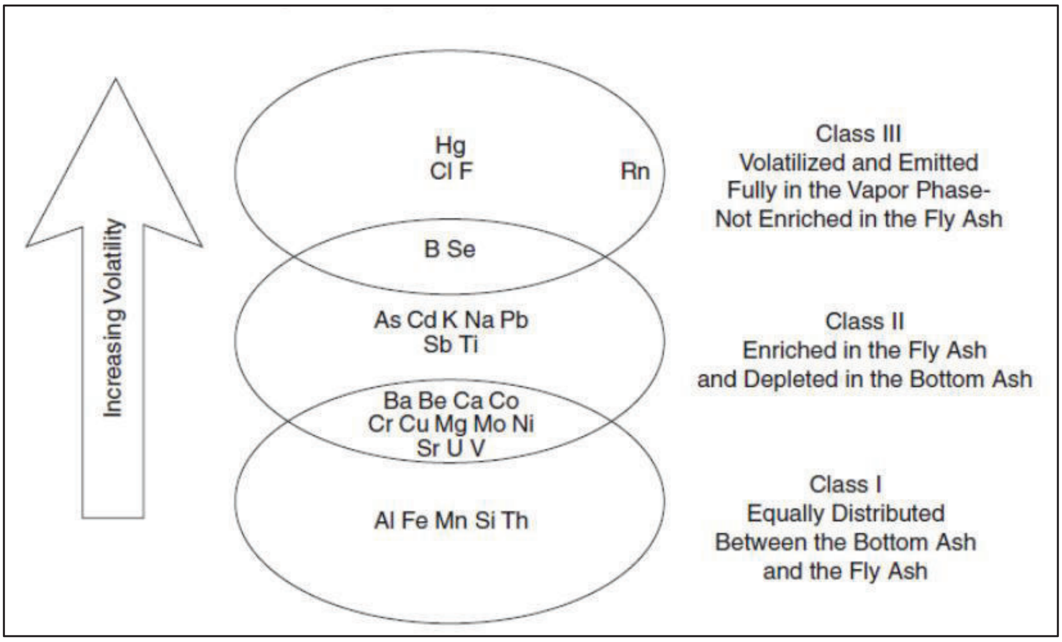


**Figure 6-20: Partitioning of trace elements according to volatility and likely distribution in power plant by-products and emissions (Miller & Miller, 2008: 300)**

Control of trace elements is mainly exercised by choice of fuel. Some of the volatilized elements are captured inside the bed material itself (dependent on material, temperature and fuel characteristics); as the flue gas cools some trace elements will condense onto the surfaces or fly ash and be captured in the dust collectors. Remaining volatiles will exit the system with the flue gas and fine particles that have escaped capture. (Miller & Miller, 2008)

The significance of these emissions is dependent on their prevalence in the feed material.

### 6.10.3 Emissions Inventory

The emissions inventory was undertaken in three sections:

- Proposed plant: The proposed power generation facility with the stack being the point emission source;
- Baseline: The emissions from the Boikarabelo mine operations around the proposed power plant location, and;
- Background: Emissions from significant sources outside of the mine boundary.

In the absence of actual measured emissions data, the use of emissions factors is the most practical means of predicting emissions rates. By virtue of the diffuse nature of fugitive emission sources it is generally not practical to measure emission rates. Various studies have been undertaken to determine the appropriate means of estimating fugitive emissions and these often employ a set of emission factors that relate the emission rate to an activity rate. An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit variable describing the activity emitting the pollutant (e.g. kilograms of particulate emitted per vehicle kilometre travelled). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category.

The general equation for emissions estimation is:

$$E = A \cdot EF \cdot \left(1 - \frac{ER}{100}\right) \qquad (1)$$

E = emission rate

A = activity rate

EF = emission factor

ER = overall emission reduction efficiency, %

(Adapted from US EPA 2008)

Emission factors from the US EPA AP42 database were used for the purposes of predicting vehicle wheel entrainment emissions for the site. It must be noted that these factors are known to conservatively overestimate particulate emission rates from unpaved roads.

Emissions quantification for the study was informed by vehicle data received from the mine, and surface particle size distribution results for samples taken.

#### 6.10.3.1 Proposed Power Generation Stack Emissions

Emissions from the proposed plant were derived based on various coal compositions likely to be used. The final configuration of emissions was conservatively selected as that with the most significant emissions.

Emission factors were applied to the calculated coal consumption (based on the energy required, 40MW) with emission factors and engineering basics to determine what the emissions would be. The stack parameters were chosen to be 100m high with a diameter of 3m, which would produce a linear velocity of 11.5 m/s. Five location alternatives were proffered for the location of the plant within the mine boundary.

$SO_2$ was calculated assuming that all sulphur in the coal is combusted to $SO_2$, $PM_{10}$ was calculated using emissions factors based on the ash content of the coal and $NO_x$ using an emission factor based on the energy consumption of the boiler.

The calculated emissions were then compared to the limits set in GN248 for category 1.1 and adjusted accordingly (taking into account oxygen correction) to calculate if the abatement required will be achievable. The final emissions calculated for the power plant is shown in Table 6-8 using the following assumptions:

- Excess air is 30%
- Coal composition is

- 49% carbon
- 38% ash
- 28.3% volatiles

- Overall plant efficiency is 27%

**Table 6-8: Expected proposed plant emissions rates**

| $SO_2$ Rate (g/s) | $NO_X$ Rate (g/s) | $PM_{10}$ Rate (g/s) | CO Rate (g/s) |
|---|---|---|---|
| 43.4 | 65.11 | 4.34 | 85.43 |

#### 6.10.3.2 Baseline

The baseline emissions cover the major contributors from the surrounding mining, which will be occurring on site. This is not dependent on the power plant but is nonetheless seen as the "existing" site emissions. The only source considered in this scenario is the unpaved road emissions. This is due to a lack of detailed information of the mine operations, an air quality impact assessment that has been performed for the mine and it has been found with in-house projects that usually unpaved road emissions can account for the majority of emissions from a mine.

The mine works emissions from the nearby Boikarabelo mine were obtained from a road emissions report which was performed during the authorization of the mine. Road emissions (calculated as a flux (grams per length of road)) and layouts were obtained from this report and inserted as is into the model using typical road emissions modelling parameters. The blasting, drilling and dragline emissions figures obtained from the report were summed and modelled as one area emission source as the exact layouts, locations, and schedules are not known. Two sites were chosen for these emissions, one on the edge of the mine closest to Lephalale and another in the middle of the mine area.

##### 6.10.3.2.1 Unpaved Roads

Emissions from roads were modelled as volume sources in accordance with best practice as confirmed by various modelling guidelines including:

- Air Dispersion Modelling Guidelines for Arizona Air Quality Permits (2004)
- Air dispersion modelling guidelines for air quality permitting - Albuquerque (2001)
- Texas Modelling Guidelines, 1999

Roads can also be modelled as area sources or line sources. Line source modelling requires the use of a different modelling suite and thus may have implications for cumulative assessment of roads in conjunction with other sources. In this case all sources were modelled using CALPUFF.

Currently the public roads are very poorly maintained and increase dust creation. Mine roads will be paved or well maintained. The mine will also pave/repair some public roads reducing existing dust creation

#### 6.10.3.3 Background Sources

Major atmospheric pollutant emission sources in the Waterberg include:

- Power generation,
- Mining,
- Industrial sources, and
- Domestic fuel burning
- Agriculture
- Denuded land
- Biomass burning (veld fires)

For the purposes of this assessment only long range sources were accounted i.e. industrial point sources. These sources are have elevated release heights (i.e. tall stacks) and emissions are buoyant (i.e. significantly warmer than ambient temperatures) and thus have propensity to contribute to background pollutant levels at the proposed site.

Low level, on-buoyant emissions (mostly fugitive emissions from mines, agriculture, and derelict land) are primarily particulate in nature and are expected to fallout relatively quickly, they are thus excluded from the assessment.

There are large existing and future power stations in the surrounding area:

- Matimba Power Station (3 990MW) – RSA, existing.
- Medupi Power Station (4 800MW) – RSA, future.
- Moropule (132MW + 600MW x 2 planned) – Botswana, existing and expanding power output.
- Mookane (300 MW) – Botswana, future.
- Mmamabula (1 200MW) - Botswana. future

These facilities have been considered as part of the background emitters. The plants that are yet to come in to operation have been included as if they are already in operation as it is assumed that they will commence operations as planned.

Significant background industrial sources of significance were identified as those sources with APPA registration certificates. Smaller industrial sources in urban conurbations were not considered, due to the relatively small emissions therefrom as well as the impracticality of identifying quantifying these sources.

APPA certificate information was employed to estimate the background industrial emissions through the use of emission factors and permitted conditions of operation. These sources included:

- Metallurgical Processes
- Cement manufacturing,
- Brick making,
- Waste incineration processes.

Emissions monitoring information was obtained from Eskom for the Matimba and Medupi power stations and the emissions were quantified accordingly. Stack parameters were also provided by Eskom and used as is. The values used in modelling assumed that flue gas desulphurisation will be equipped to the Medupi plant.

Due to the lack of information available on the power stations' situated inside Botswana it was decided to estimate their emissions based on a known power plant. Matimba was used as a base and the emissions scaled accordingly to match those of the Botswana power plant energy outputs. Stack heights and exit temperatures were assumed to be the same as Matimba's while stack diameters were changed to keep the flow rates between 12 to 16 m/s. The stacks were modelled in such a way that multiple scenarios can be made to for different phases of the projects to do individual assessment of different stages in their construction phases.

## 6.11 Visual Assessment

A Visual Impact Assessment was undertaken and the complete report can be found in Appendix K. This report has been compiled without taking into account the various developments of mines and power stations on adjacent and nearby properties. .

### 6.11.1 Visual resources

Visual resources are described as the quality of scenery and the sense of place. Both of these aspects are intangible and not easily quantified

#### 6.11.1.1 Scenic quality

Scenic Quality is a description of the scenic value of the Landscape (intangible emotional aspects) and description of the sense of place. Table 6-9 describes the value scores for scenery and sense of place.

**Table 6-9: Value of Scenic Quality**

| High | Medium | Low |
|---|---|---|
| This landscape is considered to have high | This landscape is considered to have medium scenic value | This landscape is considered to have low |

| | | |
|---|---|---|
| scenic value | | scenic value |

The scenery of the area of focus is that of Bushveld. Because of the topography of the landscape there are not extensive views and vistas offered, neither is there a large variety of land units within the study area. The extent of the Bushveld is great. The study area has been assigned a scenic quality rating of Medium.

#### 6.11.1.2 Sense of place

The Bushveld has been described as holding a unique appeal, which is regarded as extremely special to some (Joubert, 2010). This experience can be attributed to the combination of factors which make up the 'place'. Development is absent from this experience. This definite 'sense' of place is derived from experience of the natural elements of the landscape; the rural location, the lack of development, the smells, sounds and various sensory experiences associated with the area.  Mine intends to maintain the "sense" of the buffer zone.

Table 6-10 summarises the landscape components described in this section and the associated values and resulting sensitivity.

**Table 6-10: Summary table of Landscape components, values and sensitivity**

| Landscape Unit | Landscape Character Value | Scenic Value and Sense of Place | Sensitivity | Cumulative sensitivity |
|---|---|---|---|---|
| Bushveld Plains | Flat landscape, Bushveld ecological integrity modified | Valuable land unit which has definite and unique sense of place | Moderate to High | High |
| Ridge Lines | High areas within the landscape offering views over the Bushveld | Extremely Valuable land unit which has definite and unique sense of place | High | |
| Riparian areas | Landscape adjacent to the Limpopo river | Extremely valuable pristine river landscape which has definite and unique sense of place | High | |

## 6.11.2 Visual Absorption Capacity (VAC) and Visual Intrusion

The visibility of the Power Station is assessed considering a number of factors, namely the visual absorption capacity of the surrounding landscape, and the intensity of the visibility which is determined by assessing visual exposure, visual intrusion and viewer sensitivity.

### 6.11.2.1 Visual Absorption Capacity (VAC) of the landscape

The flat topography of the landscape would result in high visibility.

Screening by the Bushveld vegetation results in the VAC being largely increased. The average height of the vegetation is approximately 5 - 7 m. This results in views through the bush being short; approximately 10 - 15 metres (see Flora and Fauna Report).

As a result the VAC of the landscape in which the development is situated is regarded to be high. It must be noted, that if this vegetation is removed the VAC will be substantially decreased. View corridors in the form of cleared roads and game fence servitudes through the farms offer longer views through the vegetation, and the flat nature of the topography means that far reaching visibility is good as seen in Figure 6-21 and Figure 6-22 which are illustrative of this far lower VAC.

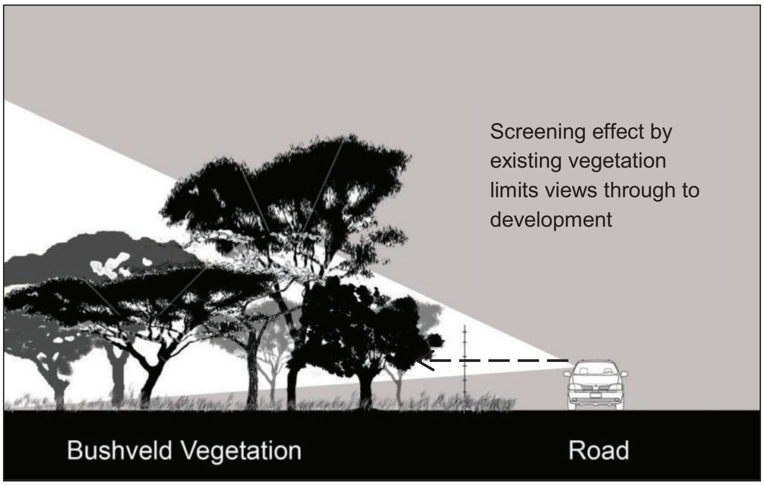


**Figure 6-21: Section illustrating the screening effect of vegetation which increases the Visual Absorption Capacity of the Landscape**

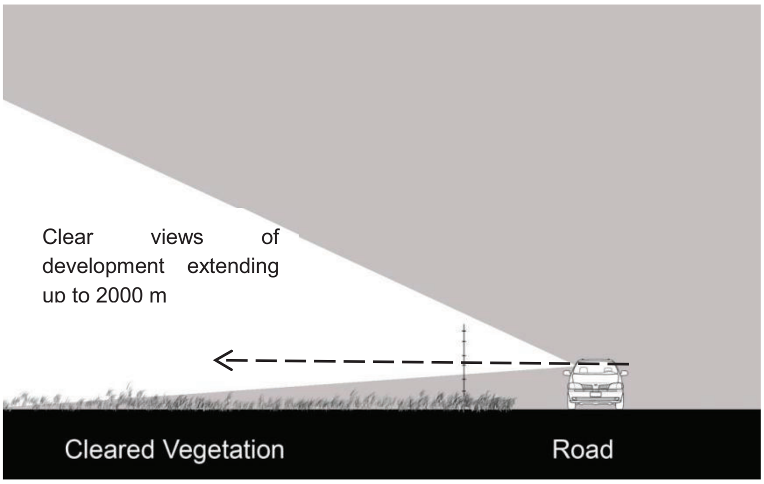


**Figure 6-22: Section illustrating the poor VAC as a result of cleared vegetation which decreases the Visual Absorption Capacity of the Landscape**

#### 6.11.2.2 Visual exposure and Visual Intrusion

Visual exposure was identified through the use of both a Viewshed analysis and field survey. Distance of the viewer from the potential infrastructure is the overriding factor that defines visual expose but other elements (such as landscape character) also have an effect

Developments of similar nature have been viewed, in some instances, further than 10 km's away. Views were possible only when the landscape aspect and there was a lack of vegetation screening. As described earlier in the report, the landscape is generally flat, with a ridge line extending north of the site, offering views over the study area.

The Viewshed map below illustrates that the landscape is extremely flat and therefore the exposure of the development would be far and wide reaching, especially for the Power Station structure. The current vegetation of the area will play a major role in screening the development. Should the vegetation be removed and the land use change the development will be far more visible in the immediate vicinity as well as from further distances. The Viewshed models describe this case, assessing the worst case scenario. However, as described earlier, currently the screening effect of the vegetation ameliorates the potential visual exposure. The Viewshed models do not take into account the vegetation.

As seen in Figure 6-23, once the temporary construction village has been developed it is expected to be visible from the eastern side of the project area, including the road.

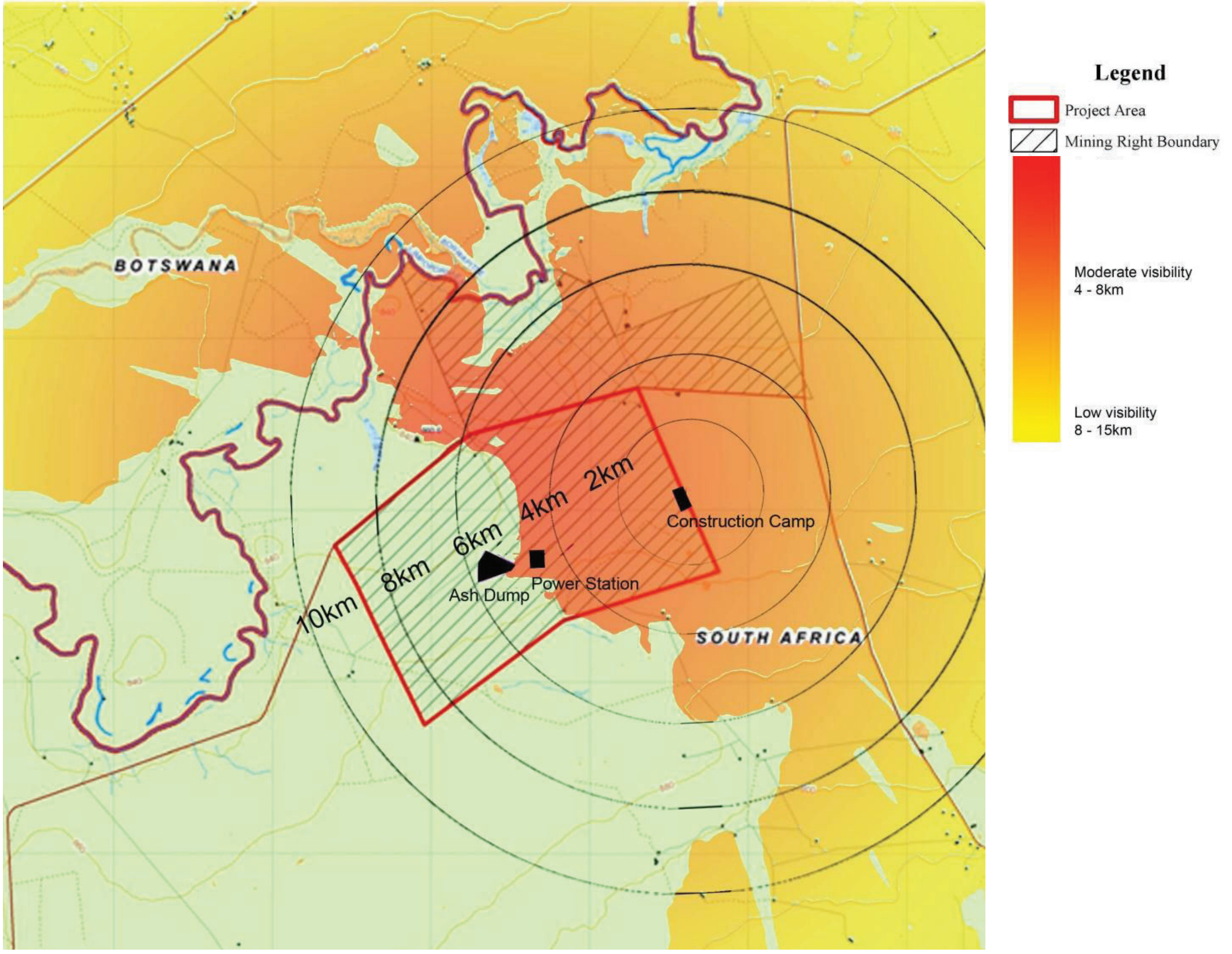


**Figure 6-23: Temporary Construction Village Viewshed analysis (worst case scenario)**

As seen in Figure 6-24, visibility, according to basic topography, of the Ash Dump will be predominantly from the western side of the project area, extending up to the fault line.