LAND-USE ASSESSMENT OF THE PROPOSED MOONLIGHT IRON ORE MINING OPERATION

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Declaration

This report has been prepared according to the requirements of Section 33 (2) of the Environmental Impact Assessments Regulations, 2006 (GNR 543). We (the undersigned) declare the findings of this report free from influence or prejudice.

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EXECUTIVE SUMMARY

Scientific Aquatic Services was appointed by Metago (Pty) Ltd. to conduct a land use impact assessment study of the area for the proposed Moonlight Iron Ore Mining Project. The field study was conducted between 12 and 15 May 2011. The areas investigated included farms in the proposed project area as well as farms in the larger area surrounding the project. The land-use maps were generated and calculations concluded from this assessment are based on the project site boundaries provided by the EAP in the form of shape files and farm boundaries were obtained from the topographic maps generated by the Surveyor-General's office. This report can therefore provide an overview of the land-uses in the project area and the associated impacts by the proposed project on the land use in the area surrounding the proposed mining site. This report will also evaluate cumulative impacts based on the total sum of all the different impacts as well as the impact on the region from other similar projects that have already been registered with the Department of Mineral Resources. The report was peer reviewed by Dr. Johan van der Waals en PS Rossouw van Terra Soil Science and the findings of the peer review are included in Appendix 2.

Current land uses in the area
It was established that the main land uses in the project area and surrounding environment are:

- Cattle farming
- Game farming
- Hunting and tourism activities
- Irrigated crop farming

For each of these land uses the availability of water was established to be the most important resource for sustainable land use.

Rating of impact
The criteria for the impact rating were defined in terms of high, medium or low impact on land use by the different environmental impacts. The impact rating can be defined as follow:

- **High impact –** one or more than one aspect of the proposed project will impact on the current land use to such an extent that it may be completely compromised or degrade over the extent of the life of mine that the present land use may not be possible at all.
- **Medium impact –** the aspects of the project will have an impact on the land use that may affect components of the land use but not to such an extent that the land use will completely be lost for the area.
- **Low impact –** aspects of the project will be observed by components of the receiving environment but it is unlikely that it will affect the land use to such an extent that it will need to change or be lost for the general area.

The effect of groundwater impacts on land use
The impact on groundwater resources are considered to be the most significant impact that will result in the most detrimental effect on current land use beyond site boundaries. No land-user will be able to continue with current cattle and game farming enterprises once the groundwater resources have diminished or disappeared. Therefore groundwater impacts will be the overriding factor in determining the impact on each specific farm and are viewed by the author of this report to be more important than impacts on noise and air quality levels, visual impacts from the mine as well traffic impacts on the roads.

The effect of noise impacts on land use
All farms within the 5 km zone around the proposed project area will be significantly impacted upon by the noise originating from the mine and its associated activities. No conclusions can be made other than that of the noise impact specialist that suggests an impact the 5 km zone.

The effect of visual impacts on land use
Farms in the zones of medium (up to 3km away from project) and low (up to 10km away from project) impact may have reduced visits from hunters and eco-tourists due to the visibility of the project from where they stay and/or hunt. Whether land-use will be severely affected by visual impact is highly debatable. No impacts on land productivity or carrying capacity will occur due to visual impacts, although it may negatively impact on the hunting and tourism industry of the area, the accommodation facilities can, however be rented out to employees of the mine on a more permanent base than is currently possible. There will be a negative impact on land users who fall within the zones of impact and that bought the property in this area for the purpose of retirement for the sense of place will be changed.

The effect of air quality impacts on land use
Although research has proved that there is a negative effect of air pollution (dust particles in this case) on the growth and function of plants and animals, no standards does yet exist by which zones of detrimental effects can be determined. As pointed out by the air quality specialists, the same criteria used for human health was used to determine a possible zone of air quality impact.

The air quality levels up to the boundary of the project site may negatively influence the animals on the land. However, this zone of impact is also overlapped by the zones of groundwater, noise and visual impact and does not affect any farm that is not already included in this list. Air quality will therefore not be the determining factor as to where current land use will be lost.

Conclusion of cumulative impact of Moonlight project
Impacts on groundwater resources by the Moonlight Iron Ore project will have the most significant negative impact on land use of farms in and around the project area. Loss of groundwater resources on a farm will result in the farm not being able to function at all and the current land use on such farms will be completely lost for the duration of the mine (30 years) as well as the period thereafter that until sufficient recharge of groundwater occurs, if at all. Although other impacts were quantified for the project such as air quality, noise pollution and visual impact, these impacts will not result in total loss of land use (Figure 1). The farms to be affected by groundwater impacts and may suffer partial or total loss of land use are listed in Table 1.

Recommendations
Where possible individual impacts on the environment should first be mitigated to either prevent or minimise the impact. However, some impacts such as that of the groundwater depletion in a 3 km zone around the project area, cannot successfully be mitigated by the supply of water from external sources for although it may supply the volumes currently provided by boreholes, it will be very difficult to replenish groundwater stored by soil that feed plant roots and sustain vegetation. These groundwater impacts will change the land use and negatively affect the economic activity of the farm. It is highly recommended that the mine develop a stringent and comprehensive groundwater and grazing capacity monitoring program to monitor impacts on the surrounding land parcels and that the mine develop a compensation plan to compensate the affected landowners for the loss of their current land use where the economic activity is no longer viable due to mine-related activities.

Table 1: Impact rating of different aspects on farms in and surrounding the project area

Name of farm	Hectares	Groundwater Impact	Noise Impact	Visual Impact	Air Quality Impact	Impact on current land use
ALEXANDERFONTEIN	1 729	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
ALICE	1 757	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
BANJA	1 268	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
BEERKRAAL	1 681	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely
BOEKENHOUTFONTEIN	1 946	High	High	Medium to Low	Low/Unlikely	High
BORDEAUX	1 960	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
CORNWALL	2 001	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
ESSEX	2 505	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
EYSSELMONDE	1 686	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
GENOA	1 777	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely
GOOD HOPE	1 763	High	High	High to Low	Low/Unlikely	High
GOUDA FONTEIN	1 695	High	High	High to Medium	High	High
GROOTEPOST	2 358	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
HANTAM	1 897	High	High	Medium to Low	Low/Unlikely	High
HUGO DE GROOT	1 438	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely
JEMMIMA	1 620	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
JULIETTA	1 652	High	High	High to Low	High	High
KARNEMELKSFONTEIN	1 899	High	High	High to Low	High	High
KLIPPOORT	1 974	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
LELIE VONTIJN	1 913	High	High	High to Low	Low/Unlikely	High
MARNITZKRAAL	2 318	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
MELINDA	1 425	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
MOONLIGHT	1 957	High	High	High	High	High
NELLY	1 744	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
OLD JEFF	1 896	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
PRAIRIE	2 109	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
ROSALIE	1 564	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
RUSLAND	1 750	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely
SMALLE PAD	2 319	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
STRYDPAN	1 774	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
SYLVESTERPAN	2 218	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
TABANA	1 583	Low/Unlikely	High	High to Low	Low/Unlikely	Low/Unlikely
VICTORIA WEST	2 078	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
ZANDKRAAL	2 013	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
TOTAL	**63 269**					

1. INTRODUCTION

Scientific Aquatic Services was appointed by Metago (Pty) Ltd. to conduct a land use impact assessment study of the area for the proposed Moonlight Iron Ore Mining Project. The field study was conducted between 12 and 15 May 2011. The areas investigated included farms in the proposed project area as well as farms in the 5 km, 10 km, 15 km and 20 km zones of possible impact. The study followed a tiered approach with more focus placed on farm units closer to the proposed mining site than areas further away where fewer representative farms were visited. Farmers and land-users were interviewed and questionnaires were completed from these interviews. These questionnaires were also distributed electronically to all other landowners in these zones that registered as interested and / or affected parties during the public participation phase. Not many landowners returned these questionnaires to the specialist.

The land-use maps were generated and calculations concluded from this assessment are based on the project site boundaries provided by the EAP in the form of shape files and farm boundaries were obtained from the topographic maps generated by the Surveyor-General's office. This report can therefore provide an overview of the land-uses in the project area and the associated impacts by the proposed project on the land use in the area surrounding the proposed mining site. This report will also evaluate cumulative impacts based on the total sum of all the different impacts as well as the impact on the region from other similar projects that have already been registered with the Department of Mineral Resources.

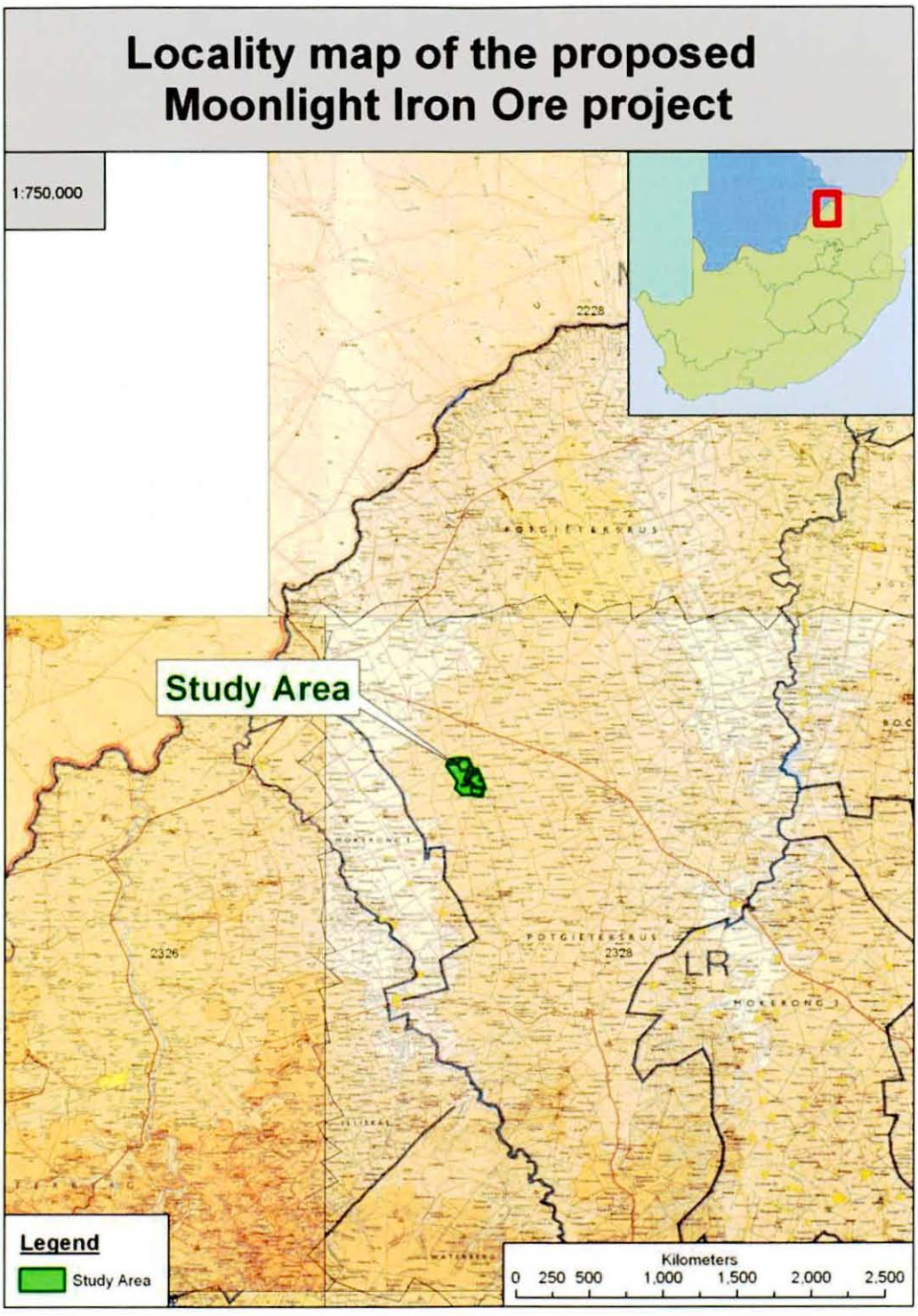

Figure 2: Locality map of the proposed Moonlight Iron Ore Project

2. SURVEY METHODS AND DATA COLLECTION

2.1 Survey methods

Sample farms with different land-uses were identified within the project area as well as in the 5, 10, 15 and 20 km zones around the project area. These land-uses included farms with tourism facilities (hunting and accommodation), cattle farming, irrigated crop production and a commercial (restaurant and café). The land-owners of these sample farms were interviewed and a questionnaire was completed from these interviews. The purpose of the questionnaire was to gain better insight on the socio-economic and agricultural activities on each land portion.

These questionnaires included questions on the following issues:

- Years of ownership and possible inheritance of land from ancestors
- Estimated amount of money spent on improvements and infrastructure within the last fifteen years
- Type of farming activities on the land
- Tourism and accommodation facilities on the farm
- Gender ratio and number of cattle on the farm
- Species ratio and estimated number of game on the farm
- Number of employees on the land as well as an estimate of the number of their dependents
- Number of boreholes on the farm
- Delivery rate of these boreholes

The author also drove on all the roads that connect the area in the different possible directions as far as 30 kilometres to determine whether there are any dramatic changes in land-use in the surrounding region.

The second aspect of the study consisted of reviewing specialist reports developed during the Environmental Impact Assessment process for various aspects and interpreting the results from the respective reports to determine the impact that these different components will have on land-use. These specialist studies reviewed included:

- Groundwater Impact Assessment
- Noise Impact Assessment
- Visual Impact Assessment
- Air Quality Impact Assessment
- Traffic Impact Assessment
- Heritage Impact Assessment
- Soil study of the project area
- Blasting and vibration impact assessment
- Vegetation and veld assessment of the project area
- A short summary of the socio-economic study

The report compiled by Mr. Deon Furstenburg of the Animal Production Institute at Irene with the title "Evaluation of Scoping Report 1 Nov 2010 – An evaluation on behalf of the Game Farmers Community of the Koedoesrand Region, 24 January 2011" was also reviewed to further establish the issues that may negatively impact on the game farming community.

Once these reports were evaluated the anticipated impacts from each report were used to determine a zone of potential impact around the site. Each of these impacts may influence the current land use in a different way.

Farms in the zones of impact were identified and listed in a table together with the size of the farm. Each farm was given an impact rating based on how severe

the influence of the combination of impacts will be on the current land use characteristics.

The criteria for the impact rating were defined in terms of high, medium or low impact on land use by the different environmental impacts. The impact rating can be defined as follow:

- **High impact** – one or more than one aspect of the proposed project will impact on the current land use to such an extent that it may be completely comprised or degrade over the extent of the life of mine that the present land use may not be possible at all.
- **Medium impact** – the aspects of the project will have an impact on the land use that may affect components of the land use but not to such an extent that the land use will completely be lost for the area.
- **Low impact** – aspects of the project will be observed by components of the receiving environment but it is unlikely that it will affect the land use to such an extent that it will need to change or be lost for the general area.

The criteria was further developed by using high impact on groundwater resources as the overriding element that will determine the degree to which land use will be impacted upon.

An example of this will be a farm that falls within the zone of low visual impact, no air quality of noise impacts but a high groundwater impact. Such a farm will still be rated as a farm with a high negative impact on land use for without its much needed water resource, the farm will cease to be able to sustain animal farming and whether there will be impacts from noise or light is irrelevant to that portion of land.

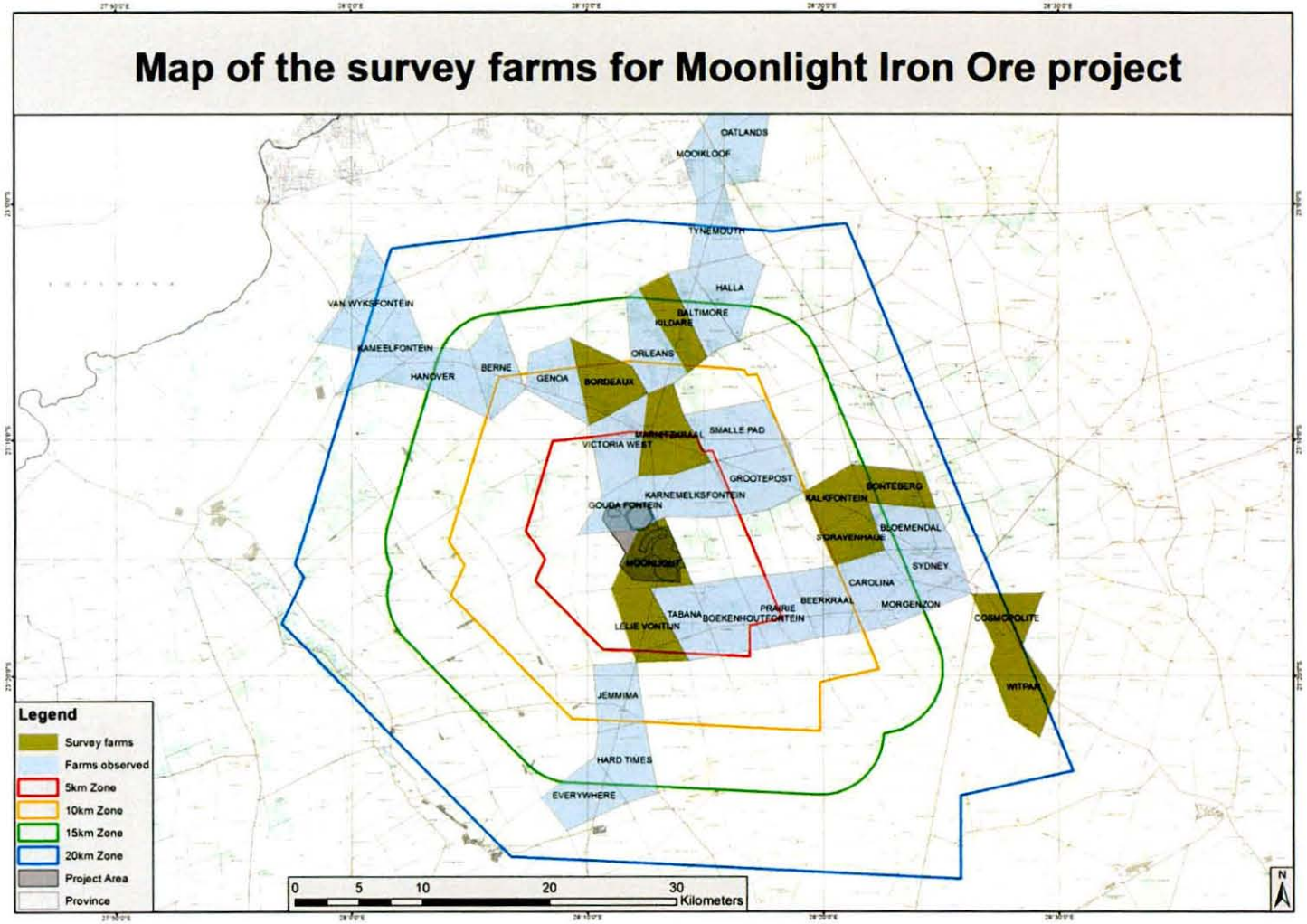

Figure 3: Map of the farms surveyed or visited for observation

3. ASSUMPTIONS AND LIMITATIONS OF THE STUDY

In any study certain assumptions are made and limitations identified with the data available. These assumptions and limitations are pointed out in the points below:

- All the impacts listed and discussed here were derived from the specialist studies and reports conducted by the respective specialists i.e. groundwater, air quality, noise, visual impact, etc. where necessary interpretation of the impacts on land use were made, however the impacts considered are largely those provided by the various specialists.
- The author of this report assumes that each specialist gave a correct representation of the potential impacts that will result from the proposed projects. Should these impacts not be correct, it will influence on the conclusions of this report.
- The scope of this study is neither a land valuation process nor an extensive game and cattle count survey. The focus of this report was to determine the current land use in the area and to determine how the proposed project will impact and possibly threaten the current land-use on farming units at varying distances from the proposed mining operation.
- During the finalisation of the report, the following specialist studies were not yet available for evaluation and the results from these reports may influence the land-use impacts determined:
    - Blasting and vibration
    - Socio-economic analysis
- Most people did not return the questionnaires and therefore it was not possible to determine whether some farms may be breeding farms for rare game species. Due to a lack of information from these farms, the general land-use of the area (cattle and game farming) was assumed to be the enterprise on their land.
- The determination of possible cumulative impacts resulting from other proposed projects were assessed with the information available of other

applications made (either for prospecting or mining). Should there be other applications in the area surrounding the project that the consultant becomes aware of, the cumulative impact map will need to be re-assessed.

4. LAND USE DEFINITIONS

To understand the concept of land use and how land use and land use impacts are determined, it is important to look at a few definitions for land use and how it can be interpreted. The definition for "land" accepted by the United Nations since 1994 at the Convention on Desertification is presented in the quoted text below:

"*Land is a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface including those of the near-surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes, and swamps), the near-surface sedimentary layers and associated groundwater reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.)*."

This definition conforms to land system units, landscape-ecological units or as building blocks of a watershed (catchment area) or a phytogeographic unit (biome). The components of the natural land unit can be termed land resources, including physical, biotic, environmental, infrastructural, social and economic components, in as much as they are fixed to the land unit.

Included in the land resources are surface and near-surface freshwater resources. These resources may move through successive land units, but the

local flow characteristics can be considered as part of the land unit. The linkages between water and land are so intimate at the management level that the water element cannot be excluded (land as a unit intermixed with water, with its land use in part depending on access to that water, and the unit at the same time affecting the quality and quantity of the passing water). Only the freshwater harnessed in major reservoirs outside the natural land unit or pumped from rivers at upstream sites can be considered as a separate resource.

Underground geological resources (oil, gas, ores, precious metals), and deeper geohydrological resources that normally bear no relation to the surface topography such as confined aquifers, are excluded from the group of components of the natural land unit, although it is recognised that some countries consider them as part of individual land ownership (and hence with rights to exploit or sell them).

In this holistic approach, a natural unit of land has both a vertical aspect - from atmospheric climate down to groundwater resources, and a horizontal aspect - an identifiable repetitive sequence of soil, terrain, hydrological, and vegetative or land use elements.

The Conservation of Agricultural Resources Act No. 43 of 1983 (CARA) defines a land user as follow:

"Land user means the owner of land, and includes-

a) any person who has a personal or real right in respect of any land in his capacity as fiduciary, fideicommissary, servitude holder, possessor, lessee or occupier, irrespective of whether he resides thereon;

b) any person who has the right to cut trees or wood on land or to remove trees, wood or other organic material from land; and

c) in relation to land under the control of a local authority, that local authority, but not a person who carries on prospecting or mining activities.

CARA also states that "natural agricultural resources" means the soil, the water sources and the vegetation, excluding weeds and invader plants.

5. CURRENT LAND USES IN THE AREA

5.1 Game farming

Almost all the farms in the area (except for the two small portions namely on which the shops and restaurant is located) have game species on the land. Some farms have game fencing to restrict game to the particular farm while others have standard five or six string cattle fences through which game species migrate.

From observations during the field survey, natural waterholes and wetland areas are scarce in this region, animals drink water at watering points and troughs that have been constructed by the farmers to which the water is supplied from boreholes on the various properties.

The game species composition differs from farm to farm and a few farms have rare game species that have been introduced to the farm for breeding purposes as well as for aesthetic purposes for their tourism businesses. The game species bred on the various farms are sold on game auctions as a source of income to the farms.

For game farming the following components of land are important:

- Water resources
- Availability of palatable vegetation
- Peaceful environment (that will be impacted upon by noise and blasting or vibrations)
- Proper infrastructure for cattle and game handling and protection
- Roads in good condition to drive to their farms

The following risks associated with the proposed project may however impact on this land use:

- **Noise from mining activities that will affect the area's sense of place** and may affect animal behaviour
- Sensitivity of animals to light pollution
- Reduction in available water resources
- Negative impact on vegetation cover
- Possible pollution of water resources
- Traffic (for small animal migration across fences and roads)
- Air quality

Should these factors be impacted upon by the proposed project, it will have an influence on this land use.

5.2 Cattle farming

Most farms have a cattle farming component that run concurrently with the game farming activities. A variety of cattle breeds graze on these farms and some farmers have registered stud animals while others have a mix of cross-breeds with which they farm. According to the veld condition

assessment conducted by Francois de Wet as part of the specialist studies for the Moonlight Iron Ore project, the grazing capacity of the farms range between 13 and 18 hectares per Large Animal Unit (ha/LAU).

According to this report, the following grazing capacities are applicable on the respective vegetation communities as identified by Ecorex CC as part of the specialist studies for the project:

- Acacia Senegal – Terminalia prunioides Closed Woodland – 13 ha/LAU;
- Sclerocarya birrea –Boscia – Aciacia tortilis Open/Closed Woodland – 16 ha/LAU;
- Commifera spp – Grewia flava Open/Closed Woodland – 17 ha/LAU; and
- Combretum apiculatum Closed Woodland – 18 ha/LAU.

Apart from the natural grass available as feed, farmers also supply cattle with dry, purchased feed in times of drought when the veld has degraded to such an extent that it can no longer support the animals. The cattle drink water from watering troughs that have been constructed in the cattle camps and the water in these troughs is supplied from boreholes located at various points on the various farms. The following environmental factors are key factors to maintain cattle farming activities on the land:

- Water resources
- Availability of palatable vegetation
- Good quality veld available

5.3 Hunting and other tourism activities

Many of the local land owners realised that they could improve their income by constructing tourism accommodation such as lodges and hunting camps. These accommodation facilities range from luxurious facilities to basic facilities between different farms with some farms having camp sites with ablution facilities for seasonal hunters.

Hunters that visit the area consist of patrons utilising the facilities as trophy hunting facilities, facilities for hunting for meat or for a combination of the two purposes. Hunting outfitters of the area usually travel to other countries such as the United States of America and Spain to market the South African hunting business and then link these hunters with the game farms. Apart from the outfitters and the landowners, the industry also make use of trackers to track the animals down, Professional Hunters (PH's) to accompany the tourists and a catering and cleaning team to tend to the guests' comfort.

Other accommodation facilities in the area include Baobab lodge which provides overnight accommodation to people travelling through the area, usually on their way to or from the Botswana border.

The following factors are considered crucial for maintaining the hunting and tourism industry on the land:

- Availability of water
- Prime game species on the land
- Sense of place (i.e. the Bushveld atmosphere of tranquillity)
- Good quality grazing and forage material available

- Pristine environment to attract tourists
- Good quality fences to protect animals from poachers

5.4 Retail businesses

Two small portions of the farm Marnitzkraal that are situated directly next to the N11, has each a shop on the property with one shop also attached to a restaurant and a lodge providing overnight accommodation. Although it may be considered by the socio-economic study that these two farms will benefit from the proposed mining development, both of the landowners have indicated during the interviews undertaken that they bought the properties due to its location in a peaceful, remote area of the country. Both of the landowners' have other main sources of income directly linked to the game farming industry surrounding them and value their shops only as a service to the community.

Agricultural support businesses in the area include the NTK (the co-op) as well as the fuel stations in both Marnitz and Baltimore. Secondary industries that also benefit from the farming and game farming industries are professionals providing a service of risk assessment and game farming insurance, game auctioneers and the drilling company who drills boreholes in search of water on the farms.

5.5 Irrigated crop farming

Very small portions of land are currently used for irrigated crop farming in the area surrounding the project site. Crop cultivation is only possible in this region where enough groundwater is available from boreholes to feed pivot or drip irrigation systems. These production units are more frequent to the east and northwest of the project site beyond the 15 km zone. Crops cultivated here include watermelons, onions, pumpkins, tomatoes, lucerne as well as small areas

of citrus orchards. The most important factor for successful crop farming is availability of groundwater for irrigation.

A map was derived using spatial imagery from Google Earth to give an indication of where crop fields are possibly located. Some old crop fields have converted to natural veld again for grazing purposes.

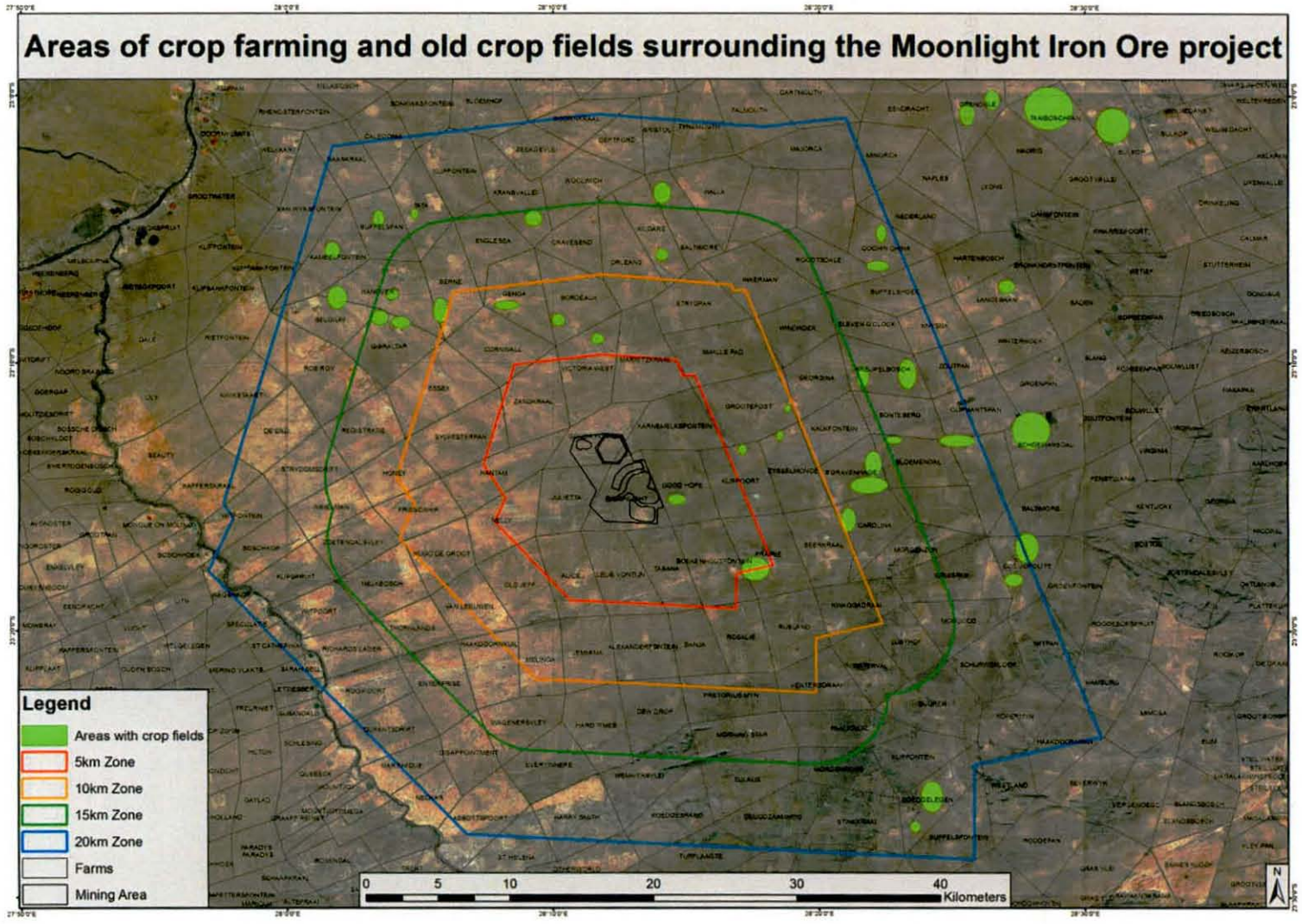

Figure 4: Map of crop farming activities in the vicinity of the Moonlight Iron Ore Project

6. LAND USE AND SUSTAINABILITY

The phrase 'sustainable development' originated in German forest management during the 19th century, but was popularized in the 1980's following the World Commission on Environment and Development and its report of 1987, Our Common Future (known as the Brundtland report). The well-used Brundtland definition of sustainable development is:

"Economic activity that meets the needs of the present without compromising the ability of future generations to meet their own needs."

It is therefore particularly important to adopt a precautionary approach to development – i.e. not to take unnecessary risks that could decrease the chances of sustainability and not to hope for technological solutions when things go wrong.

In South African legislation, sustainable development means "the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations" (National Environmental Management Act 107 of 1998). The definition of sustainable in relation to the use of a biological resource means:
"The use of such resource in a way and at a rate that –

a) would not lead to long-term decline;
b) would not disrupt the ecological integrity of the ecosystem in which it occurs; and
c) would ensure its continued use to meet the needs and aspirations of present and future generations of people."

While the Conservation of Agricultural Resources Act 43 of 1983 does not define sustainable development, sustainable use or sustainable, the Draft Sustainable Utilisation of Agricultural Resources Bill (2003) has proposed the following definitions:

- "**sustainable utilisation**" means the utilisation and protection of natural agricultural production in an environmentally sound manner, without compromising the ability of future generations to meet their own needs.
- "**sustainable**" **in relation to use of natural agricultural resources**, means the use of such resource in a way and at a rate that
  a) would not lead to its long-term decline;
  b) would not disrupt the ecological integrity of the ecosystem in which it occurs; and
  c) would ensure its continued use to meet the needs and aspirations of present and future generations of people.

7 IMPACTS ON DIFFERENT COMPONENTS OF THE LAND

7.1 Groundwater impacts

7.1.1 Introduction

During the field survey and questioning process, it became evident that the most serious concern to land-users is the availability of groundwater resources. Most farmers indicated that their boreholes have very low delivery rates (some as low as 1100 to 1500 litres per hour) and that boreholes on their land have dried up the past five years. Boreholes with higher delivery rates are present on land more than 15 kilometres east of the proposed project area and these boreholes are used for irrigated crop production such as watermelons, pumpkins and

lucerne. Water in the area surrounding the project site is almost exclusively used for household purposes and intake by game and cattle.

7.1.2 Results from the groundwater specialist study:

The following information was derived directly from the hydrogeological investigation and impact assessment conducted by a team of scientists under the supervision of Dr. Martin Holland of Metago Water Geosciences (Pty) Ltd. Nothing was added or left out from the following paragraphs in the report:

"Numerous groundwater samples taken during the investigation suggest acceptable limits. However, noticeable elements of concern for water consumption are nitrate and fluoride. In addition, several samples show major ion concentrations (e.g. Na, Cl) and subsequently electric conductivities beyond acceptable limits. This can mostly be related to the evaporative concentration of elements in discharge areas or due to low recharge values as well as long residence times for selected samples. Groundwater contaminants may travel relatively quickly in the upper weathered/fractures zone, but considerably more slowly in the underlying fractured bedrock.

The regional groundwater model was used to estimate pit inflows and to determine the extent of the drawdown depression. The impact of the modelled inflow rate of ~8 L/s (~690 m3/d) due to dewatering for the open pit seem to be limited to an approximate 3 km radius of the Moonlight site after life of mine (30 years). Although a pit-lake study wasn't performed, it is predicted that the water level in the pit will slowly rebound but will not reach the pre-dewatering level due to evaporation eventually exceeding inflow. It is expected that the potential impacts of the pit inflows on the regional groundwater flow are:

- Highly likely to occur.

- Widespread and will impact beyond the site boundaries.
- Of moderate severity with potential loss of discharge and regional groundwater flow for the affected catchment. However, higher recharge rates expected from the TSF and WRDs sites can reduce the extent of the drawdown depression.
- Yields of boreholes and wells of groundwater users located in the zone of pit dewatering could be negatively impacted and some may dry up during the life of mine.
- Reversible over time once pit dewatering stops.

A contaminated groundwater plume is not expected to extend beyond the site boundaries as the open pits will act as long term groundwater sinks and will therefore "capture" contaminated groundwater emanating from the tailings storage facility (TSF) and waste rock dumps (WRD). The potential impacts associated with the TSF and WRD on the ambient groundwater quality are:

- Highly likely to occur.
- Localised within site boundaries and of minor severity.
- Long-term beyond closure with moderate increases of pollutant concentrations.
- The intensity of the impact is a minor to moderate deterioration of the ambient groundwater quality within the site boundary.

Due to the inherent heterogeneity of the aquifer, a low to medium confidence has been assigned to the numerical groundwater model. Monitoring of groundwater levels and groundwater quality during and after mine operation will help to verify the model predictions, and are strongly recommended.

Due to the heterogeneity of the aquifer, in addition to the lack of data, a low to medium confidence has been assigned to the numerical groundwater model. Monitoring of groundwater levels and groundwater quality during and after mine operation will help to verify the model predictions, and are strongly recommended."

Following the conclusions and impact assessment on the groundwater resources of the area, issued and impacts on land use were derived based on the review of the groundwater impact assessment.

There is a strong possibility (highly likely) that groundwater resources will be affected negatively in a 3 km zone around the project area. This implies that current boreholes on the farm may become dry over the period of 30 years that the mine operates.

The impact of this on the land use of farms falling within this 3 km zone will be very serious. Current land uses of cattle and game farming will be impacted upon by loss of the water that is pumped out of boreholes for animal drinking purposes. The land-users will also be negatively affected for the water to their households will be reduced or possibly no longer be available.

Although the groundwater report indicates that groundwater resources will recover once operation at the mine ceases (although not to its original levels as it currently is), including dewatering activities. However, it is debatable whether this will have any positive influence on current land-owners and land users.

Investments made by farmers to improve the quality of their breeding stock or purchase a new game species that have higher value for trophy hunting is a long-term investment made with very slow return on capital spent. This also includes

the improvement and upgrading of fences, the drilling of boreholes to sustain the water supply on the farm and the construction of accommodation facilities that will accommodate the hunters and tourists that visit their farms.

Should land-users be forced to reduce their stock numbers (game and/or cattle) due to reduced groundwater resources available, this may result in them utilising the land below its potential capacity and land-users will have to cope with potential loss of income that may inflict on their ability to sustain themselves financially as well as their employees and their respective dependents.

It should also be considered that the report comments on boreholes and water levels in these boreholes even though the effect might also affect the water resources from which there is water uptake by plant roots. Soil has the capacity to store groundwater even it may appear dry on the surface level and plants in arid areas develop very deep root systems to enable them to take this water up through capillary forces. The cone of depression created by the mining activities will also impact on these soil water resources and systematically dry the area out and make it increasingly difficult for vegetation to survive in this affected area.

For the purpose of impact assessment on current land use in the area, the impact on groundwater resources is considered to be the most serious impact that will result in the most detrimental effect on current land use beyond site boundaries. No land-user will be able to continue with current cattle and game farming enterprises once the groundwater resources have diminished or disappeared. Therefore groundwater impacts will be the overriding factor in determining the impact on each specific farm and are viewed by the author of this report to be more important than impacts on noise and air quality levels, visual and vibrations impacts from the mine as well traffic impacts on the roads.

Referring back to definitions on land and land use in Sections 4 and 5 as well as the precautionary principle of sustainability as described in the National Environmental Management Act No. 107 of 1998 as well as in international documentation such as the Brundlandt report, the following criteria was used to determine the zone of impact on land-use:

All farms that is transacted by the 3 km zone of groundwater impact around the project area as well as any farm affected by this transect, may still be significantly impacted upon by the mining operations.

This principle is followed due to the knowledge gap in the study that there is uncertainty on exactly where each borehole and its source of groundwater is located. There are also some farms in this zone of impact that have water agreements between each other due to the fact that a few of these farms have almost no groundwater resources available.

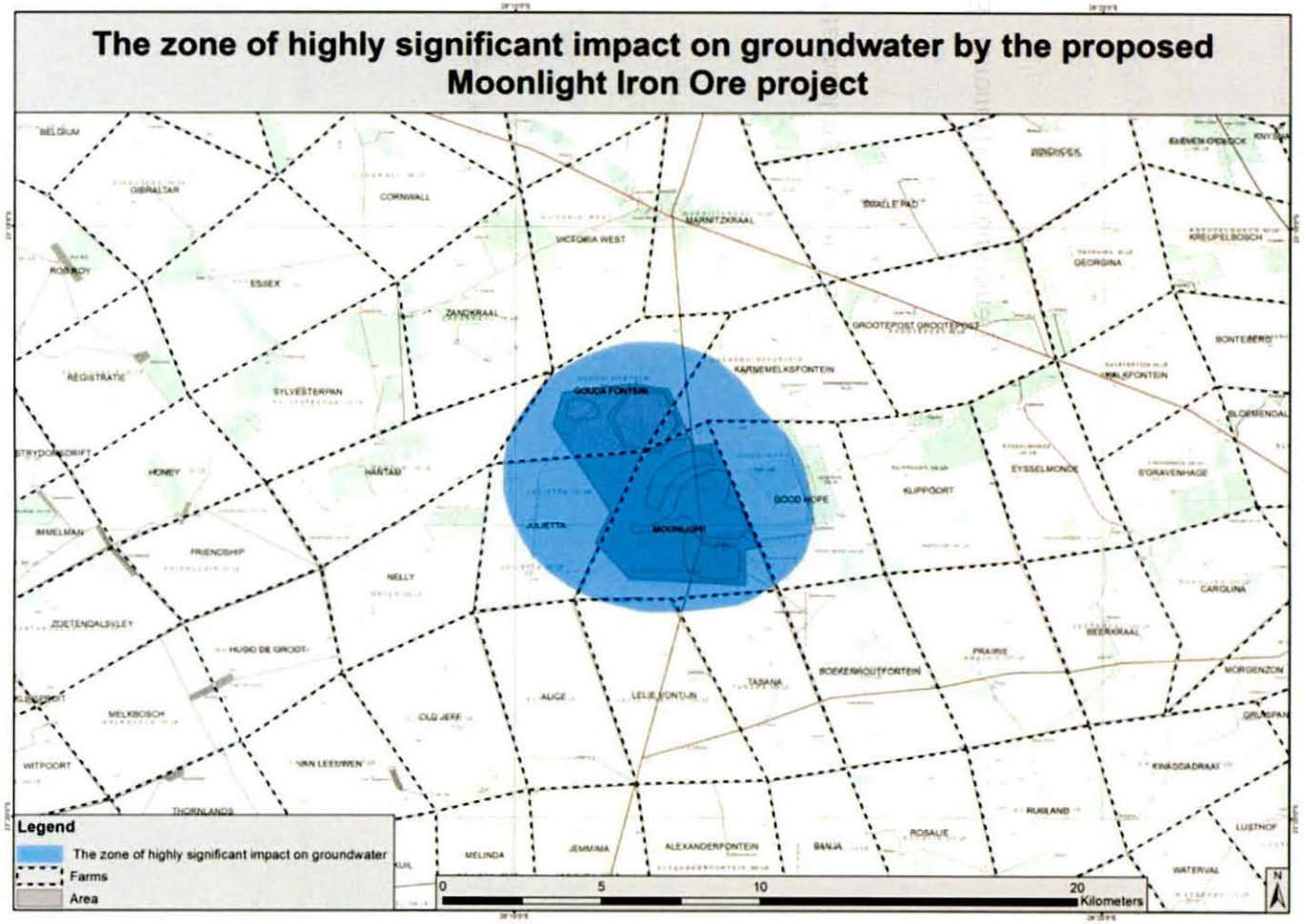

Figure 5:The zone of highly significant impact on groundwater by the proposed Moonlight iron Ore Project

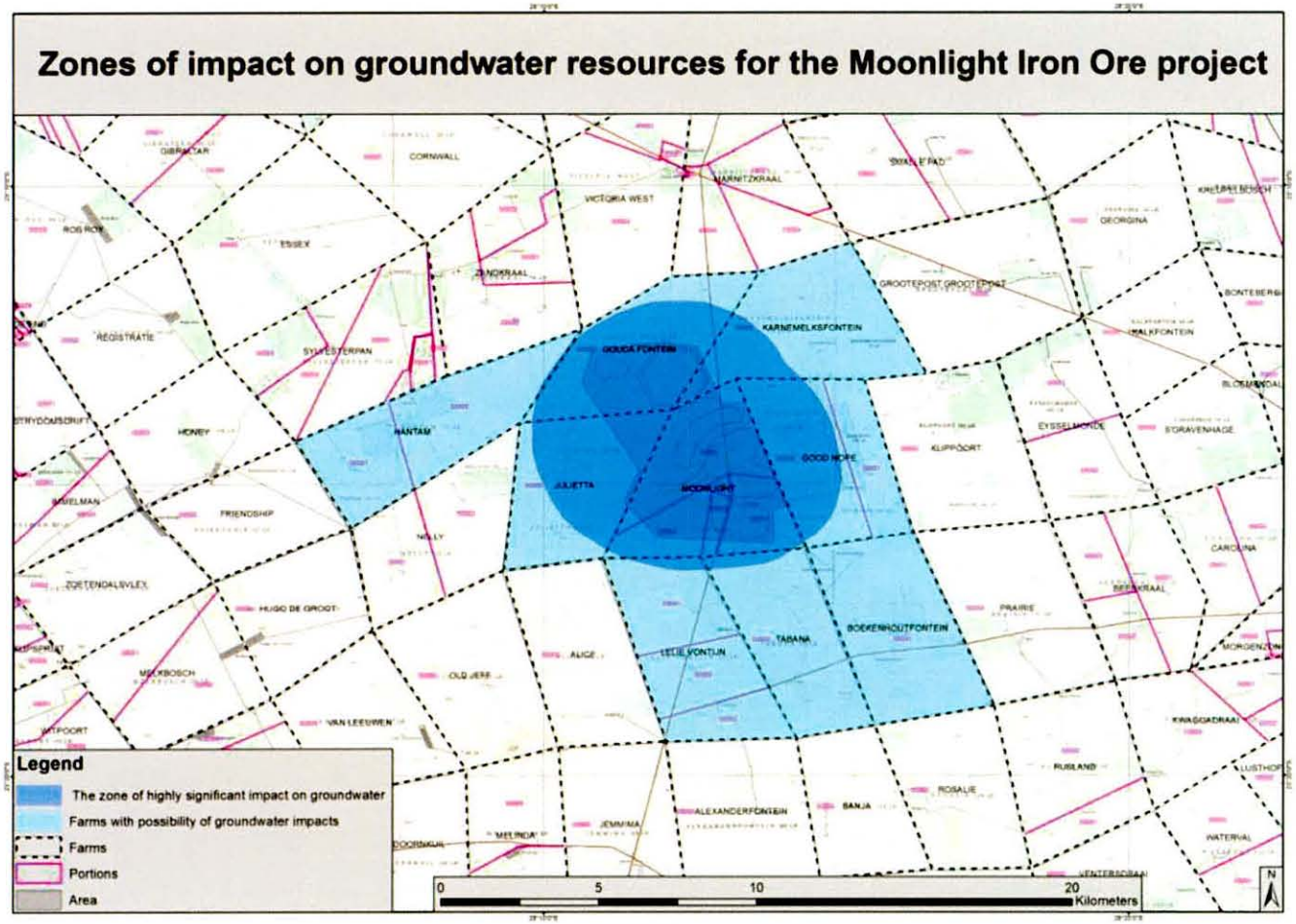

Figure 6: Zones of impact on groundwater resources for the Moonlight Iron Ore project.

From Figure 6 above, all the farms included in the zone of groundwater impact as well as total farm units that is likely to be affected as well, are listed in Table 2 below together with the size of the farm. Of these farms, the proposed project will be located on the farms Julietta, Moonlight and Goudafontein.

Table 2: List of farms to suffer high groundwater impacts

Name of farm	Hectares
MOONLIGHT	1 957
JULIETTA	1 652
HANTAM	1 897
BOEKENHOUTFONTEIN	1 946
GOOD HOPE	1 763
KARNEMELKSFONTEIN	1 899
LELIE VONTIJN	1 913
GOUDA FONTEIN	1 695
TOTAL	**14 723**

7.2 Noise impacts on the land-use of the area

7.2.1 Findings and discussion

During the public participation phase, the farm survey as well as from the Evaluation of Scoping Report 1 Nov 2010 – An evaluation on behalf of the Game Farmers Community of the Koedoesrand Region, 24 January 2011 by Mr. Deon Furstenburg, it was established that there is great concern about the impact of noise generated on the current land use systems. This is especially important to land-users involved with game farming, hunting and the rest of the tourism industry in the area. The following paragraphs were included directly from the specialist report by Dr. Ben van Zyl of Acusolv who conducted the noise impact study.

"Assessment in any scientific noise study of the impact of noise on humans, is based on well defined scientific criteria. Based on decades of statistic data, international and national standards provide consistent guidelines with respect to noise disturbance and community reaction. If the measured or predicted elevation caused by an intrusive noise, such as mining noise, exceeds certain reference levels, the response of humans to such noise can be quantified. The noise contours calculated in this study define ranges of acceptable and significant impact noise as perceived by humans.

When it comes to animals, however, not only are human criteria not applicable at all, but there simply are no national or international standards pertaining to animal response to noise – Not in terms of audibility or disturbance, let alone the effect of noise on their well-being, health or production. It should be pointed out that not even in the case of humans, can the effect of noise on human health be

quantified (except for hearing damage) and no standards or criteria exist in that regard.

It is completely understandable that farmers would be concerned about the effect of general mining or blasting noise on their livestock/game and it may very well be justifiable. But in the lack of standards or criteria, any statements made in the findings and recommendation of a noise study in that regard, would be speculative, unscientific and irresponsible. Hence in this report, we refrain to make any such unfounded statements either confirming or rejecting popular views on the matter."

The report further mentions the following:

"There are no scientific criteria for the assessment of animal response to noise (see Section 2.4.5). The author is not qualified and it is unlikely that any authoritative source exists to comment on or make statements about the absolute or relative impacts on animal behaviour caused by the following sources of noise:

- General mining noise versus the noise of low flying helicopters employed in game counting exercises;
- Blast noise versus gunshot noise to which animals are exposed in hunting.

In the absence of objective criteria, the best alternative that can be suggested for assessing the possible impact of general mining noise on animals is to use the noise contour maps presented in this report as a rough indication. Each map shows a contour of significant impact range based on human hearing and perception. The significant impact range is where mining noise will be clearly

audible above the background noise. As for hunters and visitors on game farms, the contour maps serve as an appropriate measure of noise disturbance impact.

Although animals may have more sensitive hearing, it is conceivable that noise will become audible above the background level at more or less the same threshold. Hence, as far as general mining noise is concerned, for a lack of any other guidelines, it is suggested that the findings with respect to significant impact ranges applicable to humans, be used as a rough indication for animals as well.

The assessment and rating of significant blast noise ranges is much more complex. It should be noted that irrespective of the recipient (human or animal), the contours for general noise shown on the noise maps cannot be used as an indication at all of the audibility or impact of blast noise. Those graphs only have significance and are only meaningful for continuous noise.

A blast becomes clearly audible long before the peak level reaches the acceptability rating. Because of the short duration (only a fraction of a second), the energy spread out over a full daytime period is very small."

From a literature review conducted by the author of this report, one article was found where the impact of traffic noise on the communication of a breeding anuran *Hyla aborea* (a frog) was investigated by Lengange (2008). He found that **traffic noise triggered a decrease of the males' calling activity**, with males being more affected when noise amplitude increased. Additionally, the **males' social** situation (calling in chorus versus alone) exerted a strong influence on sensitivity to noise. He concluded his study by stating that **understanding species' ability to** adapt their communicative systems to cope with human-made noise constitutes an important contribution to wildlife conservation impacts.

Dr. Van Zyl found in the Noise Impact Report that the significant levels of noise impact falls within the 35dBa noise contour which will reach up to 5 km around the proposed mining area that will reduce to 30dBa at 6 km around the site where mining noise seldom exceeds ambient levels. According to his report the noise levels will drop to 20dBa at the 10 km zone which is well below ambient levels and is not expected to have an impact. This 5km zone of impact is indicated in Fig. 7 below:

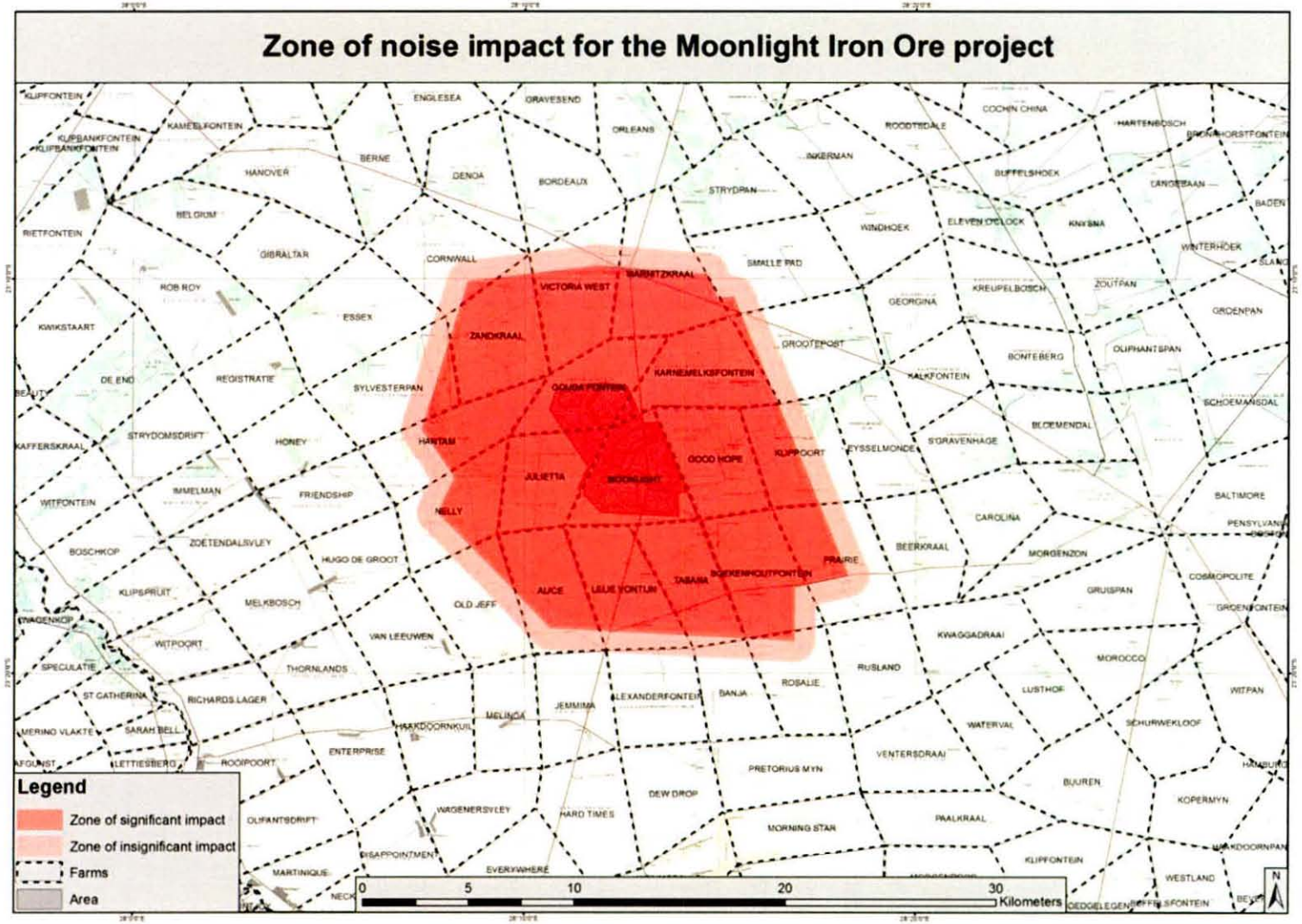

Figure 7: Zone of noise impacts for the Moonlight Iron Ore project

7.2.2 Conclusion on noise impact

All farms within the 5 km zone around the proposed project area will be significantly impacted upon by the noise originating from the mine and its associated activities. No conclusions can be made other than that of the noise impact specialist that suggests a 5 km impact zone. Table 3 shows the farms that will be impacted by high noise levels however it should be noted that the project will be situated on the farms Julietta, Moonlight and Goudafontein.

Table 3: Farms to be affected by high noise levels and the extent of each farm

Name of farm	Hectares
ALICE	1757
BOEKENHOUTFONTEIN	1946
CORNWALL	2001
GOOD HOPE	1763
GOUDA FONTEIN	1695
GROOTEPOST	2358
HANTAM	1897
JULIETTA	1652
KARNEMELKSFONTEIN	1899
KLIPPOORT	1974
LELIE VONTIJN	1913
MARNITZKRAAL	2318
MOONLIGHT	1957
NELLY	1744
OLD JEFF	1896
PRAIRIE	2109
ROSALIE	1564
SMALLE PAD	2319
SYLVESTERPAN	2218
TABANA	1583
VICTORIA WEST	2078
ZANDKRAAL	2013
TOTAL	**42 657**

7.3 Visual impacts

7.3.1 Findings and discussion

The Visual Impact Assessment of the proposed Moonlight Iron Ore Project as compiled by Yonanda Martin and Graham Young was assessed to determine the zone of potential visual impact that the mining project will have on receptors in the surrounding area. It was anticipated that visual impact may have a negative effect on the eco-tourism activities of the area, especially by disturbing the sense of tranquillity that visitors to the area experience. The following set of paragraphs was extracted directly from this report:

"In determining the visibility of the project the 'zone of potential influence' was established and is regarded to be 10km. Over 10km the impact of the proposed activities would have diminished due to the diminishing effect of distance (the project recedes into the background) and atmospheric conditions (haze) on visibility. Also, at this distance the features would appear in the background of a view and thus begin to be 'absorbed' into the landscape setting.

Visual exposure of the project is determined by the proximity of the viewer to the proposed new project component. The impact of an object in the foreground (0 – 0.8km) is greater than the impact of that same object in the middle ground (0.8km – 3km) which, in turn is greater than the impact of the object in the background (greater than 3km) of a particular scene. Therefore the visibility and visual exposure for viewers within 0.8km of the proposed project will be high, for viewers between 0.8km and 3km it will be moderate and beyond 3km it will be low.

The proposed Project will be visible from approximately 70% of the 'zone of potential influence'. It is clear from the viewshed analysis that the proposed site has a slightly rolling topography which assists in screening the view from areas within the 'zone of potential influence'. The proposed Project is screened from views along the N11 which is located towards the north and the north-east of the project site. The site is also screened from areas located to the west and south-west of the proposed Project site.

The proposed Project falls within the foreground view for viewers that will travel on the local road between Marnitz and Melinda and will therefore have a high visibility. The proposed Project will however be partially obstructed for viewers travelling along this road as the vegetation along the road forms a dense vegetation screen. This will result in a moderate visibility. The Project will become highly visible once you are travelling next to the site or approach the entrance of the mine. The only farmstead within this zone is the farmstead located on the Farm Moonlight, which is assumed will not be used as a residential unit as it falls within the footprint of the proposed Project.

The proposed Project falls within the middle-ground view for viewers from the Moonlight & Good Hope Lodge, which is located to the east of the proposed site. Views towards the Project will however be mostly obstructed or totally screened due to the dense vegetation cover and will therefore have a low visibility.

The proposed Project will fall in the background view for viewers from the Hunters Dream Lodge and farmsteads located to the west and north-west of the proposed site. The visibility will therefore be low and could even become insignificant. The proposed Project will not be visible for viewers from Marnitz as views will be screened by the natural topography and dense vegetation screen.

The Project will also not be visible for viewers from the villages located towards the west, south-west and south of the site as these villages are located 10km and beyond and the vegetation of the area forms a vegetation screen. Due to the dense vegetation cover and the slightly rolling topography the proposed Project is screened from most of the viewers travelling on the local roads within the study site as well as in the surrounding area.

During closure the proposed Project will be less visible as structures will be removed. There are however structures such as the TSF and the WRS that will remain on site. If the TSF and the WRS remains on site and is not rehabilitated successfully the visibility will remain high especially for people travelling on the local roads. The visibility can however be reduced if successfully rehabilitated. It is also suggested that as much of the mining structures and dumps (TSF and WRS) be removed as possible as it could decrease the visibility of the project after closure.

The proposed Project will have a significant impact after sunset. The study area is currently exposed to the impact of lights from the farmsteads, game lodges and the small villages. The lights from the mining activities will light up the area after sunset and will be more visible over a longer distance; it will therefore have a **visual impact beyond the 'zone of potential influence'.**"

From the report it was found that all lodges, farmsteads, local roads and possibly villages, will have some level of visual impact ranging from high to low up to a distance of 10 km around the project area. The report also classified the sensitivity of different groups of land-users to the visual impacts anticipated. The most sensitive users that will experience the visual impact as highly negative are the following:

- Users of all outdoor recreational facilities including public rights of way (tourist routes), whose intention or interest may be focused on the landscape;
- Communities where the development results in changes in the landscape setting or valued views enjoyed by the community;
- Occupiers of residential properties with views affected by the development.

During the farm survey and communications with land-owners it was clear that a very large percentage of the community surrounding the project area enjoy the peaceful scenery and atmosphere of the region. Some land-owners have indicated that they bought the property with retirement in mind and that they are opposed to the disturbance of this atmosphere. It is also feared by owners of hunting lodges and other accommodation facilities that visual impacts will scare tourists from cities away which choose their facilities to experience peace and tranquillity during their stay there.

7.3.2 Conclusion on the influence of visual impacts on land use

Due to a part of land-users in the area being dependent on some form of tourism including hunting or eco-tourism as a form of income, the visual impacts on the proposed project may have a negative influence on land-use in the area. It may reduce the number of local and overseas hunters that visit area due to the sense of place being affected by the presence of the mine. Land-users neighbouring the project area and within a 0.8 km zone around it will suffer most for the mine and its activities will be highly visible from here. The farms present in this area include:

- Moonlight
- Julietta
- Goudafontein
- Karnemelksfontein
- Good Hope

Should the main focus of their land-use be eco-tourism or hunting, it is most likely that it will be lost completely. This would either result in them leaving the property for the current land use would become unviable or shifting the focus of facilities to accommodation of mine employees.

Farms in the zones of medium (up to 3km away from project) and low (up to 10km away from project) impact may have reduced visits from hunters and eco-tourists due to the visibility of the project from where they stay and/or hunt. Some loss of income in this area is deemed likely and should be determined.

Whether land-use will be severely affected by visual impact is highly debatable. Visual impacts will however not impact on the productivity/carrying capacity of the land, although it may negatively impact on the hunting and tourism industry of the area, the accommodation facilities can be rent out to employees of the mine on a more permanent base than is currently possible. There will be a negative impact on land users who fall within the zones of impact and that bought the property in this area for the purpose of retirement for the sense of place will be changed.

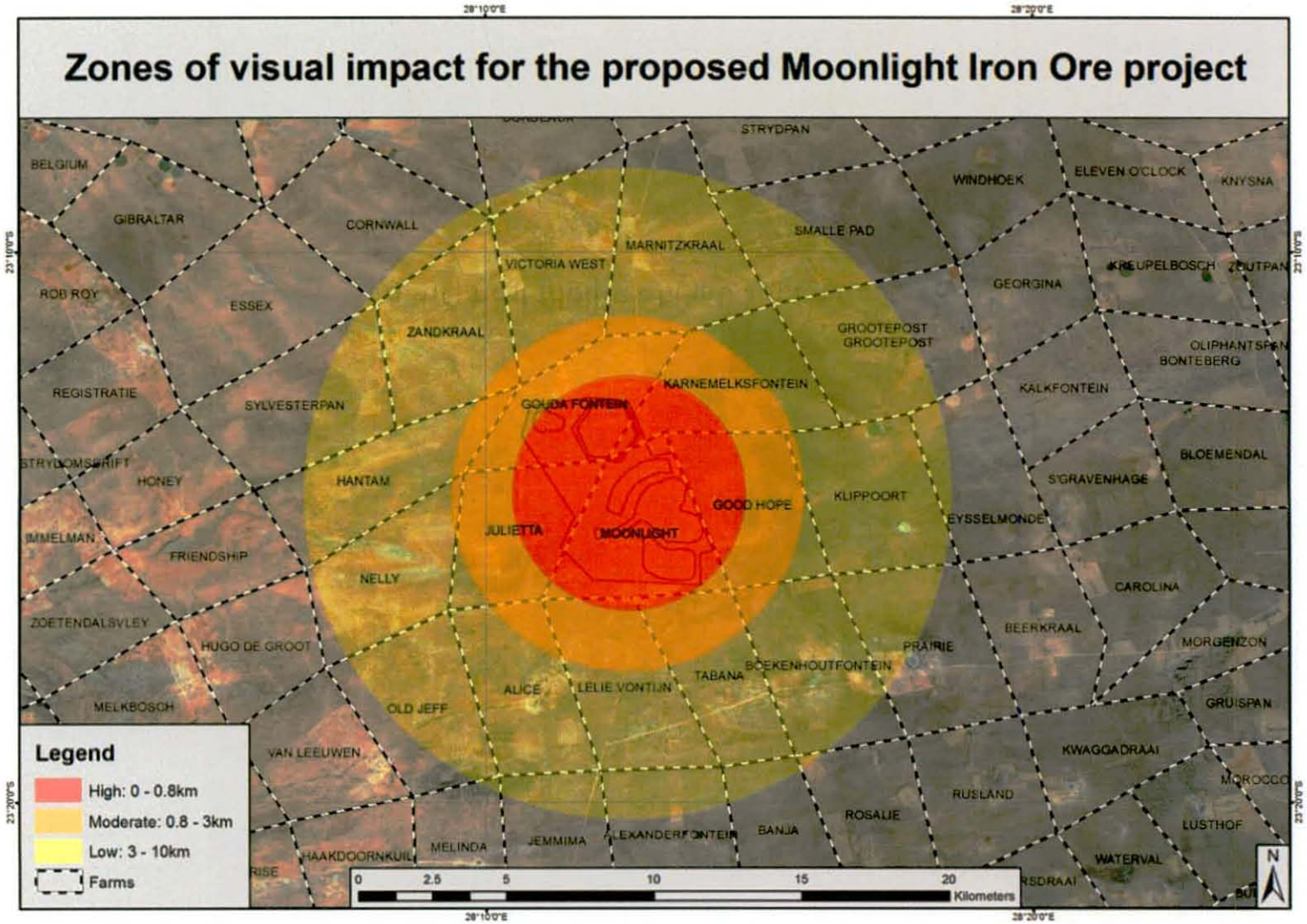

Figure 8: Zones of visual impacts for the proposed Turquoise Moonlight Iron Ore project

7.4 Air quality impacts

7.4.1 Findings and discussion

Assessment of the report by Mr. D. Furstenburg revealed concern about the effect that negative air quality impacts will have on animal and vegetation health of the area. The following was Mr. Furstenburg's concern:

"Depletion of quantity and quality of natural pasture and grazing for animal consumption due to air pollution, dust, acid rain and outfall of heavy metals and phosphates. The unpalatability and avoidance of grazing due to dust outfall and heavy metal lead outfall from low speed (30-55 km/hour) tourist vehicles in the Kruger National Park has been proved significantly by science. Heavy duty hauling trucks and wind storms running across the stock piles, and fast racing (uncontrollable taxis) will create far more outfall than tourist vehicles. Acid rain, phosphates and heavy metals are amongst the chemicals that are potentially hazardous in effecting body growth, animal bone structure and trophy development. Trophy development is the major marketing produce of game ranching."

These concerns were addressed by Liebenberg-Enslin and Grobler (2011) in the Air quality impact assessment for the proposed Moonlight Iron Ore mine, Limpopo Province - Report No.: APP/10/MEE-14 Rev 0. Below follows a direct quotation from their report on the effects of dust on vegetation:

"Suspended particulate matter can produce a wide variety of effects on the physiology of vegetation that in many cases depend on the chemical composition of the particle. Heavy metals and other toxic particles have been shown to cause damage and death of some species as a result of both the phytotoxicity and the abrasive action during turbulent deposition (Harmens et al, 2005). Heavy loads of particle can also result in reduced light transmission to the chloroplasts and the occlusion of stomata (Harmens et al, 2005; Naidoo and Chirkoot, 2004, Hirano et al, 1995, Ricks and Williams, 1974), decreasing the efficiency

of gaseous exchange (Harmens et al, 2005; Naidoo and Chirkoot, 2004, Ernst, 1981) and hence water loss (Harmens et al, 2005).

They may also disrupt other physiological processes such as budbreak, pollination and light absorption/reflectance (Harmens et al, 2005). The chemical composition of the dust particles can also affect the plant and have indirect effects on the soil pH (Spencer, 2001).

To determine the impact of dust deposition on vegetation, two factors are of importance:
(i) Does dust collect on vegetation and if it does, what are the factors influencing the rate of deposition
(ii) Once the dust has deposited, what is the impact of the dust on the vegetation?

Regarding the first question, there is adequate evidence that dust does collect on all types of vegetation. Any type of vegetation causes a change in the local wind fields, with an increase in turbulence which enhances the collection efficiency. The characteristics of the vegetation influences the rate; the larger the "collecting elements" (branches and leaves), the lower the impaction efficiency per element. This would seem to indicate that, for the same volume of tree/shrub canopy, finer leaves will have a better collection efficiency.

However, the roughness of the leaves themselves and particularly the presence of hairs on the leaves and stems play a significant role, with veinous surfaces increasing deposition of 1-5 micron particles by up to seven times compared to smooth surfaces. Collection efficiency rises rapidly with particle size; for moderate wind speeds wind tunnel studies show a relationship of deposition velocity on the fourth power of particle size (Tiwary and Colls 2010).

In wind tunnel studies, windbreaks or "shelter belts" of three rows of trees has shown a decrease in 35 to 56% in the downwind mass transport of inorganic particles. On the effect of particulate matter once it is deposited on vegetation, this depends on the composition of the dust. South African ambient standards are set in terms of PM10 (particulate matter

smaller than 10 µm aerodynamic diameter) but internationally it is recognised that there are major differences in the chemical composition of the fine PM (the fraction between 0 and 2.5 µm in aerodynamic diameter) and coarse PM (the fraction between 2.5 µm and 10 µm in aerodynamic diameter).

The former is often the result of chemical reactions in the atmosphere and may have a high proportion of black carbon, sulphate and nitrate, whereas the latter often consist of primary particles resulting from abrasion, crushing, soil disturbances and wind erosion (Grantz et al. 2003). Sulphate is however often hygroscopic and may exist in significant fractions in coarse PM. This has been shown to be the case in South Africa, where the sulphate content of PM10 at the Eskom measuring station at Elandsfontein has been shown to have between 15% (winter) and 49% (spring) sulphate (Alade 2009). Grantz et al (op .cit.) do however indicate that sulphate is much less phototoxic than gaseous sulphur dioxide and that "it is unusual for injurious levels of particular sulphate to be deposited upon vegetation".

Naidoo and Chirkoot conducted a study during the period October 2001 to April 2002 to investigate the effects of coal dust on Mangroves in the Richards Bay harbour. The investigation was conducted at two sites where 10 trees of the Mangrove species: *Avicennia Marina* were selected and mature, fully expose, sun leaves tagged as being covered or uncovered with coal dust. From the study it was concluded that coal dust significantly reduced photosynthesis of upper and lower leaf surfaces. The reduced photosynthetic performance was expected to reduce growth and productivity. In addition, trees in close proximity to the coal stockpiles were in poorer health than those further away.

Coal dust particles, which are composed predominantly of carbon were found not to be toxic to the leaves; neither was it found occluding stomata as these particles were larger than fully open stomatal apertures (Naidoo and Chirkoot, 2004).

In general, according to the Canadian Environmental Protection Agency (CEPA), air pollution adversely affects plants in one of two ways. Either the quantity of output or yield is

reduced or the quality of the product is lowered. The former (invisible) injury results from pollutant impacts on plant physiological or biochemical processes and can lead to significant loss of growth or yield in nutritional quality (e.g. protein content). The latter (visible) may take the form of discolouration of the leaf surface caused by internal cellular damage. Such injury can reduce the market value of agricultural crops for which visual appearance is important (e.g. lettuce and spinach). Visible injury tends to be associated with acute exposures at high pollutant concentrations whilst invisible injury is generally a consequence of chronic exposures to moderately elevated pollutant concentrations.

However given the limited information available, specifically the lack of quantitative dose-effect information, it is not possible to define a Reference Level for vegetation and particulate matter (CEPA, 1998). Exposure to a given concentration of airborne PM may therefore lead to widely differing phytotoxic responses, depending on the mix of the deposited particles. The majority of documented toxic effects indicate responses to the chemical composition of the particles. Direct effects have most often been observed around heavily industrialised point sources, but even there, effects are often associated with the chemistry of the particulate rather than with the mass of particulate."

The report authors' response about potential dust effects on animals were as follow:

"Most of the literature regarding air quality impacts and animals, specifically cattle, refers to the impacts from feedlots on the surrounding environment, hence where the feedlot is seen as the source of pollution. This mainly pertains to odours and dust generation. The US.EPA has recently started to focus on the control of air pollution from feed yards and dairies, primarily regulating coarse particulate matter (http://www.vetcite.org/publish/items/000944/index.html). The National Cattle Beef Association in the USA in response has disputed this decision based on the lack of evidence on health impacts associated with coarse dust (TSP) concentrations (http://hill.beef.org/newview.asp?DocumantID=16319).

A study was conducted by the State University of IOWA on the effects of air contaminants and emissions on animal health in swine facilities. Air pollutants included gases, particulates, bioaerosols, and toxic microbial by-products. The main findings were that ammonia is associated with lowered average number of pigs weaned, arthritis, porcine stress syndrome, muscle lesions, abscesses, and liver ascarid scars. Particulates are associated with the reduction in growth and turbine pathology, and bioaerosols could lower feed efficiency, decrease growth, and increase morbidity and mortality.

The study concurred the lack of information on the health effects and productivity problems of air contaminants on cattle and other livestock. Ammonia and hydrogen sulphide are regarded the two most important inorganic gases affecting the respiratory system of cattle raised in confinement facilities, affecting the mucociliary transport and alveolar macrophage functions. With regard to particulates, it was found that it is the fine inhalable fraction is mainly deriving from dried faecal dust (Holland et al., 2002).

Another study conducted by DSM Nutritional Products North America indicated that calves exposed to a dust-stress environment continued to have lower serum vitamin E concentration (http://www.dsm.com/enUS/html/dnpus/antexasstudy.htm).

Inhalation of confinement house dust and gases produces a complex set of respiratory responses. An individual's response depends on characteristics of the inhaled components (such as composition, particle size and antigenicity) and of the individual's susceptibility, which is tempered by extant respiratory conditions (http://www.cdc.gov/nasd/docs). Most of the studies concurred that the main implication of dusty environments are causing animal stress which is detrimental to their health. However, no threshold levels exist to indicate at what levels these are having a negative effect. In this light it was decided to use the same screening criteria applied to human health, i.e. the South African Standards and SANS limit values (Section 3)."

From reviewing the Air Quality Impact Assessment it was established that air pollution by dust particles (PM10) are perceived to be the highest impact on air quality levels. This report pointed out that significant impact will be up to 2.5 km beyond the boundaries of the project to the north-east of this site. The zone of potential impact by dust particles is indicated in Figure 9 below.

7.4.2 Conclusion on the effect of air quality impacts on land use

Although research has proved that there is a negative effect of air pollution (dust particles in this case) on the growth and function of plants and animals, no standards does yet exist by which zones of detrimental effects can be determined. As pointed out by the air quality specialists, the same criteria used for human health was used to determine a possible zone of air quality impact.

The air quality levels up to the boundary of the project site may negatively influence the animals on the land. However, this zone of impact is also overlapped by the zones of groundwater, noise and visual impact and does not affect any farm that is not already included in this list. Air quality will therefore not be the determining factor as to where current land use will be lost.

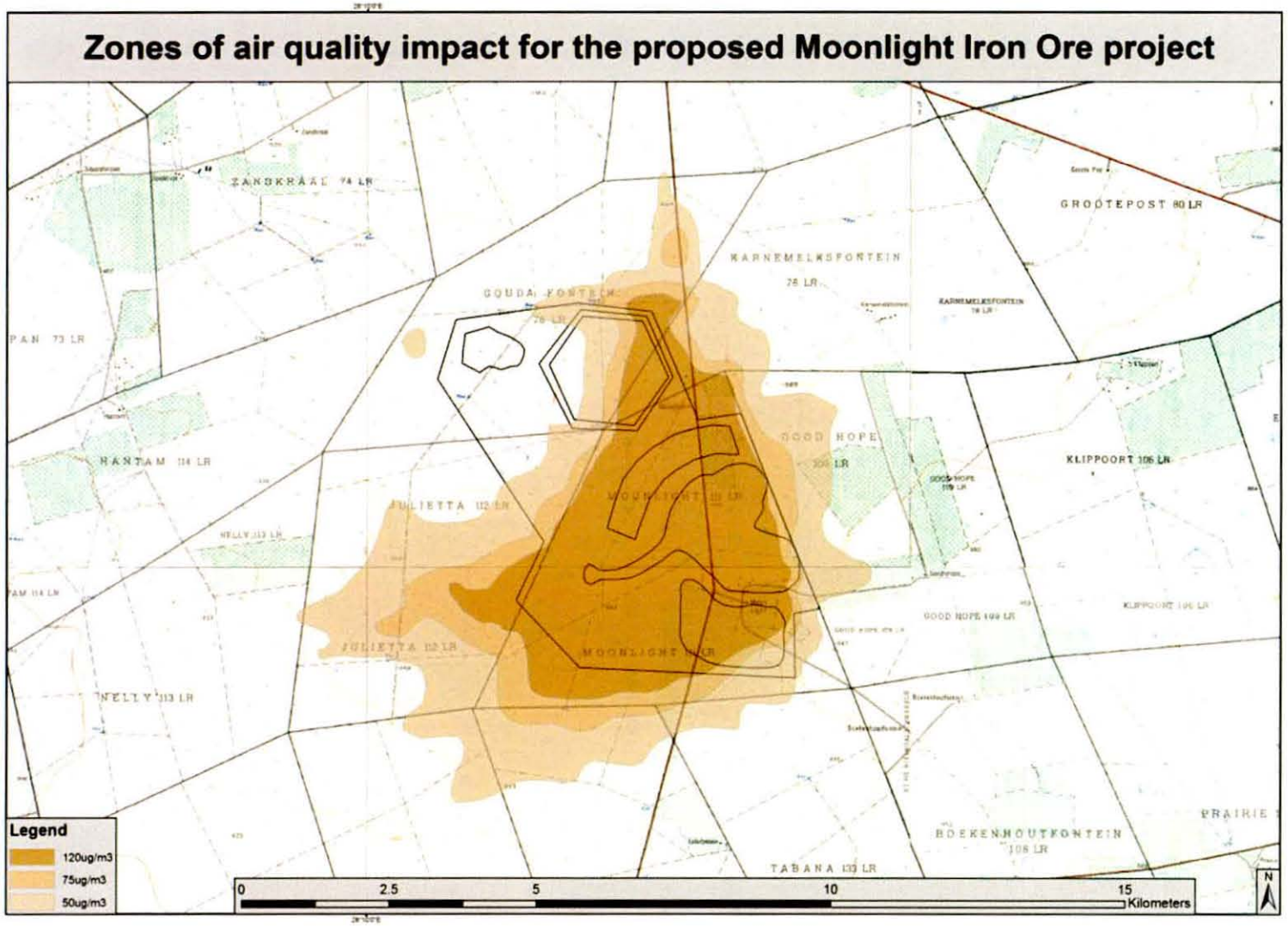

Figure 9: Zones of air quality impact for the proposed Moonlight Iron Ore project

8. CONCLUSION

The impact on groundwater resources are considered to be the most serious impact that will result in the most detrimental effect on current land use beyond site boundaries. No land-user will be able to continue with current cattle and game farming enterprises once the groundwater resources have diminished or disappeared. Therefore groundwater impacts will be the overriding factor in determining the impact on each specific farm and are viewed by the author of this report to be more important than impacts on noise and air quality levels, visual impacts from the mine as well traffic impacts on the roads.

All farms within the 5 km zone around the proposed project area will be significantly impacted upon by the noise originating from the mine and its associated activities. No conclusions can be made other than that of the noise impact specialist that might suggest impact the 5 km zone.

Farms in the zones of medium (up to 3km away from project) and low (up to 10km away from project) impact may have reduced visits from hunters and eco-tourists due to the visibility of the project from where they stay and/or hunt. Whether land-use will be severely affected by visual impact is highly debatable. No impact on land productivity or carrying capacity is deemed likely to occur although it may negatively impact on the hunting and tourism industry of the area, the accommodation facilities can be rent out to employees of the mine on a more permanent base than is currently possible. There will be a negative impact on land users who fall within the zones of impact and that bought the property in this area for the purpose of retirement for the sense of place will be changed.

Although research has proved that there is a negative effect of air pollution (dust particles in this case) on the growth and function of plants and animals, no

standards does yet exist by which zones of detrimental effects can be determined. As pointed out by the air quality specialists, the same criteria used for human health was used to determine a possible zone of air quality impact.

The air quality levels up to the boundary of the proposed project site around may negatively influence the animals on the land. However, this zone of impact is also overlapped by the zones of groundwater, noise and visual impact and does not affect any farm that is not already included in this list. Air quality will therefore not be the determining factor as to where current land use will be lost.

Impacts on groundwater resources by the Moonlight Iron Ore project will have the most significant negative impact on land use of farms in and around the project area. Loss of groundwater resources on a farm will result in the farm not being able to function at all and the current land use on such farms will be completely lost for the duration of the mine (30 years) as well as the period thereafter that until recharge of the groundwater resources takes place, if at all. Although other impacts were quantified for the project such as air quality, noise pollution and visual impact, these impacts will not result in total loss of land use (Figure 11). The farms to be affected by groundwater impacts and may suffer partial or total loss of land use are listed in Table 4. Table 5 and figure 11 provide summaries of the cumulative impact on land use in the area surrounding the Moonlight Iron Ore project area.

Table 4: Farms and Farm Portions affected by loss of groundwater and associated surface area

Name of farm	Hectares
MOONLIGHT	1 957
JULIETTA	1 652
HANTAM	1 897
BOEKENHOUTFONTEIN	1 946
GOOD HOPE	1 763
KARNEMELKSFONTEIN	1 899
LELIE VONTIJN	1 913
GOUDA FONTEIN	1 695
TOTAL	**14 723**

Table 5: Impact rating of different aspects on farms in and surrounding the project area

Name of farm	Hectares	Groundwater Impact	Noise Impact	Visual Impact	Air Quality Impact	Impact on current land use
ALEXANDERFONTEIN	1 729	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
ALICE	1 757	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
BANJA	1 268	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
BEERKRAAL	1 681	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely
BOEKENHOUTFONTEIN	1 946	High	High	Medium to Low	Low/Unlikely	High
BORDEAUX	1 960	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
CORNWALL	2 001	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
ESSEX	2 505	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
EYSSELMONDE	1 686	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
GENOA	1 777	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely
GOOD HOPE	1 763	High	High	High to Low	Low/Unlikely	High
GOUDA FONTEIN	1 695	High	High	High to Medium	High	High
GROOTEPOST	2 358	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
HANTAM	1 897	High	High	Medium to Low	Low/Unlikely	High
HUGO DE GROOT	1 438	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely
JEMMIMA	1 620	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
JULIETTA	1 652	High	High	High to Low	High	High
KARNEMELKSFONTEIN	1 899	High	High	High to Low	High	High
KLIPPOORT	1 974	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
LELIE VONTIJN	1 913	High	High	High to Low	Low/Unlikely	High
MARNITZKRAAL	2 318	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
MELINDA	1 425	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
MOONLIGHT	1 957	High	High	High	High	High
NELLY	1 744	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
OLD JEFF	1 896	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
PRAIRIE	2 109	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
ROSALIE	1 564	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
RUSLAND	1 750	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely	Low/Unlikely
SMALLE PAD	2 319	Low/Unlikely	High	Low	Low/Unlikely	Low/Unlikely
STRYDPAN	1 774	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
SYLVESTERPAN	2 218	Low/Unlikely	Low/Unlikely	Low	Low/Unlikely	Low/Unlikely
TABANA	1 583	Low/Unlikely	High	High to Low	Low/Unlikely	Low/Unlikely
VICTORIA WEST	2 078	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
ZANDKRAAL	2 013	Low/Unlikely	High	Medium to Low	Low/Unlikely	Low/Unlikely
TOTAL	**63 269**					

10. RECOMMENDATIONS

Where possible individual impacts on the environment should first be mitigated to either prevent or minimise the impact. However, some impacts such as that of the groundwater depletion in a 3 km zone around the project area, cannot successfully be mitigated by the supply of water from external sources for although it may supply the volumes currently provided by boreholes, it will be very difficult to replenish groundwater stored by soil that feed plant roots and sustain vegetation. These groundwater impacts will change the land use and negatively affect the economic activity of the farm. It is highly recommended that the mine develop a stringent and comprehensive groundwater and grazing capacity monitoring program to monitor impacts on the surrounding land parcels and that the mine develop a compensation plan to compensate the affected landowners for the loss of their current land use where the economic activity is no longer viable due to mine-related activities.

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Legislation

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Conservation of Agricultural Resources Act No. 43 of 1983

National Environmental Management Act No. 107 of 1998

Appendix 1: CV of report author

CURRICULUM VITAE OF MARINÉ PIENAAR

Name of staff	**Marinè Pienaar**
Date of Birth	**25 July 1982**
Nationality	**South African**
Address	**P.O. Box 433, Ottosdal, 2610**
Contact details	**018-5713005** **086 558 7478** **082 828 3587** **mpienaar@terraafrica.co.za**
Language	**Fluent in English, Afrikaans, French and Spanish**
Computer literacy	**Fully literate in all the Microsoft Office programs as well as ArcGIS 9**
Professional affiliation	**South African Council for Natural Scientific Professions (SACNASP) – Reg. no. 400274/10**

ACADEMIC QUALIFICATIONS

2001 - 2004	**:**	**BSc. (Agric) Horticulture**
2005 - 2009	**:**	**Environmental Management Systems ISO 14001:2004** **Environmental Law** **Environmental Impact Assessment** **Landscape Design Diploma – Garden Design Institute, UK**
2006 – 2011 currently	**:**	**MSc. Agric. (Horticulture) (University of Pretoria – being completed)**
2010 – 2011		**MSc. Environmental Science (University of the Witwatersrand - currently being completed)**

Her major subjects were: Soil Science, Horticulture, Agricultural Economy, Land-Use Planning, Irrigation, Plant Breeding Genetics, Crop Production, Agronomy, Crop Physiology, Plant Pathology, Climatology, and Biometry.

Subjects for the MSc (Env. Sci). include: Environmental Impact Assessment, Waste Water Engineering, Environmental Management, Climate and Society, Wetlands and Sedimentology, Energy and the Environment.

Topic of dissertation (MSc. Env. Sci.): Are leguminous plants currently fixing nitrogen on gold and uranium tailings?

Topic of dissertation (MSc. Agric.): The drought response of three landscape rose cultivars

ASSOCIATION MEMBERSHIP:

- IAIA (International Association for Impact Assessment)
- SASCP (South African Society for Crop Production)
- SASSO (South African Soil Surveyors Organisation)
- SAAGA (South African Avocado Growers Association)

COURSES ATTENDED AND SUCCESSFULLY COMPLETED:

- Hydrus 1D, 2D and 3D-Modelling – modelling of soil-water-leachate movement in saturated and unsaturated conditions
- Project Management
- Wetland Rehabilitation
- Environmental Impact Assessment – A practical approach
- Environmental Management Systems – ISO 14001:2004
- Environmental Law
- Presentation and Sale Skills
- Landscape Design

UPCOMING COURSES THAT WILL BE ATTENDED:

- AVCASA
- Enviropreneur Institute at Montana State University, U.S.A.
- Auditor's Course for Carbon Footprint Auditing
- Youth Encounter on Sustainability 2011, Switzerland

EMPLOYMENT RECORD

2002 – 2004	:	University of Pretoria – Research Assistant
2005 – 2006	:	Omnia Fertilizer – Horticulturist and Soil Scientist
2006 – 2009	:	Self-employed – Land-use specialist
2010 – 2011	:	MSc. Environmental Science (Wits) while part-time consulting

EMPLOYMENT EXPERIENCE

January 2002 – December 2004

- Assisted crop researchers in the R&D Department with trials, reporting on results and incorporating it on the information system.
- Statistical analysis and interpretation of results
- Developing new technology to assist rural farming in the Agricultural Industry.
- Managing daily activities on behalf of the Mispah Trust.

January 2005 – June 2006

- Working as a GIS specialist with spatial programmes such as ArcGIS 9 to create precision farming data and mapping.
- Interpretation of chemical soil analysis and soil classification.
- Statistical analysis of fruit quality data and exports.
- Research on NDVI and NDVI instruments on a institutional level.
- Liaison with other Omnia horticulturalists in fruit producing areas in the country in solving production-related problems.
- Coordinated and finalized research on nutrient requirements for tropical fruits to assist problem solving and nutrition recommendations for farmers in Western Cape.
- Interpretation of water, soil, leaf and sap analysis.

June 2006 – to Date

- Agricultural consultation on plant nutrition and integrated farm management
- Conducting physical and chemical soil classification projects
- Environmental impacts assessments, water-use licenses, mining permits and environmental auditing.
- Compiling comprehensive reports relating to agricultural investigations for environmental impact assessments.
- Agricultural planning for the redistribution projects in Gauteng area.
- Coordinating teams conducting land use studies.
- Coordinating skill transfers for LED Projects.
- Facilitate arbitration between mines and land-owners on remuneration issues.
- Compile land rehabilitation plans for polluted or physically disturbed soil.

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Involvement in special projects during last 3 years :

Batsamaya Mmogo, Hartswater

Conducted a soil and water assessment for the farm and compiled management and farming plans for Boer goats grazing on *Sericea lespedeza* with pecan nuts and lucerne under irrigation.

Akwavaal Boerdery
Conducted a EIA for the construction of additional broiler houses on the farms of Akwavaal Boerdery, Zeerust. Environmental authorization was granted.

Exxaro Glisa Colliery
Conducted the specialist soil and land capability study on the farm Paardeplaats where the Exxaro Glisa Colliery is situated. The project included the compilation of a soil management and rehabilitation plan.

Blinkklip Diamante
Facilitated the complete mining application to DMR for the mining rights of alluvial diamonds including the environmental management program, public participation as well rehabilitation plan and environmental control.

Zeerust Chrome Mine
Conducted an independent land value and rehabilitation status assessment as part of the arbitration process between the land owner and the mine to solve remuneration and closure issues.

Oersonskraal
Represented a group of farmers on whose land unlawful prospecting applications rights were in the process of being granted. Part of the strategy was an agricultural potential study as well as investigation into the false information presented in the environmental management plan by the applicants of the prospecting rights. The result of this process was the rights not being granted.

Anglo Platinum Twickenham Mine – Irrigated Cotton Project
Project management of an irrigated cotton production project for Twickenham Platinum Mine. This project will ensure that the community benefit from the excess water that is available from the mine activities.

Soil study and problem analysis for Anglo Platinum at Twickenham Mine
Independent evaluation of soil conditions and problematic crop growth in existing community vegetable gardens to determine whether the mine has any liability for production decline.

Soil study and business plans for agricultural development at Anglo Platinum's Twickenham Mine
Conducted a soil survey to determine the potential of the area for irrigated agricultural production with excess water produced by the mine. After conclusions were made on the environmental factors, a detailed business plan were provided for irrigated cotton production, a community ornamental nursery, landscaping around the mine offices and infrastructure as well as sport fields for the community.

Area-based agricultural business plans for municipalities in Dr. Kenneth Kaunda Municipal District
Evaluation of the agricultural and environmental status of the total district as well as for each municipality within the district. This included the critical evaluation of current agricultural projects in the area. The writing of sustainable, executable agricultural business plans for different agricultural enterprises to form part of the land reform plans of each Municipality within the district.

Bekkersdal Urban Renewal Project – Farmer Support Programme
Independent consultation on the farmer support programme that forms part of Bekkersdal Renewal Project. This entailed the production of short and long term business plans based on soil and water research conducted. Part of responsibilities were the evaluation of current irrigation systems and calculation of potential water needs, etc. as well as determining quantities and prices of all project items to facilitate the formalisation of tender documents.

Ellisras
Soil and agricultural survey on 23 000 ha (32 farms) to determine the potential impact that the construction of power stations by Eskom will have. Physical and chemical soil analyses were conducted. Land-use capability and suitability for development was determined.

Botswana (Limpopo-Lipadi Game Reserve)
Soil research study on 36 000 ha on the banks of the Limpopo River. This soil study forms part of an environmental management plan for the Limpopo-Lipadi Game Reserve situated here as well as the basis for the Environmental Impact Assessment for the development of lodges in this area.

Booysendal (Steelpoort)
Soil, agricultural potential and land suitability study of the Booysendal farm for Northam Platinum Mine Group. The study included the calculation of soil volumes for stockpiling, stripping, etc. as well as a soil rehabilitation plan.

Union Mine Pipeline
Investigation for Union Mine on the impact of a new sewer pipeline that included a soil and land-use study.

Waterberg Estate
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural Impact assessment. Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water (2000ha).

Bulhoek & Vaalkop
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural Impact assessment. Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water. Summarising the occurrence and frequency of plants growing in the area (450ha).

Rietvallei Phase 1
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural Impact assessment. Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water (48ha).

Rietvallei Phase 2
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural assessment. Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water (37ha).

Hartebeesfontein
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural assessment. Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water (240ha).

Mimosa Development
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural assessment for a local economic development project (LED). Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water (220ha).

Paardeplaats
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural assessment. Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water (35ha).

Orchards
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural assessment. Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water (40ha).

Townlands Development
Investigating and classifying key agricultural aspects which would assist in the delivering of a thorough Agricultural assessment. Focusing especially on the classification of viable agricultural soil, existing infrastructure and the availability and quality of water (25ha).

Appendix 2: Report from peer review author

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TERRASOIL SCIENCE

Contact person	PS Rossouw
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E-mail:	ps@terrasoil.co.za

1. TERMS OF REFERENCE

Me Marinè Pienaar, Terra Africa Concult cc, requested Terra Soil Science cc to peer review a document prepared for Metago (Pty) Ltd. The report is titled *LAND-USE ASSESSMENT OF THE PROPOSED MOONLIGHT IRON ORE MINING OPERATION* and dated May 2011. Terra Africa Consult compiled the report in association with Aquatic Scientific Services cc.

2. FEEDBACK ON THE REPORT

Terra Soil Science must commend me Pienaar on the quality of the report. Concepts are well defined and background information is given to inform the reader and to elaborate on approaches, findings etc.

It is especially noteworthy that "assumptions and limitations of the study" are listed. This shows confidence and places certain findings into perspective. Many consultants tend to disguise uncertainties and this often brings about expectations, on the client's side, that can later not be met.

The report incorporates the views and findings of the specialists (i.e. groundwater, vegetation, noise impact etc.) in a balanced and objective manner. The tiered approach "with more focus placed on farm units closer to the proposed mining site than areas further away" that was followed in this study is a novel approach and serves the aims of the study well.

The report addresses the stated aims in a responsible and scientifically sound way and this report can be regarded as an example of a thorough study and well thought out study.

PS Rossouw
MSc. Agric. Soil Science

Member of:

Soil Science Society of South Africa
Soil Surveyors Organisation of South Africa

Johan van der Waals PhD (Pret), Pr.Sci.Nat.
Company registration number: CK2007/052375/23 Vat No: 4020241586

APPENDIX Q: HERITAGE (INCLUDING CULTURAL ASPECTS) STUDY

Specialist report prepared by Dr Julius Pistorius, January 2011

Prepared for:

METAGO ENVIRONMENTAL ENGINEERS

TURQUOISE MOON TRADING 157 (PTY) LTD

A PHASE I CULTURAL-HERITAGE IMPACT ASSESSMENT STUDY FOR THE MOONLIGHT AND DE LOSKOP IRON ORE PROJECT IN THE LIMPOPO PROVINCE OF SOUTH AFRICA

Prepared by:

Dr Julius CC Pistorius

Archaeologist and Heritage Consultant

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January 2011

Member ASAPA

Executive Summary

A Phase I Cultural-Heritage Impact Assessment (HIA) study as required in terms of Section 38 of the National Heritage Resources Act (Act 25 of 1999) was done for Turquoise Moon Trading 157 (Pty) Ltd's Moonlight Iron Ore Project on several farms near Marnitz in the Limpopo Province of South Africa.

The aims with the Phase I HIA were the following:

- To establish whether any of the types and ranges of heritage resources ('national estate') as outlined in Section 3 of the National Heritage Resources Act (Act 25 of 1999) do occur in the Project Area.
- To determine the significance of these heritage resources and whether they will be affected by the iron ore mine.
- To propose mitigation measures for those heritage resources that may be affected by the proposed iron ore mine.

The Phase I HIA study revealed the following types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999) in the Project Area, namely:

- A residence with historical significance.
- Formal and informal graveyards, some of which hold historical significance.

The heritage resources were geo-referenced and mapped (Figure 3, Tables 1 & 2). The significance of these heritage resources is indicated whilst mitigation measures are outlined for those heritage resources which may be affected by the Moonlight Project.

The significance of the heritage resources

The Historical House (HH01) and graveyards (GY01 to GY03) in the Project Area may be affected by the Moonlight Project. The significance of these heritage resources therefore is indicated by means of stipulations derived from the National Heritage Resources Act (No 25 of 1999) and from specific criteria relating to the significance of the heritage resource that may be affected by the Moonlight Project.

The Historical House

All buildings, structures and remains older than sixty years are protected by Sections 34 and 38 of the National Heritage Resources Act (No 25 of 1999).

However, the Historical House (HH01) can be considered to be of low to medium significance when considering the following criteria:

- The residence does not have any cultural or historical context any longer.
- The residence represents one of many similar farm houses which still exist in the wider area and therefore is not the last of a specific type that should be preserved.
- The residence has been changed and altered in the past and therefore does not represent (reflect) it's original architectural style, characteristics and features any longer.

The graveyards

All graveyards and graves can be considered to be of high significance and are protected by various laws. Legislation with regard to graves includes Section 36 of the National Heritage Resources Act (No 25 of 1999) whenever graves are older than sixty years. The act also distinguishes various categories of graves and burial grounds. Other legislation with regard to graves includes those which apply when graves are exhumed and relocated, namely the Ordinance on Exhumations (No 12 of 1980) and the Human Tissues Act (No 65 of 1983 as amended).

Mitigating the heritage resources

It is highly likely that all the heritage resources may be affected (alter, demolish, remove) as a result of the Moonlight Project. Mitigation measures therefore have to be applied to those heritage resources that may be affected by the Moonlight Project (Tables 1 & 2):

The Historical House

The historical house has low-medium significance and has to be investigated by a historical (conservation) architect) *prior* to its destruction. The conservation architect (in conjunction with the developer) has to obtain a destruction permit for the house from the South African Heritage Resources Authority (SAHRA) before it can be destroyed.

The graveyards

Graveyards can be mitigated in two ways depending whether they are to be affected, directly or indirectly, namely:

- By means of exhumation and relocation when they are affected directly. The exhumation of human remains and the relocation of graveyards are regulated by various laws, regulations and administrative procedures. This task is undertaken by forensic archaeologists or by reputed undertakers who are acquainted with all the administrative procedures and relevant legislation that have to be adhered to whenever human remains are exhumed and relocated. This process also includes social consultation with a 60 days statutory notice period for graves older than sixty years. Permission for the exhumation and relocation of human remains have to be obtained from the descendants of the deceased (if known), the National Department of Health, the Provincial Department of Health, the Premier of the Province and the local police.
- Graveyards can be demarcated with brick walls or with fences. Conserving graveyards *in situ* in mining areas create the risk and responsibility that they may be damaged, accidentally, that the mine remains responsible for its future unaffected existence, maintenance and that controlled access must exist for any relatives or friends who wish to visit the deceased.

General

If any heritage resources of significance are exposed when the iron ore project commences or during its operation the South African Heritage Resources Authority (SAHRA) should be notified immediately, all development activities must be stopped and an archaeologist accredited with the Association for Southern African Professional Archaeologist (ASAPA) should be notified in order to determine appropriate mitigation measures for the discovered finds. This may include obtaining the necessary authorisation (permits) from SAHRA to conduct the mitigation measures.

CONTENTS

1 INTRODUCTION

This document contains the report on the results of a Phase I Cultural-Heritage Impact Assessment (HIA) study which was done for Turquoise Moon Trading 157 (Pty) Ltd's Moonlight Iron Ore Project near Marnitz in the Limpopo Province of South Africa.

Focused archaeological research has been conducted in the Limpopo Province for several decades. This research consists of surveys and of excavations of Stone Age and Iron Age sites as well as of the recording of rock art and historical sites in this area. The Limpopo Province has a rich heritage comprised of remains dating from the pre-historical and from the historical (or colonial) periods of South Africa. Pre-historical and historical remains in the Limpopo Province of South Africa form a record of the heritage of most groups living in South Africa today.

Various types and ranges of heritage resources that qualify as part of South Africa's 'national estate' (as outlined in the National Heritage Resources Act [No 25 of 1999]) occur in the Limpopo Province (see Box 1, next page).

Box 1: Types and ranges of heritage resources (the national estate) as outlined in Section 3 of the National Heritage Resources Act, 1999 (No 25 of 1999).

The National Heritage Resources Act (Act No 25 of 1999, Art 3) outlines the following types and ranges of heritage resources that qualify as part of the National Estate, namely:

(a) places, buildings structures and equipment of cultural significance;
(b) places to which oral traditions are attached or which are associated with living heritage;
(c) historical settlements and townscapes;
(d) landscapes and natural features of cultural significance;
(e) geological sites of scientific or cultural importance;
(f) archaeological and palaeontological sites;
(g) graves and burial grounds including-
  (i) ancestral graves;
  (ii) royal graves and graves of traditional leaders;
  (iii) graves of victims of conflict;(iv) graves of individuals designated by the Minister by notice in the Gazette;
  (v) historical graves and cemeteries; and
  (vi) other human remains which are not covered by in terms of the Human Tissues Act, 1983 (Act No 65 of 1983);
(h) sites of significance relating to the history of slavery in South Africa;
(i) movable objects, including -
(i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
  (ii) objects to which oral traditions are attached or which are associated with living heritage;
  (iii) ethnographic art and objects;
  (iv) military objects;
  (v) objects of decorative or fine art;
  (vi) objects of scientific or technological interest; and
  (vii) books, records, documents, photographs, positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1(xiv) of the National Archives of South Africa Act, 1996 (Act No 43 of 1996).

The National Heritage Resources Act (Act No 25 of 1999, Art 3) also distinguishes nine criteria for places and objects to qualify as 'part of the national estate if they have cultural significance or other special value ...'. These criteria are the following:

(a) its importance in the community, or pattern of South Africa's history;
(b) its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
(c) its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
(d) its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
(e) its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
(f) its importance in demonstrating a high degree of creative or technical achievement at a particular period;
(g) its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons; (h)
(h) its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa;
(i) sites of significance relating to the history of slavery in South Africa

2 AIMS WITH THIS REPORT

Turquoise Moon Trading 157 (Pty) Ltd intends developing an iron ore mine on several farms near Marnitz in the Limpopo Province of South Africa. The iron ore mine may affect some of the types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999) that may occur in the Project Area. Consequently, Metago Environmental Engineers who is responsible for compiling the environmental impact assessment report for the Moonlight Iron Ore Project commissioned the author to undertake a Phase I Heritage Impact Assessment (HIA) study for the Project Area. The aims with the Phase I HIA were the following:

- To establish whether any of the types and ranges of heritage resources ('national estate') as outlined in Section 3 of the National Heritage Resources Act (Act 25 of 1999) do occur in the Project Area.
- To determine the significance of these heritage resources and whether they will be affected by the iron ore mine.
- To propose mitigation measures for those heritage resources that may be affected by the proposed iron ore mine.

3 METHODOLOGY

This Phase I HIA study was conducted by means of the following:

- Surveying the proposed Project Area with a vehicle and selected spots on foot.
- Briefly surveying literature relating to the pre-historical and historical context of the Project Area.
- Consulting maps of the proposed Project Area.
- Consulting archaeological (heritage) data bases.
- Consulting spokespersons regarding the possible presence of graveyards and graves in the Project Area.
- Synthesising all information obtained from the data bases, fieldwork, maps and literature survey.

3.1 Fieldwork

The Project Area was surveyed with a vehicle where accessible roads existed while selected, sensitive spots in the Project Area were surveyed on foot.

3.2 Databases, literature survey and maps

Databases kept and maintained at institutions such as the Provincial Heritage Resources Agency (PHRA) and the Archaeological Data Recording Centre at the National Flagship Institute (Museum Africa) in Pretoria were consulted to determine whether any heritage resources of significance has been identified during earlier heritage surveys in or near the Project Area.

The author is not unacquainted with the Project Area at large as he has done several heritage impact assessment studies near the proposed Project Area (see Part 9, 'Select Bibliography').

Literature relating to the pre-historical and the historical unfolding of the region where the Project Area is located was reviewed (see Part 5, 'Contextualising the Project Area' and Part 9 'Select Bibliography).

It is important to contextualise the pre-historical and historical background of the Project Area in order to comprehend the identity and meaning of heritage sites in and near the Project Area.

In addition, the Project Area was studied by means of maps on which it appears such as the 1:50 000 topographical maps (2328AA Marnitz and 2328AC Abbotspoort and the 1:250 000 map (2326 Lephalale) outlining the Project Area.

3.3 Consulting spokespersons

Spokespersons acquainted with the Project Area were consulted regarding the possible presence of solitary graves and graveyards in the Project Area.

3.4 Assumptions and limitations

If any heritage resources of significance are exposed when the iron ore project commences or during its operation the South African Heritage Resources Authority (SAHRA) should be notified immediately, all development activities must be stopped and an archaeologist accredited with the Association for Southern African Professional Archaeologist (ASAPA) should be notified in order to determine appropriate mitigation measures for the discovered finds. This may include obtaining the necessary authorisation (permits) from SAHRA to conduct the mitigation measures.

3.5 Some remarks on terminology

Terms that may be used in this report are briefly outlined in Box 2.

Box 2- Terminology relevant to this report

The Heritage Impact Assessment (HIA) referred to in the title of this report includes a survey of heritage resources as outlined in the National Heritage Resources Act , Act 25 of 1999 (see Box 1).

Heritage resources include all human-made phenomena and intangible products that are the result of the human mind. Natural, technological or industrial features may also be part of heritage resources, as places that have made an outstanding contribution to the cultures, traditions and lifestyles of the people or groups of people of South Africa.

The term 'pre-historic' refers to the time before any historical documents were written or any written language developed in a particular area or region of the world. The historical period and historical remains refer, for the Project Area, to the first appearance or use of 'modern' Western writing brought to the Waterberg region by the first colonists who settled in this area after c. 1839.

The term 'relatively recent past' refers to the 20th century. Remains from this period are not necessarily older than sixty years and therefore may not qualify as archaeological or historical remains. Some of these remains may, however, be almost sixty years old and these may qualify as heritage resources in the near future.

It is not always possible, based on observations alone, to distinguish clearly between archaeological remains and historical remains, or between historical remains and remains from the relatively recent past. Although certain criteria may help to make this distinction possible, these criteria are not always present, or, when they are present, they are not always clear enough to interpret with great accuracy. Criteria such as square floor plans (a historical feature) may serve as a guideline. However, circular and square floors may occur together on the same site.

The term 'sensitive remains' is sometimes used to distinguish graves and cemeteries, as well as ideologically significant features such as holy mountains, initiation sites or other sacred places. Graves in particular are not necessarily heritage resources if they date from the recent past and do not have headstones that are older than sixty years. The distinction between 'formal' and 'informal' graves in most instances also refers to graveyards that were used by colonists and by indigenous people. This distinction may be important, as different cultural groups may uphold different traditions and values with regard to their ancestors. These values have to be recognised and honoured whenever graveyards are exhumed and relocated.

The term 'Stone Age' refers to the prehistoric past, although Late Stone Age peoples lived in South Africa well into the historical period. The Stone Age is divided into an Earlier Stone Age (3 million years to 150 000 thousand years ago) the Middle Stone Age (150 000 years to 40 000 years ago) and the Late Stone Age (40 000 years to 200 years ago).

The term 'Iron Age' refers to the last two millennia and 'Early Iron Age' to the first thousand years AD. 'Late Iron Age' refers to the period between the 16th century and the 19th century and can therefore include the historical period.

Mining heritage sites refer to old, abandoned mining activities, underground or on the surface, which may date from the pre-historic, historical or the relatively recent past.

The term 'mining area' ('critical area') refers to the area where the developer wants to focus development activities.

The term 'peripheral area' refers to the area that will not be affected by the proposed new development activities.

The 'South Shaft 3 Project Area' refers to both the mining and peripheral areas.

Phase I studies refer to surveys using various sources of data in order to establish the presence of all possible types of heritage resources in any given area.

Phase II studies include in-depth cultural heritage studies such as archaeological mapping, excavating and sometimes laboratory work. Phase II work may include the documenting of rock art, engraving or historical sites and dwellings; the sampling of archaeological sites or shipwrecks; extended excavations of archaeological sites; the exhumation of bodies and the relocation of graveyards, etc. Phase II work may require the input of specialists and requires the cooperation and approval of SAHRA.

4.1 Location

The proposed Moonlight Iron Ore Project (hereafter referred to as the Moonlight Project) involves the development of an open cast iron ore mine with associated infrastructure on the farms Goudafontein 886 (previously known as Gouda Fontein 76LR), Moonlight 111LR and Julietta 112LR near Marnitz in the Limpopo Province. The development of the iron ore mine and associated infrastructure on these farms is referred to as the Project Area in this report.

Figure 2- The Project Area on Moonlight 111LR, Julietta 112LR and Goudafontein 886 (previously known as Gouda Fontein 76LR) during summer shows pristine bush with open patches and minor developmental activities such as dirt roads and fences (above).

The proposed Project Area is located approximately 6km to the south of the village of Marnitz on the Baltimore-Groblersbrug road. It is situated to the north of Marken which is located on the northern edge of the Waterberg. The farms Goudafontein 886 (previously known as Gouda Fontein 76LR), Moonlight 111LR and Julietta 112LR are located on opposite sides of the Jemima dirt road which runs from the R518 in the south to Marnitz in the north.

The Project Area incorporates a vast outstretched piece of veldt with pristine indigenous bush. Smaller patches were cleared in the past for agricultural activities (2328AA Marnitz and 2328AC Abbotspoort [1:50 000 maps] and the 1:250 000 map [2326 Lephalale]).

Figure 2- The larger Project Area seen from the air during the winter. Outstretched open savannah veldt with little surface water is a dominant feature of the landscape. This inhospitable environment was not conducive for human settlement in the past (above).

4.2 The human past (heritage potential) of the Project Area

The Project Area is part of a level land mass marked by two major water courses namely, the Lephalale and the Magalakwena Rivers to the west and to the east of the Project Area. No conspicuous topographical features other than an iron outcrop near its centre and consistent level sandy plains covered with savannah bush occur in and near the Project Area.

The larger Project Area (or region) was sparsely populated by humans in the past. However, occupation started at an early period so that humans may have been present in the area over a long time span but on a limited scale. This occupation occurred from the Stone Age, hundreds of thousands of years ago, throughout the Early Iron Age which covers the first millennium AD and the Historical Period which commences with the arrival of the first colonial hunters, traders and farmers (see Part 5, 'Contextualising the Project Area', below).

5 CONTEXTUALISING THE PROJECT AREA

A brief overview of pre-historical and historical information below contextualises the larger Project Area or region. This information is necessary to understand the meaning and significance of heritage resources which may exist in the Project Area itself.

5.1 The Stone Age (hunter gatherers)

Stone Age sites are marked by stone artefacts that are found scattered on the surface of the earth or as parts of deposits in caves and rock shelters. The Stone Age is divided into the Early Stone Age (ESA) (covers the period from 2.5 million years ago to 250 000 years ago), the Middle Stone Age (MSA) (refers to the period from 250 000 years ago to 22 000 years ago) and the Late Stone Age (LSA) (the period from 22 000 years ago to 200 years ago).

The LSA is also associated with rock paintings and engravings which were done by the San, Khoi Khoi and in more recent times by Iron Age farmers.

Near the Project Area

Hunter gatherers from the Stone Age, including the few who left rock paintings during the last 20 000 years in the mountainous Waterberg to the south of the Project Area, occurred throughout the larger region from as early as the MSA. MSA and LSA tools occur along the banks of the Mokolo (Mogol) River and on numerous farms in the Waterberg Mountains.

Surveys, although limited, have recorded scattered finds of Stone Age sites, rock paintings and engravings in the region. At least one rock shelter (Olieboompoort) with MSA and LSA assemblages in the Waterberg has being researched. At Nelsonskop, a small protrusion in the Onverwact Mine's premises near Lephalale

engravings of animal spoor, cupules and other incisions were found on a face of Nelsonskop.

Most of the Stone Age sites can be classified as open (surface) sites which imply that most of the artefacts occur 'out of context'. (Such assemblages have less significance that artefact types which occur in closed stratigraphic layers). MSA and LSA collections also occur in rock shelters and caves. Hunter-gatherers preferred caves as settlements from the MSA onwards as these shelters provided warmth and safety. No mountains or ridges with caves occur in the Project Area.

Rock shelters and caves with rock paintings are common in the Waterberg to the south of the Project Area.

5.2 The Iron Age (earliest farmers)

Hunter-gatherers were followed by the first agro-pastoralists who lived in semi-permanent villages and who practised metal working during the last two millennia, the so-called Iron Age. The Iron Age is usually divided into the Early Iron Age (EIA) (covers the 1st millennium AD) and the Later Iron Age (LIA) (covers the first 880 years of the 2nd millennium AD).

Whilst the EIA is marked by small scattered sites with (elaborately) decorated pottery and in many instances with iron smelting, LIA sites may occur in clusters covering large tracks of land constituting cultural landscapes. These sites are mostly marked by stone walls and pottery. Metal working during the LIA occurs when this activity have attained specialised status. Historical links between LIA complexes and communities close to the sites can usually be pointed out. (This provides opportunities for oral traditions, cultural landscapes and aspects of living [tangible and intangible] heritage to be investigated as well).

EIA sites are limited to the northern and eastern parts of the country whilst LIA farmers' settlements cover a large part of South Africa – except the far western low-summer rainfall region and the southern extreme of the country.

Near the Project Area

EIA farmers utilized pieces of land close to the banks of major rivers, such as the Limpopo or Mogol outside the Project Area or near confluences between major rivers and small streams. Here, some farmers planted crops while small numbers of cattle and small stock were kept if grazing and shrubbery allowed for stock keeping. Woods, such as the Vaalbos (*Terminalia Sericea*), growing on sand veldt, was fired to make charcoal which was used to smelt iron ores. Magnetite ore was collected from the surface (if available) or was carried long distances to smelting sites. Large scale iron smelting with substantial evidence for habitation occurred at Diamant near Lephalale, south-west of the Project Area during the EIA.

EIA as well as LIA communities did not prefer the flat outstretched sand veldt of the Project Area for habitation and for farming. The scarcity of drinkable surface water for humans and animals; low annual summer rainfalls, high temperatures with accompanying high evaporation rates and soils which lacked nutrients were not conducive to crop planting. The absence of all year round grazing also did not encourage mixed farming in the Project Area.

Late Iron Age occupation on the scale that marked the Ga-Seleka and Shongwane areas further to the south did not occur in the Project Area. The Seleka and Batlhalerwa people established spheres of influence that covered large areas. The mountain stronghold Bobididi near Villa Nora which was occupied by the Batlhalerwa illustrates the kind of sites which were used by second millennium farming communities who occupied the region.

The absence of mountains and kopjes and therefore stone that was used as building material during the LIA is a conspicuous feature of the Project Area.

No historically known tribal groupings or clans occupied the Project Area during the LIA or the Historical Period. Communities known as the 'Vaalpense' (mixed Negroid and San) lived further to the south and their descendants can still be found. These communities were nomadic hunters and herders before they became employed by the first colonial farmers. They did not occupy large, permanent settlements that have left traces on the landscape.

LIA and historical farmers left rock paintings much younger than those which date from the Stone Age. These phenomena were restricted to areas occupied by historically known communities and therefore did not occur in the Project Area.

5.3 The Historical Period

The restricted hunting and farming practises supported by Stone and Iron Age communities were intensified and expanded when the first colonial hunters and traders, followed by colonial settlers arrived in the region from the second half of the 19th century. Whilst little has been recorded about these early farmers in the Project Area some research has been done on the colonial farmers who occupied the Waterberg further to the south.

Near the Project Area

Farm houses with outbuildings, family graveyards, cattle posts, outlying bore holes with drinking troughs and grazing fields lead to the establishment of cultural landscapes of some proportions in the region from the second half of the 19th century. First generation homesteads, or 'hartbeeshuise' constructed with clay or clay bricks and thatched roofs, have all disappeared by now and have been replaced with second and third generation farm residences. Such historically significant structures, which are older than sixty years, occur throughout the

region and include family graveyards as well as informal cemeteries used by farm labourers.

However, nowadays, farm homesteads and associated infrastructure in the region have been transformed as a result of changing subsistence patterns. Cattle ranching and crop planting have in many instances, been replaced by game farming.

The opening of the Onverwacht open cast coal mine near Lephalale in the 1960's introduced a new economic dimension to the region. The town of Lephalale also came into being during this time period. Primarily mined and transported away for the smelting of iron ores, low-grade coal is now also used locally by the Matimaba Power Station to generate electricity.

6 THE PHASE I HERITAGE IMPACT ASSESSMENT (HIA) STUDY

6.1 Types and ranges of heritage resources

The Phase I HIA study revealed the following types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999) in the Project Area, namely:

- A residence with historical significance.
- Formal and informal graveyards, some of which hold historical significance.

The heritage resources were geo-referenced and mapped (Figure 3, Tables 1 & 2). The significance of these heritage resources is indicated whilst mitigation measures are outlined for those heritage resources which may be affected by the Moonlight Project.

The heritage resources are now briefly discussed and illuminated with photographs.

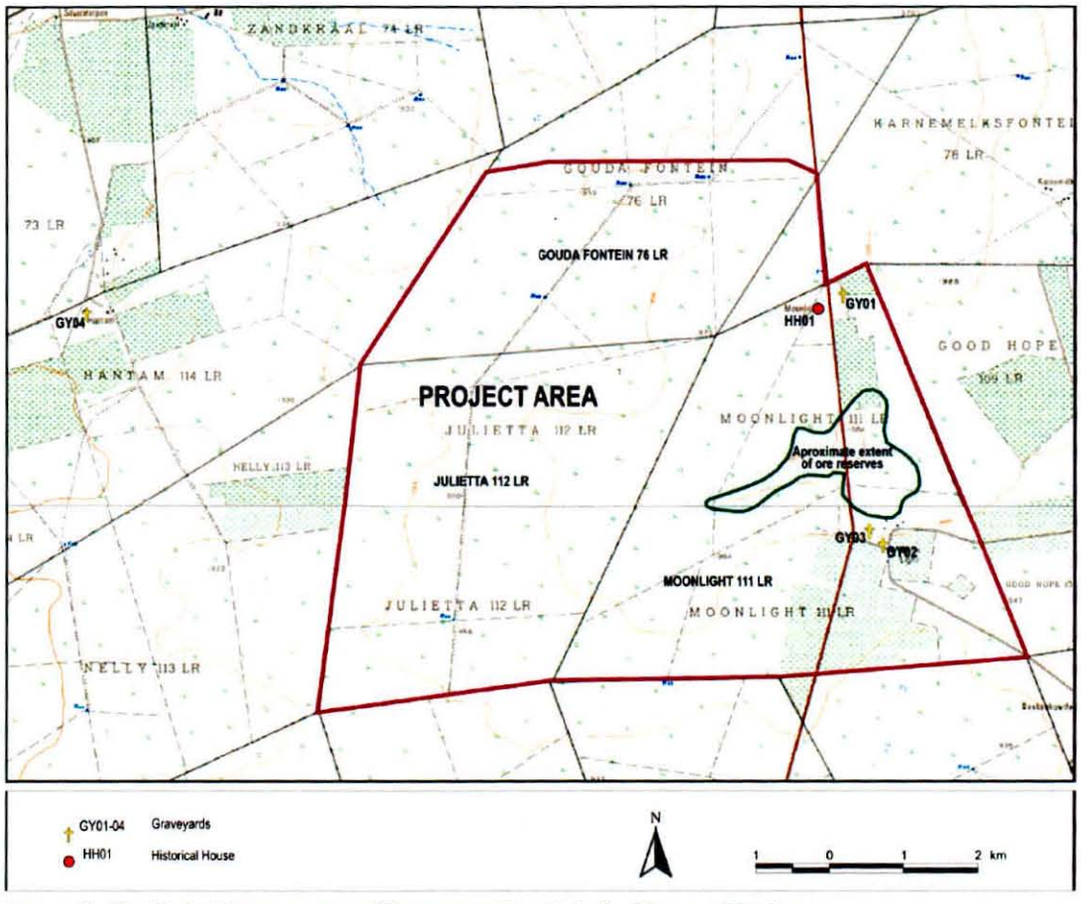

Figure 3 - The Project Area on several farms near Marnitz in the Limpopo Province.
Note the graveyards and Historical House that were recorded in and near the Project Area (above)

6.1.1 Historical House

Very little infrastructure occurs in the Project Area. Structures such as houses and sheds are limited and those that do occur mostly date from the more recent past and therefore do not hold historical significance.

At least one historical house was recorded on Moonlight 111LR. This residence was constructed with clay bricks and is fitted with a low pitched corrugated iron roof. It seems as if the original structure of the house has been altered and changed in the past.

Figure 6- A historical house on Moonlight 111LR. This residence dates from the 1930's or 1940's and was constructed with clay bricks and thereafter white-washed. It is fitted with a pitched corrugated iron roof (above).

At least one abandoned village with mud houses were observed on Hantam 112LR, outside the Project Area. These structures also date from the more recent past.

6.1.2 Graveyards

At least three graveyards were recorded in and near the Project Area. They are the following, namely:

6.1.2.1 Graveyard 01

This graveyard (GY01) on Moonlight 111LR falls in the Project Area.

Figure 7- GY1 holds three graves under a tree. One of the graves is fitted with an upright cement stone which serves as a head stone. It has no inscriptions (above).