BASELINE AIR QUALITY STUDY

FOR THE

KEBRAFIELD ROODEPOORT COLLIERY NATIONAL ENVIRONMENTAL MANAGEMENT ACT APPLICATION FOR AUTHORISATION REF:17/2/3N-289 & INTEGRATED WATER USE LICENSE APPLICATION

Department: Minerals Resources Ref: MP 30/5/1/2/2/479 MR

REPORT
2014

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eco elementum
ENVIRONMENTAL & PROJECT MANAGEMENT PROFESSIONALS

Key Project Information	
Project Title:	Kebrafield Roodepoort Colliery
Farm Description:	Roodepoort 151 IS Portion 17
SG Code:	T0IS00000000115100017
Mining Right Reference Number:	MP30/5/1/2/2/479 MR
District Municipality:	Nkangala District
Local Authority:	Steve Tshwete Local Municipality
Nearest Town:	Pullenshope
Site Midpoint Coordinates:	26° 0'25.87"S 29°34'41.21"E

Project applicant:	Kebrafield (Pty) Ltd		
Trading name (if any):	Kebrafield		
Contact person:	Wayne van der Burgh c/o Burgh Group Holdings (Pty) Ltd		
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Qualifications & relevant experience	Masters Degree specializing in Environmental Management 10 Years' experience in Environmental Consultancy		
Professional affiliation(s) (if any)	Chartered Environmental Assessment Practitioner South Africa (CEAPSA)		
Landowner:	Joseph Christiaan van Wyk - ID 7604145228088		
Contact person:	Van Wyk Attorneys, 48 Mouton Street, Hendrina, 1095		
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Contents

1. INTRODUCTION

Eco Elementum (Pty) Ltd has been appointed by Eyethu on behalf of the applicant Kebrafield (Pty) Ltd to undertake the Scoping Environmental Impact Assessment and Water Use Licensing for all the relevant listed activities that will potentially be triggered during the opencast mining of the coal reserve. The mining right which has been awarded to Kebrafield (Pty) Ltd, MP30/5/1/2/2/479 MR, includes various farms and associated farm portions although for this specific project only the farm Roodepoort 151 IS portion 17 in the vicinity of the town of Pullenshope in Mpumalanga is being applied for. The project falls within the district municipality of the Nkangala District while the local authority is the Steve Tshwete Local Municipality. This report entails an application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010, and falls within the jurisdiction of the Department: Economic Development, Environment and Tourism, Mpumalanga Provincial Government.

As part of this authorisation process Eco Elementum (Pty) Ltd was commissioned to determine the baseline air quality environment prior to the commencement of mining and to determine the potential air quality impacts that might occur on the surrounding sound environment due to the establishment of the Kebrafield Roodepoort Colliery on the farm Roodepoort 151 IS Portion 17.

The proposed project relate to the opencast mining of approximately 800 000tons of high grade coal over a period of approximately three years. When coal seams are near the surface, it may be economical to extract the coal using open cut (also referred to as open cast, open pit, or strip) mining methods. Open cast coal mining recovers a greater proportion of the coal deposit than underground methods, as more of the coal seams in the strata may be exploited. The activity will cover approximately 50 hectares and is situated next to the town of Pullenshope downstream of the Eskom Hendrina Power Station.

2. SCOPE OF WORK

BASELINE AIR QUALITY STUDY

A baseline air quality study was conducted by Eco Elementum (Pty) Ltd as part of the Kebrafield Roodepoort Colliery EIA.

The purpose was to:

- Study the available information relevant to the pre-development ambient air quality pollution concentrations in the environment;
- Identify the major existing air emission sources in the environment;
- Identify the existing sensitive air pollution areas in the environment;

- Estimate by means of measurements and integration of the results with those of any relevant existing information the present ambient air quality climate; and
- Identify the processes and equipment that will cause the major contribution to the future air quality impact.

From the historical data that was presented during the mining right application is it not clear whether a baseline air quality study for the area has ever been conducted, and therefore new measurements had to be taken in field to gather data for analysis.

3. STUDY AREA

3.1. LOCATION

Kebrafield Roodepoort Colliery is located on the farm Roodepoort 151IS Portion 17, which is situated on the western border of the town Pullenshope in Mpumalanga. Pullenshope is approximately 5 km west of the N11 between Middelburg and Hendrina. The propsed development is situated south of Optimum Colliery, which supplies coal to the Hendrina power station immediately southwest of Pullenshope. Pullenshope used to be the village of Hendrina powerstation which housed all the employees of the powerstation. Now the properties belong mostly to private owners although not all has been sold off by the powerstation. Coal mining operations forms an integrated part of the Hendrina power generation activities. Big scale coal mining operations occur in the local catchment area of the power station. The image below illustrates the relative position of the proposed project site to other towns in the vicinity of the operation. The farm Roodepoort 151IS Protion 17 of which only the northern section fo the property is proposed for the development is indicated by the reddish polygon to the west of the town Pullenshope.

The proposed activities are primarily surrounded by agricultural small holdings, power generation and neighbouring mining operations. Major residential areas in the region include Middelburg (~25km northwest), eMalahleni (~35km west-northwest), Bethal (~45 km southwest) and Ermelo (~60km southeast). Smaller residential areas in the region include Arnot (~20 km northeast), Pullen's Hope (~1 km east), Komati (~12 km southwest), KwaZamokuhle (~17 km southeast) and Hendrina (~17 km southeast) which may include schools and hospitals/clinics. Individual residences (i.e. farm houses) are also in the immediate vicinity of the proposed operations.

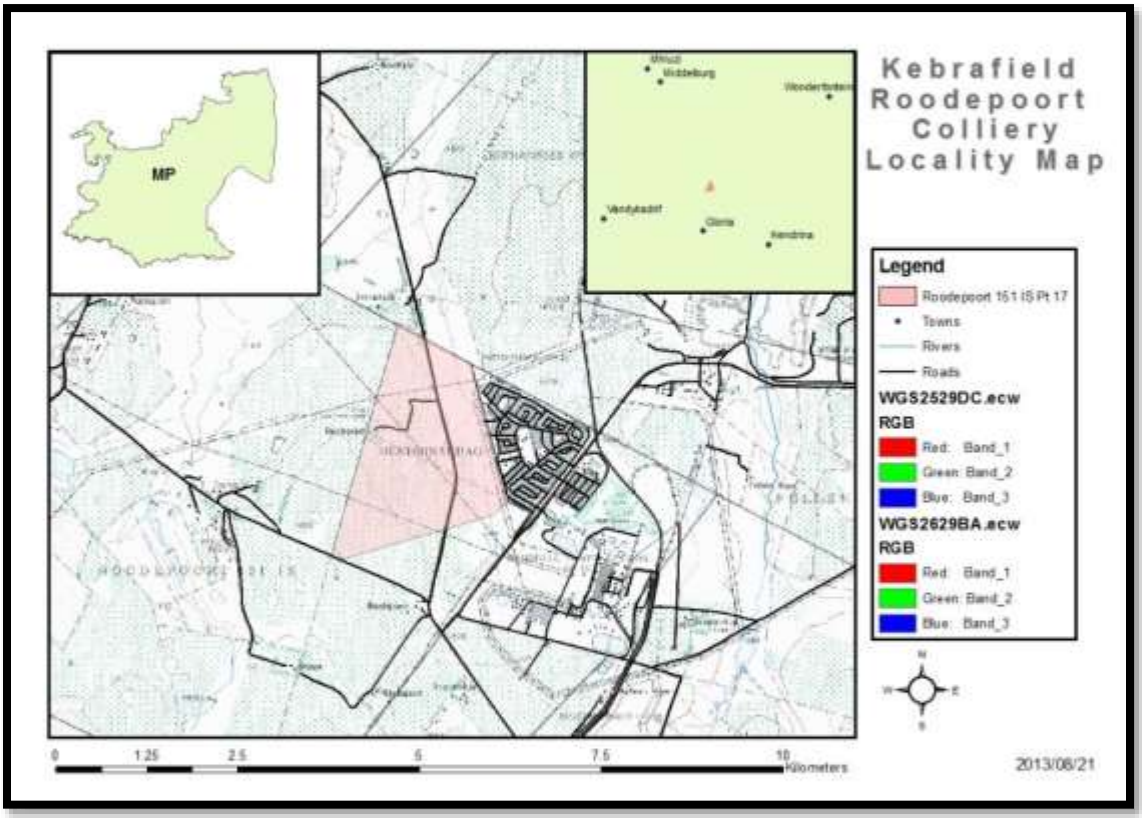

Figure 1: Kebrafield Roodepoort Colliery Locality Map – 1:50 000 Topographical Datasheets WGS2529DC & WGS2629BA

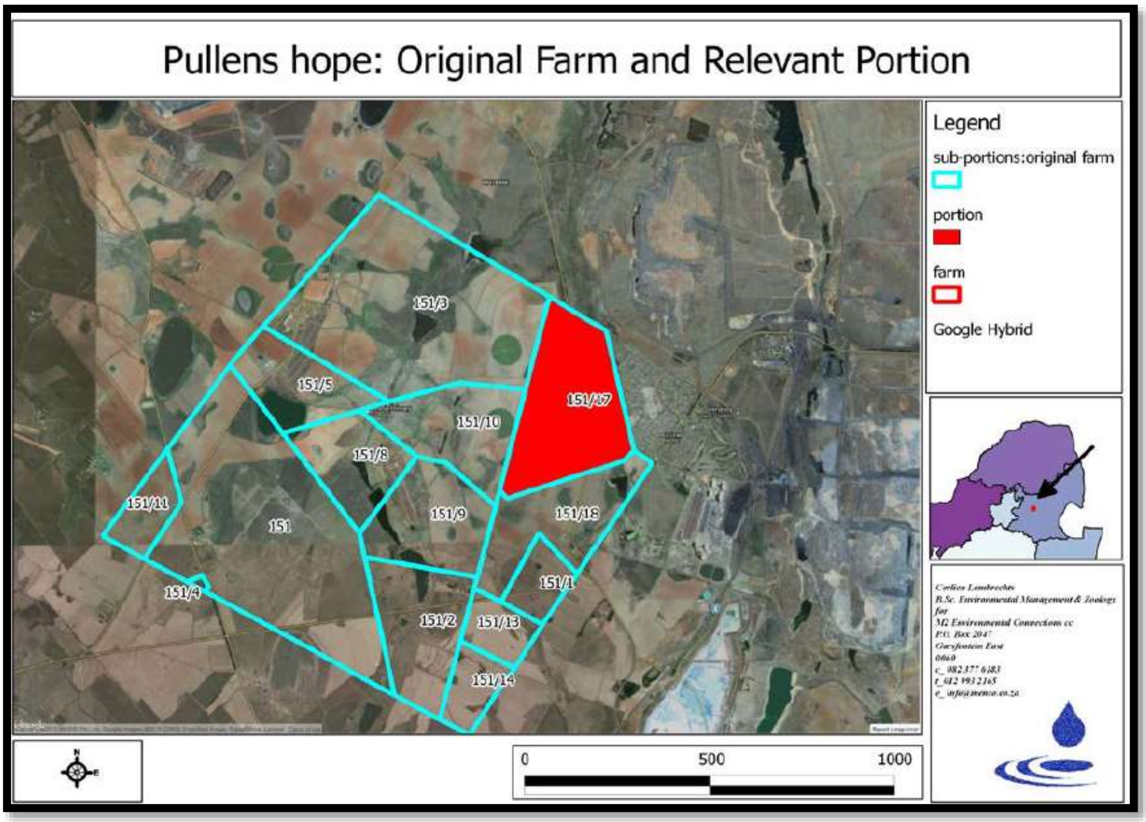

Figure 2: Roodepoort: Original Farm and Relevant Portion

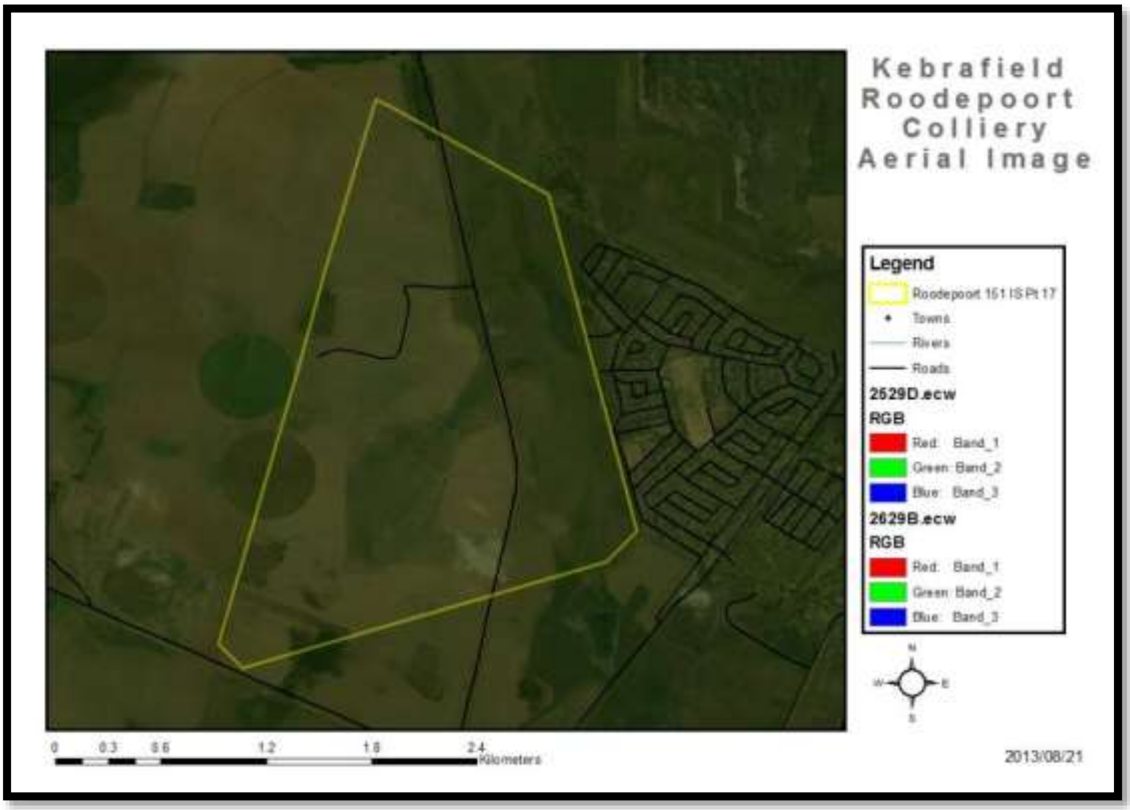

Figure 3: Aerial imagery (2010 Landsat Data) indicating the extent of the farm Roodepoort 151IS Portion 17

3.2. TOPOGRAPHY

The surface topography of the area is typical of the Mpumalanga Highveld, mainly a gently undulating plateau, varying between approximately 1680 mamsl underneath Ash Dam 4 to 1600 mamsl along the Woest-Alleen Spruit (East) and the lower reaches of the Woest-Alleen Spruit (West). The mining area is situated between the contour lines of the 1600 mamsl to 1610 mamsl. Several man-made features are also of significance at the site. Numerous dams have been constructed for a variety of purposes, the most obvious of which is the man made dam to the east of the study area, situated right in the middle of a wetland. Various Eskom power lines transect the proposed mining area while there is a gravel road that runs straight through the middle of the mining footprint. These features are indicated in the figure below, 1:50 000 topographical map.

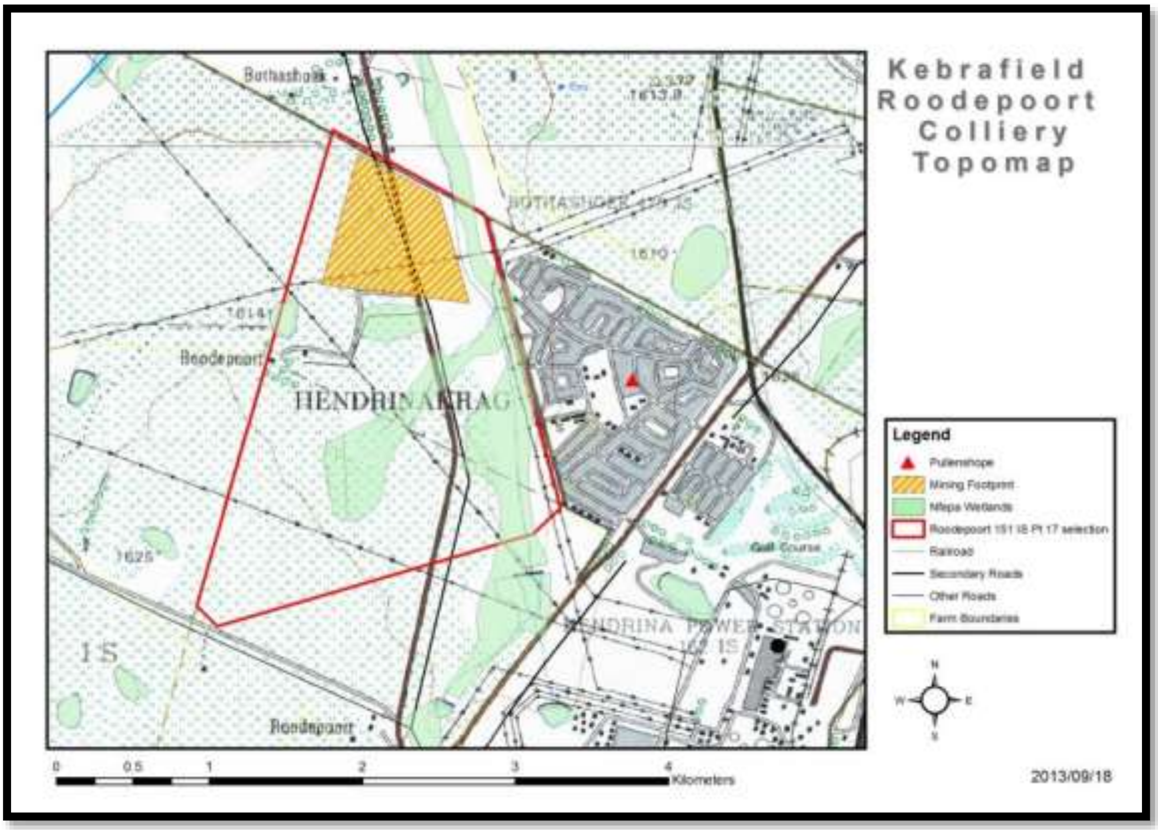

Figure 4: Topography according to the 1:50 000 topographical map

3.3. ROADS AND RAIL ROADS

A gravel road runs straight through the middle of the proposed operation, but an application to the Mpumalanga Department of Roads was successful in allowing the diversion of the road further to the West – therefore also further away from the community. From the image below the road has been indicated in yellow running thorugh the anticipated mining area in red, while there's also a railroad to the north of the study area. The rail road runs paralel to the north of the town Pullenshope before turning north and away from the study area.

Figure 5: Main road (yellow) and railway (white)

3.4. LANDUSE

The land cover of the proposed mining site as indicated in the figure below is mainly grasslands and cultivated commercial areas. The study area (yellow diagonal lines in the image below) covers only the northern portion of portion 17 of the Farm Roodepoort 151IS (indicated as a red polygon in the image below). A NFEPA wetland is situated to the east of the proposed study area and has been discussed under the previous section under the heading “Wetlands”. The large yellow polygon to the north and east of the study area has been classified according to the ENPAT data set as “Mining and Quarries”. Various previous studies conducted in the study region have acknowledged the fact that the catchment has already been largely transformed by mining activities. The proposed Kebrafield Roodepoort Colliery intends to keep clear of the wetland areas while adhering to a 100m buffer as proposed by the Wetland specialists during an initial prefeasibility study. The majority of the area to the east has been built up by the previous Hendrina Power Station Village, which today has become known as the town of Pullenshope as the majority of land ownership vest with private persons/entities.

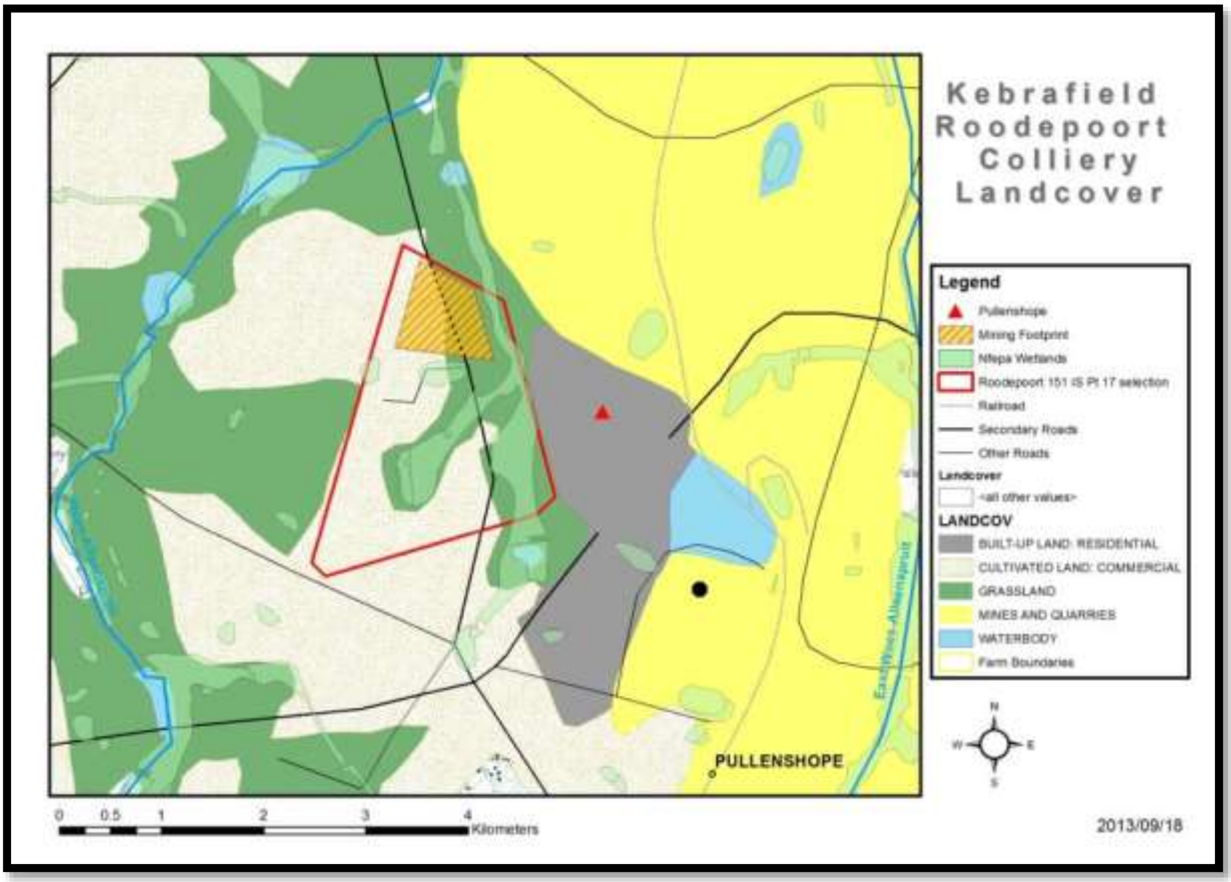

Figure 6: Land Cover map indicating overall land-cover of the study area (NFEPA and ENPAT data sets)

Land cover categories are presented in above. For the purpose of this assessment, land cover are loosely categorised into classes that represent natural habitat and land use categories that contribute to habitat degradation and transformation on a local or regional scale. Areas that are characterised by high levels of transformation and habitat degradation is generally accepted as being suitable for development purposes as it is unlikely that biodiversity attributes of sensitivities will be present or affected by development. Conversely, areas that are characterised by extensive untransformed and pristine habitat are generally not regarded suitable options for development purposes.

The status of natural habitat does however have bearing on the suitability of a site. The region comprises extensive transformed habitat that resulted from agriculture and mining, rendering remaining habitat fragmented and isolated and ultimately relatively sensitive. Little natural grassland habitat remains in the area, the majority being around streams and rivers where ploughing is not possible or soils are poor in nutrients. One of the shortfalls of the Environmental Potential Atlas database (ENPAT) is that it does not reflect the current status of natural habitat within the study area. At this stage of the process it is therefore assumed that all areas indicated to comprise of natural grassland is representative of the regional vegetation types and are in a good condition. While this assumption is unlikely to hold true for most of the study area, an assessment of the actual ecological status of grasslands within the study area is beyond the scope of this report and will only be compiled during the EIA phase.

Surrounding land uses in the vicinity of the proposed mining site are farming with agricultural as the predominantly activity as well as Power generation and the residential areas of Pullens Hope to the right. Agricultural activities include cultivated crops with clear irrigation practices and livestock farming. Optimum Colliery is an active colliery located to the right of Portion 17.

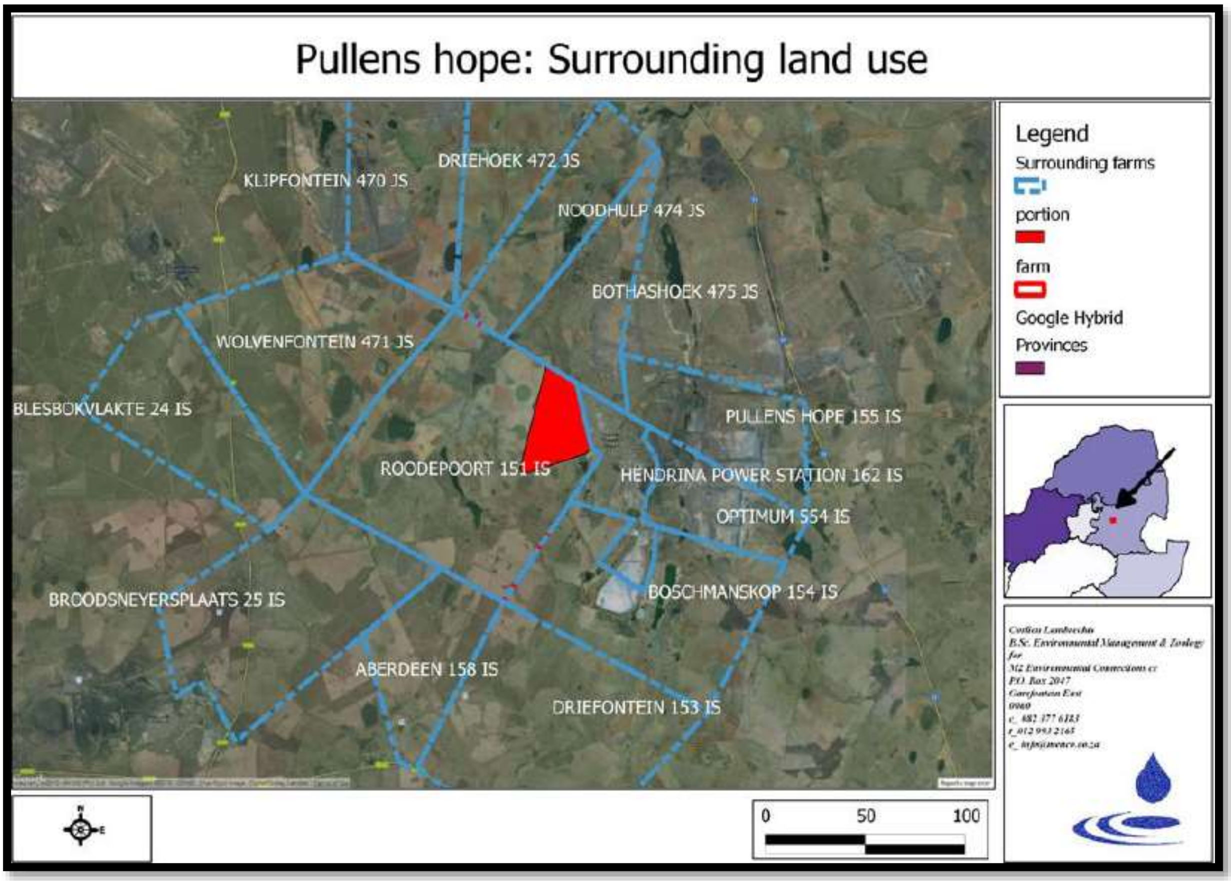

Figure 7: Surrounding land use description

Table 1: Zoning information for surrounding land uses

Title name	SG Code of Original	Zoning information
Roodepoort 151 IS	T0IS00000000015100000	Agricultural Holding (All Portions)
Bothashoek 475 JS	T0JS00000000047500000	Mining: Optimum Coal Mine
Pullens hope 155 IS	T0IS00000000015500000	Mining: Optimum Coal Mine (Portion 0 – 3, 9 - 12) Other Purposes: RSA Government Property (Portion 5) Mining: Privately Owned (Portion 6) Mining: Billiton Energy Coal (Portion 8)
Optimum 554 IS	T0IS00000000055400000	Open Cast Colliery: Mining Right
Hendrina Power Station 162 IS	T0IS00000000016200000	Other Purposes: Eskom (Portion 0) Government: Schools (Portion 1) Government: Business (Portion 2) Residential Area (Portion 4) Commercial / Industrial Purposes (Portion 6)
Boschmanskop 154 IS	T0IS00000000015400000	Agricultural Holding (All other) Other Purposes: Eskom (Portion 5) Commercial / Industrial Purposes (Portion 8) Mining: Optimum Coal Mine (Portion 11, 21)
Driefontein 153 IS	T0IS00000000015300000	Agricultural Holding (All other) Commercial / Industrial (Portion 38 – 41)
Aberdeen 158 IS	T0IS00000000015800000	Agricultural Holding (All)
Broodsneyersplaats 25 IS	T0IS00000000002500000	Agricultural Holding (All other) Public Service Infrastructure (Portion 14, 20, 21, 23-35) Mining: Billiton Energy Coal (Portion 9) Other Purposes: RSA Government Property (Portion 22)
Blesbokvlakte 24 IS	T0IS00000000002400000	Agricultural Holding (All other) Public Service Infrastructure (Portion 11-13)
Wolvenfontein 471 JS	T0JS00000000047100000	Agricultural Holding (All other) Mining: Anglo Operations (Portion 8) Commercial / Industrial Purposes (Portion 14) Other Purposes: RSA Government Property (Portion 15) Public Worship (Portion 23)
Klipfontein 470 JS	T0JS00000000047000000	Mining: Ingwe Surface Holdings (Portion 0-2)
Driehoek 472 JS	T0JS00000000047200000	Agricultural Holding (All)

		Other Purposes: Eskom (Portion 5) Commercial / Industrial Purposes (Portion 8) Mining: Optimum Coal Mine (Portion 11, 21)
Driefontein 153 IS	T0IS00000000015300000	Agricultural Holding (All other) Commercial / Industrial (Portion 38 – 41)
Aberdeen 158 IS	T0IS00000000015800000	Agricultural Holding (All)
Broodsneyersplaats 25 IS	T0IS00000000002500000	Agricultural Holding (All other) Public Service Infrastructure (Portion 14, 20, 21, 23-35) Mining: Billiton Energy Coal (Portion 9) Other Purposes: RSA Government Property (Portion 22)
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Klipfontein 470 JS	T0JS00000000047000000	Mining: Ingwe Surface Holdings (Portion 0-2)
Driehoek 472 JS	T0JS00000000047200000	Agricultural Holding (All)

3.5. METEOROLOGICAL INFORMATION

3.5.1. REGIONAL CLIMATE

Kebrafield Roodepoort Colliery is situated on the Mpumulanga Highveld. The usual highveld weather conditions prevail with warm summers and cold winters with the main temperature at 14:00 in winter being about 17°C. The climate of the area under investigation is classified as the Highveld region (Region H), which is defined as a climate with a temperate to warm temperature and summer rains.

3.5.2. RAINFALL DATA

The average annual precipitation in the Highveld region varies from about 900 mm on its eastern border to about 650 mm in the west. The rainfall is almost exclusively due to showers and thunderstorms and falls mainly in summer, from October to March, the maximum fall occurring during January. The winter months are normally dry and about 85% of the annual rainfall falls in the summer months; heavy falls of 125 mm to 150 mm occasionally fall in a single day. This region has about the highest hail frequency in South Africa; about 4 to 7 occurrences may be expected annually at any one spot.

Kebrafield Roodepoort Colliery lies within quaternary sub-catchment B12B of rainfall zone B1B. The average precipitation for this region at weather station 0516 480 is 672 mm.

The average monthly rainfall recorded at weather stations within quaternary sub-catchment B12B is summarised in in the table below and displayed graphically in the figure below. Data from the measurements taken during 70 years (1920 - 1989) were obtained. From the data listed in the table it can be seen that the wettest months (on average) are November, December and January whilst the driest months are June, July and August.

Table 2: Average rainfall recorded at weather station within quaternary sub-catchment B12B.

Month	Average rainfall	
	(516 480)	(516 414)
Jan	115.92	115.75
Feb	87.36	87.23
Mar	72.31	72.20
Apr	42.07	42.00
May	14.92	14.90
Jun	7.73	7.72
Jul	6.45	6.44
Aug	6.85	6.84
Sep	25.00	24.96
Oct	68.54	68.44
Nov	113.43	113.26
Dec	109.67	109.51

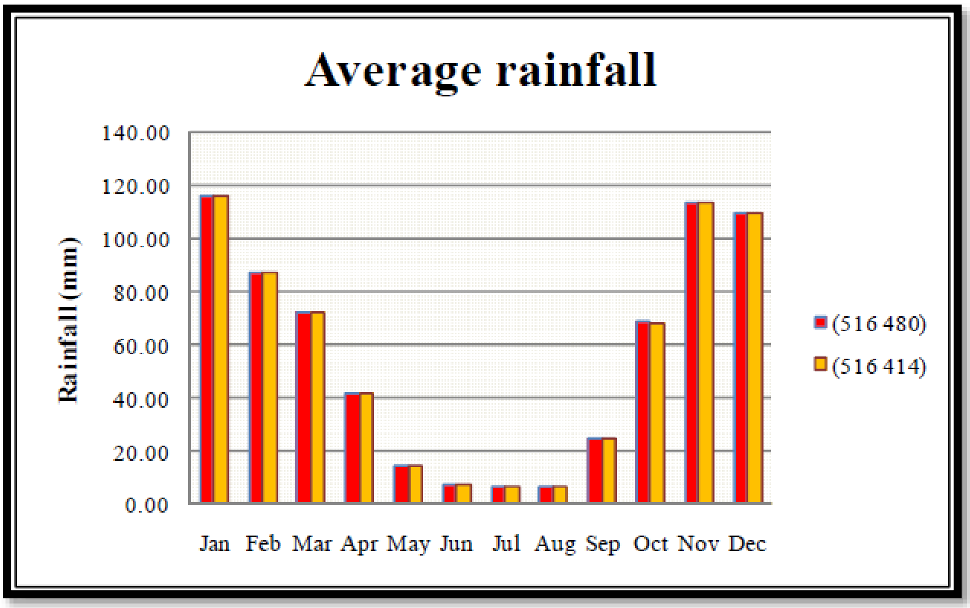


Figure 8: Average rainfall recorded at weather station 0516 480 (Over a period of 70years)

Rainfall represents an effective removal mechanism of atmospheric pollutants and is therefore frequently considered during air pollution studies. Monthly rainfall for the site (2007 – 2009) is given in the table below. Average monthly rainfall for this period is in the range of 306 mm. The study area falls within a summer rainfall region, with over 85% of the annual rainfall occurring during the October to March period.

Table 3: Monthly average rainfall for the site for the period 2007 – 2009

Month	Average rain (mm)	Average No. hours>0.254mm	Average No. days>0.254mm
Jan	973	182	21
Feb	315	87	13
Mar	236	74	12
Apr	107	37	7
May	60	19	3
Jun	23	10	2

3.5.3. TEMPERATURE

Average daily maximum temperatures are roughly 27°C in January and 17°C in July but in extreme cases these may rise to 38°C and 26°C respectively. Average daily minima range from about 13°C in January to 0°C in July, whereas extremes can sink to 1°C and –13°C respectively. The period during which frost is likely to form lasts on the average for about 120 days from May to September.

Table 4: Average monthly temperatures. – Climate of SA, WB 42 (1961 – 1990)

	AVERAGE OF DAILY			
	MAX	MIN	MEAN	RANGE
	TX	TN	(TX+TN)/2	TX - TN
J	25,6	13,8	19,7	11,8
F	25,2	13,2	19,2	12,1
M	24,6	11,8	18,2	12,8
A	21,8	8,6	15,1	13,2
M	19,5	4,4	11,9	15,1
J	16,5	0,8	8,7	15,6
J	17,1	1,0	9,0	16,2
A	19,9	3,8	11,9	16,1
S	23,2	7,5	15,3	15,7
O	23,9	9,9	17,0	14,1
N	24,0	11,8	17,9	12,3
D	25,3	13,1	19,2	12,2
YR	**22,2**	**8,3**	**15,3**	**13,9**

Table 5: Average Max temperatures. – Climate of SA, WB 42 (1961 – 1990)

	MAXIMUM (TX) P = 26 Years											
	HIGHEST (TXX)			AVERAGE NUMBER OF DAYS WITH TX						LOWEST (TXN)		
	MAX	YY/DD	MEAN	>=35	>=30	>=25	>=20	>=15	<10	MEAN	MIN	YY/DD
J	33,7	69/13	30,0	0,0	2,0	19,5	29,5	30,9	0,0	18,8	13,1	72/23
F	34,4	83/27	29,5	0,0	1,2	16,3	26,9	28,2	0,0	18,6	13,2	76/12
M	32,6	73/15	28,7	0,0	0,7	15,4	28,8	30,6	0,0	17,4	11,5	67/19
A	30,0	87/04	26,3	0,0	0,0	4,9	22,9	29,0	0,1	14,6	7,9	72/30
M	27,0	83/01	23,8	0,0	0,0	0,4	14,4	28,9	0,1	13,0	7,9	72/12
J	23,5	66/11	20,9	0,0	0,0	0,0	3,2	23,2	1,1	9,5	3,3	84/14
J	24,6	88/17	21,5	0,0	0,0	0,0	4,4	25,5	0,8	9,8	2,5	67/14
A	26,6	65/22	25,1	0,0	0,0	1,4	17,4	28,6	0,6	11,3	6,0	68/10
S	32,0	83/29	28,8	0,0	0,2	12,9	24,0	28,4	0,4	12,2	6,4	88/02
O	33,0	65/31	29,9	0,0	1,7	14,8	25,3	29,8	0,1	14,1	8,0	81/04
N	32,6	68/07	29,4	0,0	1,2	13,5	26,0	29,0	0,2	15,4	6,8	68/11
N	33,0	68/29	29,6	0,0	1,4	18,0	29,2	30,9	0,0	18,0	14,1	73/10
YR	**34,4**	**83/27**	**31,6**	**0**	**9**	**117**	**252**	**343**	**3**	**7,1**	**2,5**	**67/14**

A correlation exists between the temperatures and the evaporation tempo, therefore the highest temperatures and evaporation occurs during the summer.

Table 6: Average Min temperatures. – Climate of SA, WB 42 (1961 – 1990)

MINIMUM (TN) P = 26 Years												
HIGHEST (TNX)			AVERAGE NUMBER OF DAYS WITH TN						LOWEST (TNN)			
MAX	YY/DD	MEAN	>=20	<15	<10	<5	<0	<-5	MEAN	MIN	YY/DD	
18,5	83/29	16,6	0,0	22,2	1,1	0,0	0,0	0,0	9,7	6,5	77/02	J
20,5	79/05	16,6	0,0	22,2	2,4	0,0	0,0	0,0	8,6	5,5	63/28	F
20,1	79/20	15,8	0,0	28,6	6,3	0,2	0,0	0,0	6,6	0,5	74/19	M
15,5	87/05	13,4	0,0	30,0	18,7	3,7	0,2	0,0	2,2	-1,4	88/26	A
12,7	79/04	9,6	0,0	31,0	30,0	17,7	2,1	0,0	-1,3	-3,9	63/31	M
10,5	79/01	6,3	0,0	30,0	30,0	26,7	11,4	0,8	-4,4	-9,2	64/27	J
8,7	83/14	6,1	0,0	31,0	31,0	28,5	11,0	0,5	-4,1	-8,0	64/26	J
11,5	86/28	9,5	0,0	31,0	30,4	18,7	4,2	0,2	-2,8	-7,5	72/02	A
14,8	65/18	12,7	0,0	30,0	22,6	5,9	0,9	0,0	0,4	-4,8	74/08	S
16,9	67/24	14,7	0,0	30,5	13,4	2,1	0,2	0,0	3,7	-1,2	65/21	O
18,0	80/11	15,6	0,0	28,1	5,8	0,4	0,0	0,0	6,6	3,0	69/12	N
17,7	87/21	16,1	0,0	25,2	2,0	0,1	0,0	0,0	8,2	2,6	70/07	D
20,5	**79/05**	**17,3**	**0**	**340**	**194**	**104**	**30**	**1**	**-5,5**	**-9,2**	**64/27**	**YR**

Air temperature has important implications for the buoyancy of plumes; the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise. Temperature also provides an indication of the extent of insolation, and therefore of the rate of development and dissipation of the mixing layer.
The diurnal temperature profile for the site (2009) is given in the figure below (Diurnal temperature for site during 2009). Annual maximum, minimum and mean temperatures for the site are given as 25.7°C, 2.2°C and 15°C, respectively, based on the calculated MM5 data for the period 2009. Average daily maximum temperatures range from 25.7°C in December to 12.6°C in July, with daily minima ranging from 16.6°C in January to 2.2°C in July (Figure: Minimum, maximum and average monthly temperatures for the site during the period 2009).

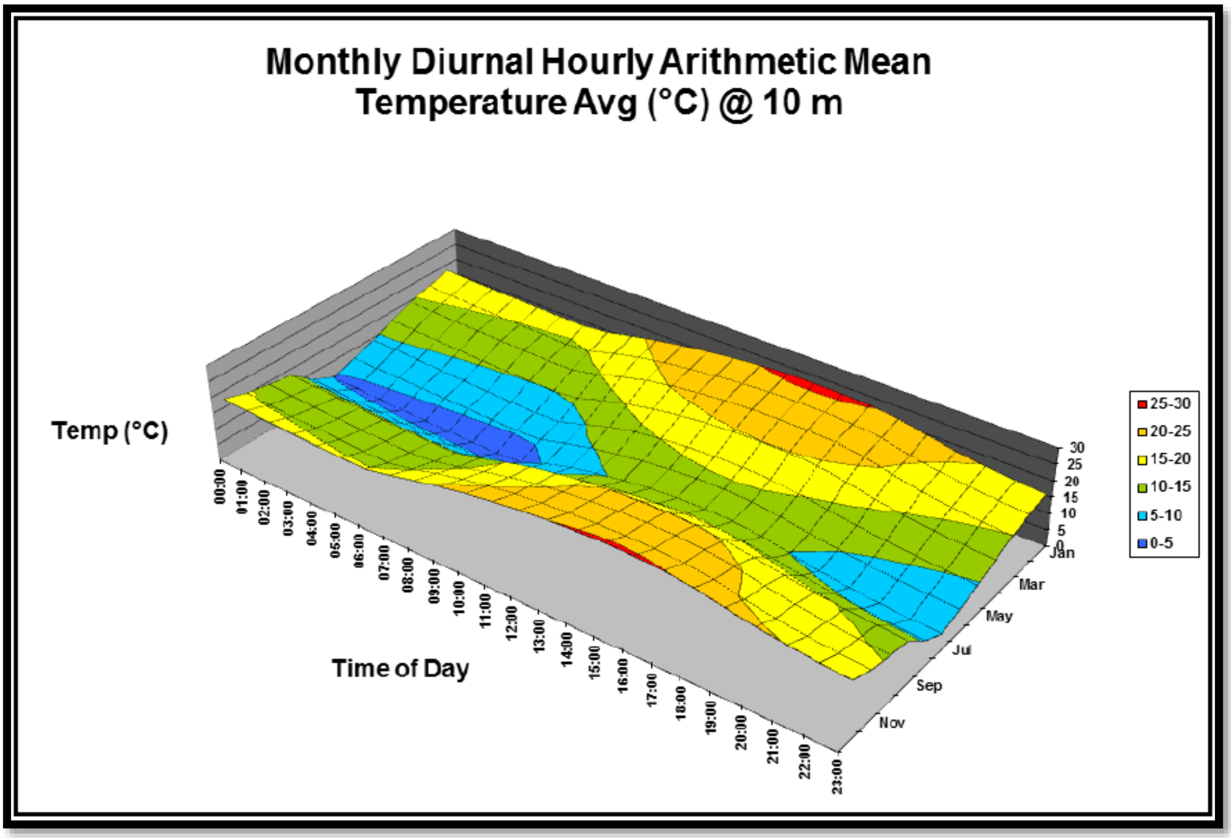


Figure 9: Diurnal temperature profile for the site (2009)

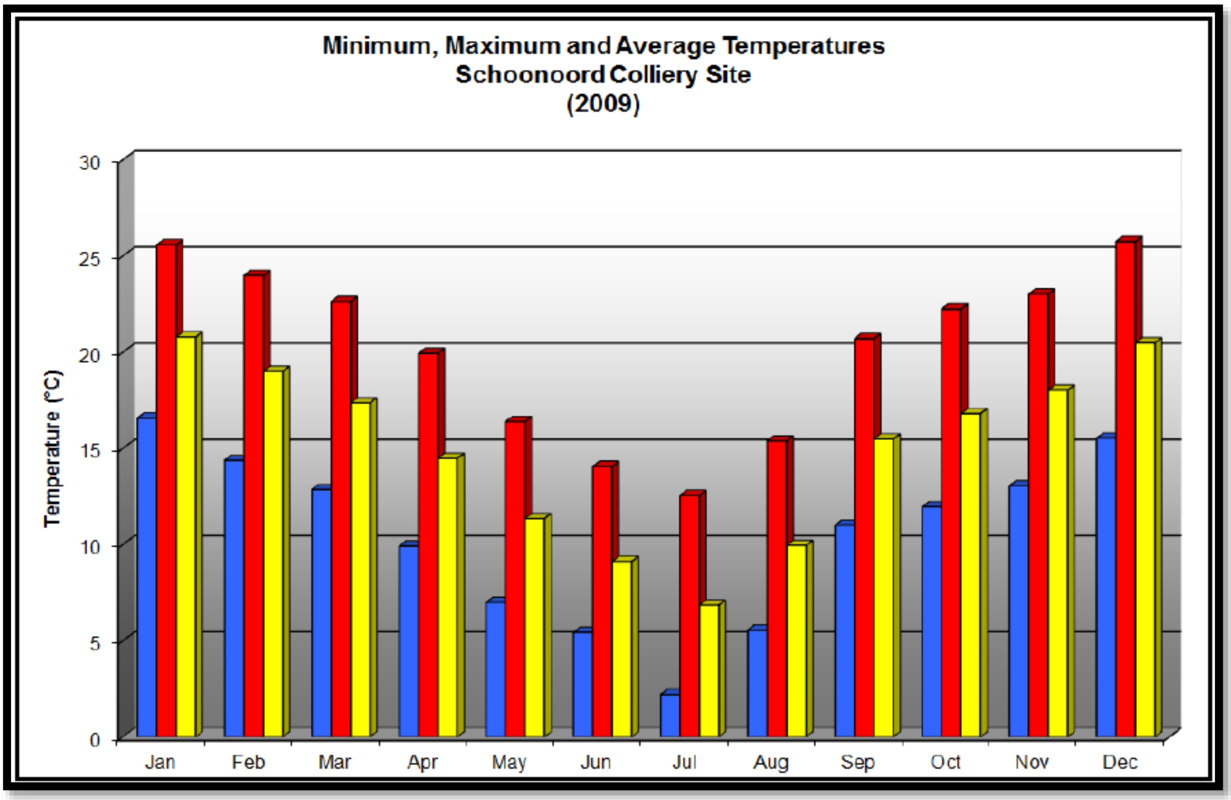


Figure 10: Minimum, maximum and average monthly temperatures for the site during the period 2009

3.5.4. EVAPORATION

The mean monthly evaporation records are obtained from Hydrological Information Publication No. 13, Evaporation and Precipitation Records, WB42, 1990. These records are listed in the table below.

Table 7: Evaporation data. – Climate of SA, WB 42.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1963	167.6	202.2	117.2	107.2	97.3	60.5	79.2	141.2	176.3	188	151.4	216.7
1964	177	180.6	187.7	123.7	106.9	78.5	94.5	142.5	194.3	160.9	189	158
1965	185.4	179.6	174.2	106.4	105.2	80.3	90.4	137.7	168.7	222	185.7	217.4
1966	187.7	135.1	179.3	128.8	121.2	82.3	115.3	142	181.4	196.3	189	166.4
1967	170.9	115.8	140	87.1	83.6	78.7	80.8	117.9	178.8	199.6	166.9	204
1968	200.5	188	110.2	102.2	78.4	67 8	106.2	137.3	186.9	241.1	155.7	209.5
1969	228.1	162.3	110.2	111.3	70.7	83.2	87.9	131.9	180.2	168.3		
1970		154.7	189	140.1	123.2	92.3		178.2		212	199.7	256.6
1971	163.3	154.1	195.5	123.8	98	93.4	117.7	167	200.8	196		198
1972	153	160.8	137.7	131.3	104.9	101.2	121.6	166.7	209.7	211.9	179.1	264.4
1973	227.4	157.2	188.5	98.6	114	105.6	108	147.4	230.9			190
1974	153.9	161.7	170.9	93.7	104	99.6	103	168.3	213.4	259.4	168.8	218.4
1975	174.5	136.6	138.5	103.2	81.8	66.2	81.9	116.3	142.2	174.6	158	
1976		130.6	100.2		59.5		75.5			157.6	159.7	174.9
1977	179.3	136.4	108.4	103.5	97.7	91.9	85.5	119.2	130.7			
1978					92.8		67.6	124.3	144.9	176	163.6	186.4
1979	178.6	157.1	151.6	117.2	84.9	73.9		104.5		165.5	159.8	164.5
1980	189.3	130.6	130.8	123.3	101.2	66.2	73.1		137.7	198.2	181.2	168.2
1981	156.2	109.5	131.5	102.8	70.8	74.3	72.4	88.8	144.2	148.5	175.7	184.8
1982	174.1		139	92.4	86.8	71.2	76	106	133.3	158.2	140.2	222.8
1983	177.3	153.5	141.9	109.7	102.6	69.9	82.4	104.2	167.4	153.4	169.9	158.5
1984	161.5	144.2	127.1	99.6	96.2	64.4	69.5	108.7	124	153.2	139.9	201.7
1985	164.1	123.5	130.4	116.4	85.5	76.9	82.2	114.6	125.8	169.2	174.5	189.2
1986	196.7	148.8	153.1	108.9	93.4	66.4		127.1	128.4	146.7	143.1	166.1
1987	189	153.2	139.4	123.2	110.3	77.1	87	122	118			184.5
AVE	**179.8**	**151.1**	**147.8**	**111.1**	**94.8**	**79.2**	**89**	**132**	**167**	**186.6**	**167.6**	**195.9**
	YEAR	AVE :	**1702**									

3.5.5. WIND REGIME

On the whole winds are light except for the short periods during thunderstorms. Very occasionally tornadoes do occur and cause tremendous damage if they happen to a strike a populated area. The figure indicating wind roses below provides period wind roses for the proposed Kebrafield Roodepoort Colliery, with the next figure including the seasonal wind roses for the same site. The predominant wind direction is northwesterly and easterly with a >10% frequency of occurrence. Winds from the southwesterly sectors are relatively infrequent occurring <5% of the total period. Calm conditions (wind speeds < 1 m/s) occur for 11% of the time.

Table 8: Hourly wind analysis. – Climate of SA, WB 42 (Witbank 1993 - 2000)

Hourly Wind Analysis

Percentage frequency (f) for each direction (incl calms) and average speed (s) in m/s

Analysis based on hourly values. - Witbank (1993/11/01 - 2000/12/31)

Month	Calm	N		NNE		NE		ENE		E		ESE		SE		SSE		S		SSW		SW		WSW		W		WNW		NW		NNW	
		f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s	f	s
1	5	9	3	4	3	3	2	4	3	19	4	19	4	7	4	3	4	4	3	3	3	2	3	2	3	5	3	4	3	3	3	5	3
2	4	8	3	4	2	3	2	4	3	21	4	22	4	6	3	3	3	5	3	3	3	2	3	2	3	5	3	3	3	3	2	3	2
3	6	10	3	4	3	3	2	4	2	17	3	17	4	6	3	3	3	4	3	2	3	2	3	2	3	5	3	5	3	5	3	5	3
4	8	11	3	4	3	2	2	2	2	12	3	12	3	6	3	4	3	6	3	3	3	2	3	3	3	6	3	7	3	6	3	5	3
5	8	8	3	3	2	2	2	2	2	7	3	11	3	7	3	4	3	8	3	6	3	5	3	5	3	9	3	7	3	6	2	4	2
6	11	8	3	2	2	1	2	1	3	4	3	8	3	6	3	4	3	9	3	7	3	4	3	5	3	9	3	8	3	7	3	5	2
7	9	11	3	3	3	2	3	2	2	8	4	12	4	7	3	4	3	7	3	5	4	3	3	3	3	7	3	7	3	6	3	6	3
8	7	14	3	5	3	3	2	3	3	9	3	10	3	5	3	2	3	6	3	6	4	3	4	3	3	6	3	6	3	6	3	6	3
9	4	20	3	7	3	4	3	4	3	12	4	7	4	3	3	1	3	3	3	4	4	3	4	2	3	5	3	6	3	6	3	10	3
10	3	19	4	8	3	5	3	4	3	14	5	10	5	3	4	2	3	4	4	2	4	1	4	2	3	5	3	5	3	5	3	8	3
11	3	24	3	8	3	5	3	5	3	11	4	7	4	3	3	1	3	3	4	3	4	2	4	2	3	4	3	5	4	6	3	7	4
12	3	20	3	6	3	4	3	4	3	13	4	9	4	3	4	2	3	3	4	2	4	1	3	2	3	5	3	7	3	6	3	8	3
Year	6	13	3	5	3	3	3	3	3	12	4	12	4	5	3	3	3	5	3	4	4	3	3	3	3	6	3	6	3	5	3	6	3

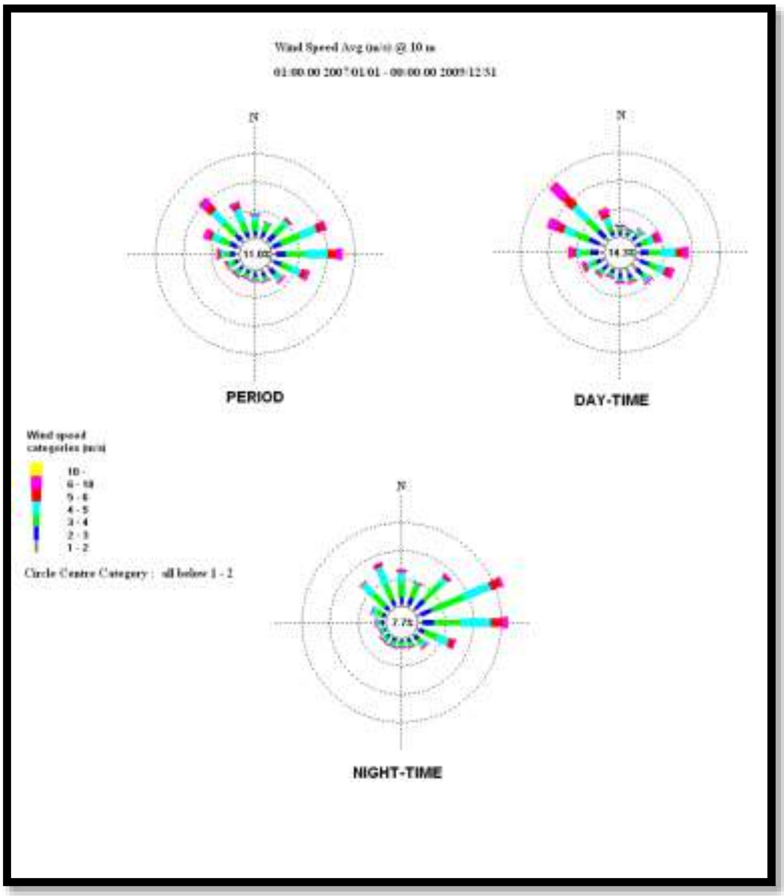


Figure 11: Period, day-time and night-time wind roses for Hendrina Wet Ash Disposal facility (1 January 2007 to 31 December 2009)

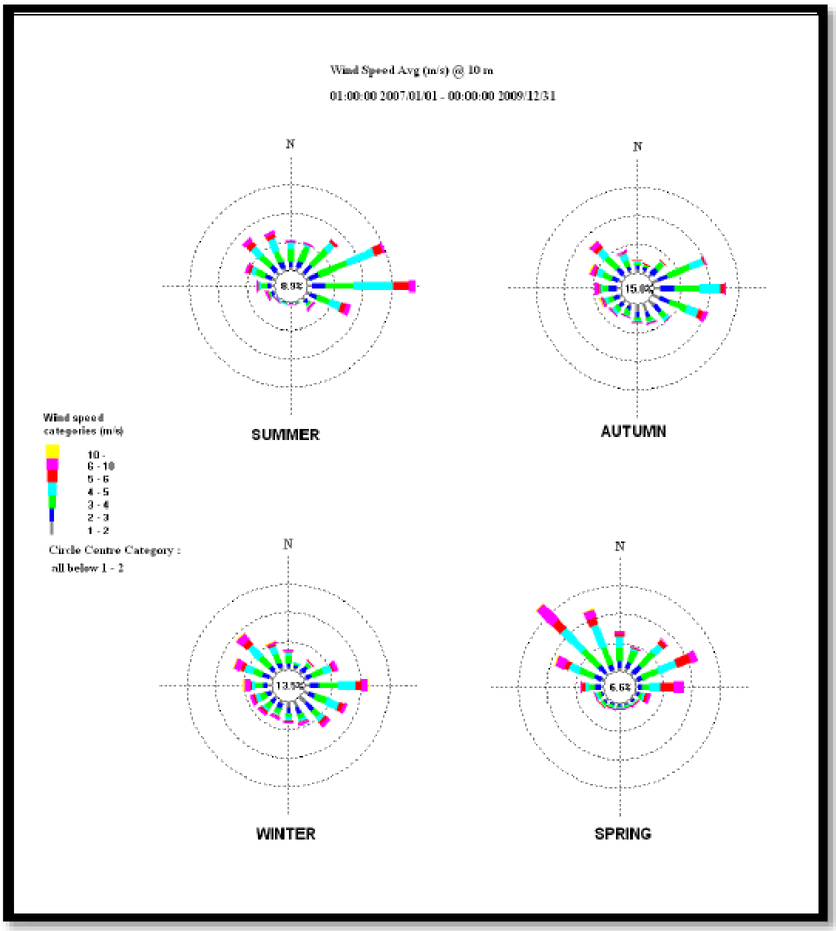


Figure 12: Seasonal wind roses for Hendrina Wet Ash Disposal facility (1 January 2007 to 31 December 2009)

A frequent northwesterly flow dominates day-time conditions with ~15% frequency of occurrence. During the night-time an increase in easterly and east-northeasterly flow is observed with a decrease in northwesterly air flow. During summer months, winds from the east become more frequent, due to the strengthened influence of the tropical easterlies and the increasing frequency of occurrence of ridging anticyclones off the east coast. There is an increase in the frequency of calm periods (i.e. wind speeds <1 m/s) during the winter months of 13.5%. Wind speeds in general range between 0 m/s and 14 m/s, with an average of 3.4 m/s.

3.5.5.1. ATMOSPHERIC STABILITY

The vertical component of dispersion is a function of the extent of thermal turbulence and the depth of the surface mixing layer. Unfortunately, the mixing layer is not easily measured, and must therefore often be estimated using prognostic models that derive the depth from some of the other parameters that are routinely measured, e.g. solar radiation and temperature. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated inversion. Radiative flux divergence during the night usually results in the establishment of ground based inversions and the erosion of the mixing layer. The mixing layer ranges in depth from ground level (i.e. only a stable or neutral layer exists) during night-times to the base of the lowest-level elevated inversion during unstable, day-time conditions. Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in the table below;

Table 9: Atmospheric stability classes

A	very unstable	calm wind, clear skies, hot daytime conditions
B	moderately unstable	clear skies, daytime conditions
C	unstable	moderate wind, slightly overcast daytime conditions
D	neutral	high winds or cloudy days and nights
E	stable	moderate wind, slightly overcast night-time conditions
F	very stable	low winds, clear skies, cold night-time conditions

The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

For low level releases, such as due to vehicle entrainment from unpaved roads, the highest ground level concentrations will occur during weak wind speeds and stable (night-time) atmospheric conditions. Wind erosion, on the other hand, requires strong winds together with fairly stable conditions to result in high ground level concentrations i.e. neutral conditions.

3.5.5.2. REGIONAL AMBIENT AIR QUALITY

The Department of Environmental Affairs (DEA) operates a monitoring network over the Highveld region at the residential areas of Hendrina, Ermelo, Middleburg, Secunda and eMalahleni. The closest monitoring station to the proposed Kebrafield Roodepoort Colliery is located at Hendrina. The highest daily and monthly PM10 concentrations for the period 2008-2010 are given in the following two figures respectively.

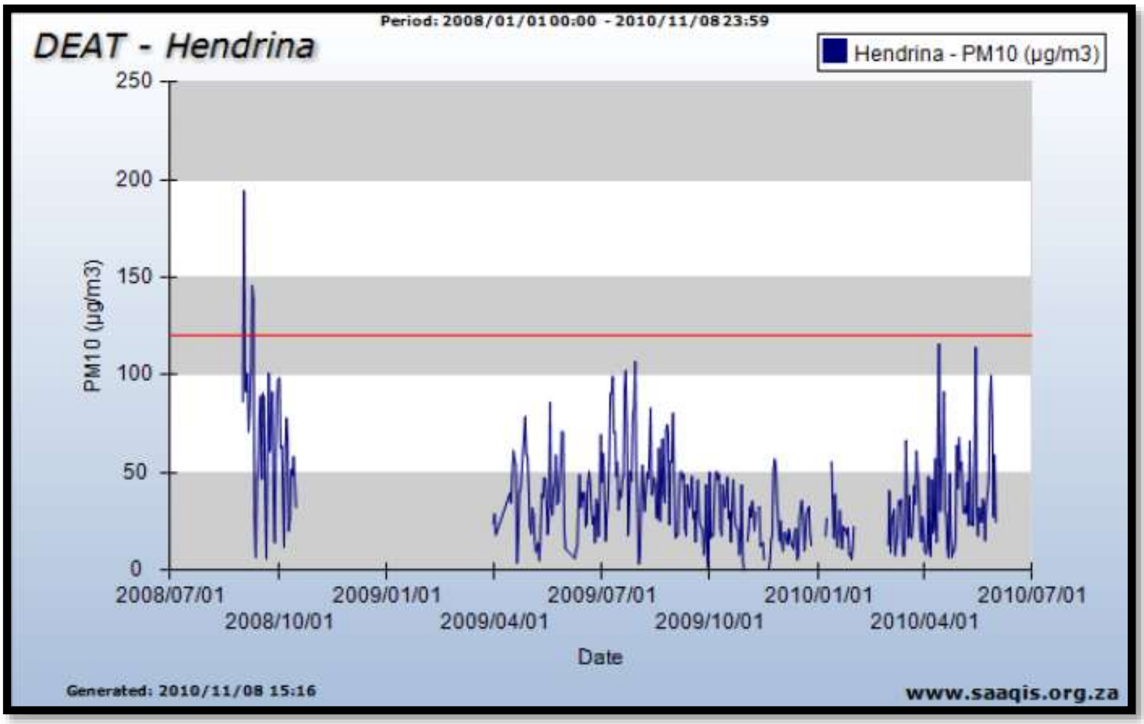


Figure 13: Daily measured PM10 ground level concentrations (µg/m³) at the Hendrina DEA monitoring station (for the period 2007-2010) (as downloaded from the SAAQIS website)

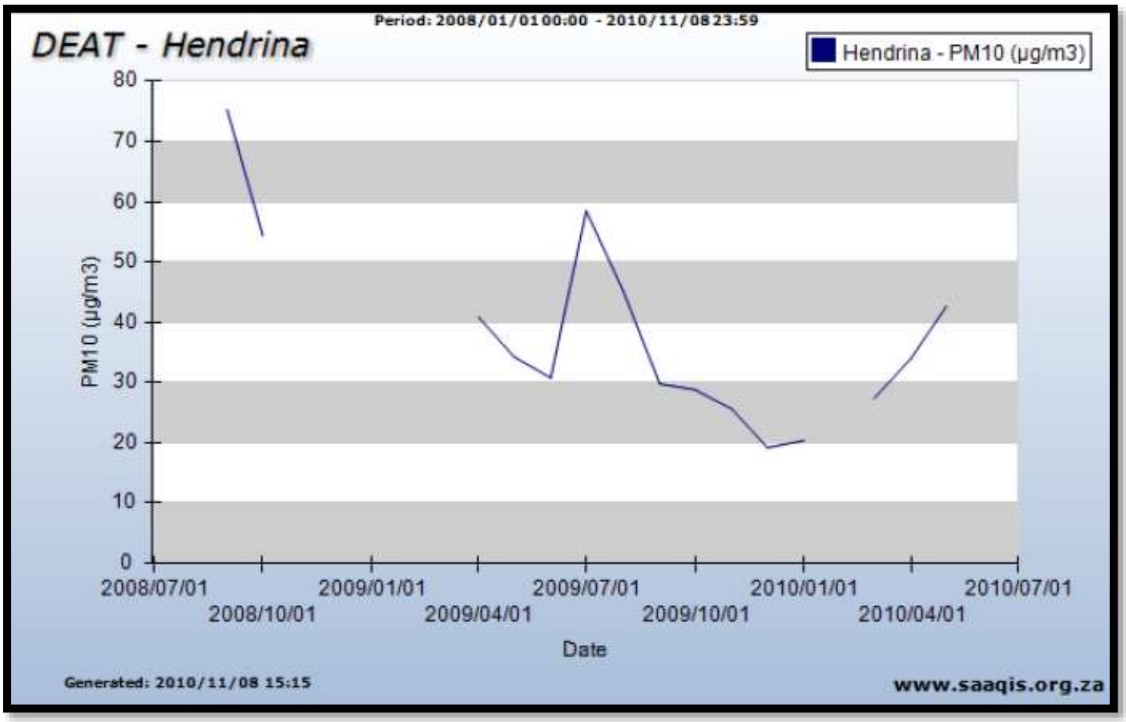


Figure 14: Monthly measured PM10 ground level concentrations (µg/m³) at the Hendrina DEA monitoring station (for the period 2007-2010) (as downloaded from the SAAQIS website)

Exceeding of the SA air quality PM10 limits were found to occur at the Hendrina monitoring station. However, the National Ambient Air Quality Standards (NAAQS) allow 4 daily exceedances per calendar year. When compared to the NAAQS applicable immediately till 31 December 2014, the predicted PM10 concentrations for the period

2008 – 2010 were found to result in less than 4 allowable exceedances. For the NAAQS applicable from 1 January 2015, the predicted concentrations for the period 2008 – 2010 were found to result in more than 4 allowable exceedances for the period 2009. Annual concentrations were estimated from the monthly PM10 concentrations for the period April 2009 to March 2010.

High ambient particulate concentrations have been found to coincide with low ambient temperatures and low rainfall. Increases in domestic coal burning and poor atmospheric dispersion potentials, together with persistent industrial emissions, combine to produce elevated ambient concentrations during winter months. High concentrations during summer months are usually associated with increases in fugitive dust emissions. Rainfall events result in a reduction of airborne concentrations due to reductions in the potential for fugitive dust emissions and due to the removal of particulates in the atmosphere by raindrops.

4. OVEVIEW

The National Environmental Management: Air Quality Act, Act No. 39 of 2004 is in the process of replacing, and has to a large extent already replaced, the Atmospheric Pollution Prevention Act (APPA), Act 45 of 1965. The Air Quality Act requires a shift from source-based air pollution control to a receiving environment, air quality management approach. Key features of the new approach to air quality governance include:

- Decentralisation of air quality management responsibilities
- A requirement that all significant sources be identified, quantified and addressed
- Setting of ambient air quality targets as goals to achieve emission reductions
- Recognition of source-based, command-and-control measures (i.e. authorities set source requirements and emission limits requiring adherence by responsible parties), in addition to alternative measures, including market incentives and disincentives, voluntary programmes, and education and awareness
- Promotion of cost-optimised mitigation and management measures
- Required air quality management planning by authorities and emission reduction and management planning by sources
- Access to information and public consultation
- The new approach has significant implications for government, business and civil society.

This report and investigation aims to identify potential air quality impacts which may result due to the proposed operations. This assessment forms part of the environmental impact assessment phase of this investigation and will focus on the impacts from the proposed mine in order to provide a better understanding of the magnitude of these impacts.

As a summary the following activities will be established and are associated with the proposed Kebrafield Roodepoort Colliery;

- Site preparation;
- Box cut opencast mining with a roll over rehabilitation sequence;
- Crushing and screening of the ROM coal;
- Access road, haul road construction and road diversion of the existing road;
- Semi temporary site offices and security office;
- Semi temporary sanitation and change house;
- Stores and store yard;
- Workshop and maintenance area;
- Bulk fuel storage;
- Pollution control facility/dam(s) (evaporation and dust suppression use);
- Clean and dirty water separation system;
- Trenching;
- Fencing;
- Mine fleet hard park;
- Staff and visitors parking;
- Drilling, blasting and explosives handling;
- Topsoil, subsoil, overburden, discard and ROM stockpiles;
- Weighbridge;
- Waste management;
- Mine closure and rehabilitation.

Particulate Matter

Particulate matter (PM) is the collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface. PM includes dust, smoke, pollen and soil particles (Kemp, 1998). PM has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease, aggravated asthma, acute respiratory symptoms, chronic bronchitis, decreased lung function, and an increased risk of myocardial infarction (USEPA, 1996).

PM can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions (USEPA, 1996):

- PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung);

- PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less);
- PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- Ultra fine particles generally defined as those less than 0.1 microns.

Particles can be classified by their aerodynamic properties into coarse particles, PM10 (particulate matter with an aerodynamic diameter of less than 10 µm) and fine particles, PM2.5 (particulate matter with an aerodynamic diameter of less than 2.5 µm) (Harrison and van Grieken, 1998). The fine particles contain the secondarily formed aerosols such as sulphates and nitrates, combustion particles and recondensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dust from roads and industries (Fenger, 2002).

Fine and coarse particles are distinct in terms of the emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters. Fine particles are directly emitted from combustion sources and are also formed secondarily from gaseous precursors such as sulphur dioxide, nitrogen oxides, or organic compounds. Fine particles are generally composed of sulphate, nitrate, chloride and ammonium compounds, organic and elemental carbon, and metals. Combustion of coal, oil, diesel, gasoline, and wood, as well as high temperature process sources such as smelters and steel mills, produce emissions that contribute to fine particle formation. Fine particles can remain in the atmosphere for days to weeks and travel through the atmosphere hundreds to thousands of kilometres, while most coarse particles typically deposit to the earth within minutes to hours and within tens of kilometres from the emission source. Some scientists have postulated that ultra fine particles, by virtue of their small size and large surface area to mass ratio may be especially toxic. There are studies which suggest that these particles may leave the lung and travel through the blood to other organs, including the heart. Coarse particles are typically mechanically generated by crushing or grinding and are often dominated by resuspended dusts and crustal material from paved or unpaved roads or from construction, farming, and mining activities (USEPA, 1996).

In terms of health impacts, particulate air pollution effects are broad, but are predominately associated with effects of the respiratory and cardiovascular systems (WHO, 2005). Particle size is important for health because it controls where in the respiratory system a given particle deposits. Fine particles have been found to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991). Larger particles are deposited into the extra thoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000). A study by Pope and Burnett (2002) indicated that PM2.5 leads to high plaque deposits in arteries, causing vascular inflammation and atherosclerosis (Kaonga and Kgabi, 2009). As yet, no evidence of a threshold in the relationship between particulate concentrations and adverse human health effects has been determined (Burger and Scorgie, 2000a; Burger and Scorgie 2000b; WHO 2005).

Short-term exposure

Recent studies suggest that short-term exposure to particulate matter leads to adverse health effects, even at low concentrations of exposure (below 100 µg/m3). Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function.

Long-term exposure

Long-term exposure to low concentrations (~10 µg/m3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000). Those most at risk include the elderly, individuals with pre-existing heart or lung disease, asthmatics and children; with an increased risk associated with an increase in exposure (WHO 2005).

<u>Nuisance Dust</u>

Nuisance dust may be defined as coarse fraction of airborne particulates. Nuisance dust is known to result in the soiling of materials and has the potential to reduce visibility. Nuisance dust has a long history of having little adverse effect on the lungs. Any reaction that may occur from nuisance dust is potentially reversible. However, excessive concentrations of nuisance dust in the workplace may reduce visibility, may cause unpleasant deposits in eyes, nasal passages and may cause injury to the skin or mucous membranes by the chemical or mechanical action. The light is scattered and visibility is diminished by the atmospheric particulate.

Various costs are associated with the loss of visibility, including: the need for artificial illumination and heating; delays, disruption and accidents involving traffic; vegetation growth reduction associated with reduced photosynthesis; and commercial losses associated with aesthetics. The soiling of building and materials due to dust frequently gives rise to damages and costs related to the increased need for washing, cleaning and repainting. Dustfall may also impact negatively on sensitive industries, e.g. bakeries or textile industries. Certain elements in dust may damage materials. For instance it was found that sulphur and chlorine if present in dust may cause damage to copper (Maeda *et al.*, 2001).

Nuisance dust can also cause serious aesthetic deterioration in the surrounding environment and communities. Fortunately due to relatively large particulate matter sizes associated with the mining emissions and the relatively short release height of the pollutants, such negative impacts are usually confined in relatively small areas. Within these areas of impact, fugitive dust may result in damage to the vegetation and agriculture. The deposited particulate matter may block the plant leaf stomata hence inhibit gas exchange, or smother the plant leaf surfaces reducing photosynthesis levels. Besides the impacts on vegetation, health effects of particulates on mine personnel and public may also be significant.

Air pollution is a recognized health hazard for man and domestic animals (Newman *et al.*, 1979). Air pollutants have had a worldwide effect on both wild birds and wild mammals, often causing decreases in local animal populations (Newman *et al.*, 1979). The major effects of industrial air pollution on wildlife include direct mortality, debilitating industrial-related injury and disease, physiological stress, anaemia, and bioaccumulation. Some air pollutants have caused a change in the distribution of certain wildlife species.

The importance of managing dust

Managing dust from coal mines is important as it can impact local and regional air quality, adversely affect local amenity and pose a risk to public health.

- **Protecting local and regional air quality**

An important aspect of the protection of air quality from coal mining operations is to minimise dust generated from sources such as wind erosion, crushing & screening, vehicles using unsealed roads and blasting. Coal mines are required by the National Environmental Management Air Quality Act to meet certain criteria for ambient air quality. In order to meet these criteria, coal mines must manage the emissions of dust from their activities in a competent manner.

- **Community health**

Health impacts of coal mine dust vary depending on the nature of the particles, their origin and their size, which is measured as particulate matter (PM). Exposure to fine particles can have potential health impacts on the respiratory system. Infants and children, elderly people, people with existing respiratory conditions, heart disease or diabetes may be more susceptible to the health effects from fine and coarse particles. Mines should be operated with proper dust controls to ensure that people are not affected by the dust they generate and their related health effects.

- **Community amenity**

If not properly managed, dust from coal mines can be a nuisance to local communities. Nuisance dust usually has a particle size larger than 10 microns (gravimetric dust fallout). High levels of nuisance dust may reduce visibility and amenity. The presence of nuisance dust can also cause a perceived increase in health risk. The impact of dust from mines on local amenity depends on the distance from the mine site and climatic conditions including wind speed and direction. Concerns about amenity from mine site dust often relate to the ‘visibility’ of dust plumes and dust sources. Visible dust is usually due to short-term episodes of high emissions, such as blasting. Other amenity impacts include dust depositing on fabrics (such as washing) or on house roofs, and dust transported from roofs to water tanks during rain.

5. RELEVANT LEGISLATION, GUIDELINES AND STANDARDS

National Environmental Management: Air Quality, 2004 (Act 39 of 2004)

The National Environmental Management: Air Quality Act 39 of 2004 has shifted the approach of air quality management from source-based control to receptor-based control. The Act made provision for National ambient air quality standards, however it is generally accepted that more stringent standards can be established at the Provincial and Local levels. Emissions are controlled through the listing of activities that are sources of emission and the issuing of emission licences for these listed activities. Atmospheric emission standards have been established for each of these activities and an atmospheric licence is now required to operate. The issuing of emission licences for Listed Activities will be the responsibility of the Metropolitan and District Municipalities. Municipalities are required to 'designate an air quality officer to be responsible for co-ordinating matters pertaining to air quality management in the Municipality'. The appointed Air Quality Officer will be responsible for the issuing of atmospheric emission licences or the Air Quality Officer could delegate the responsibility to the Director of community environmental services.

National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (Government Gazette No. 36794 - No. R 827)

Water and Environmental Affairs Minister Edna Molewa has published the National Dust Control Regulations on 1 November 2013, in terms of the National Environmental Management Air Quality Act, which prescribes general measures for the control of dust.

Restriction Areas	Dustfall rate (D) (mg/m²/day, 30-days average)	Permitted frequency of exceeding dust fall rate
Residential area	D < 600	Two within a year, not sequential months.
Non-residential area	600 < D < 1200	Two within a year, not sequential months.

According to the regulations, any person conducting any activity in such a way as to give rise to dust in quantities and concentrations that exceeded the dustfall standard set out in the regulation was impelled to, upon receipt of a notice from an air quality officer, implement a dustfall monitoring programme. The method to be used for measuring the dustfall rate and the guideline for locating sampling points would be the American Standards for Testing and Materials method, or an equivalent method approved by any internally recognised body.

The regulation further stated that an air quality officer could require any person, through a written notice, to undertake a dustfall monitoring programme if the officer reasonably suspected that the person was contravening the regulations or that the activity being conducted required a fugitive dust emission management plan.

A person required to implement the programme must then, within a specified period, submit a dustfall monitoring report to the air quality officer. A dustfall monitoring report must provide information on the location of sampling sites, classification of the area where samplers were located, as well as reference to the standard methods used for site selection, sampling and analysis. The report would also be required to provide meteorological data for the sampling area, the dustfall monitoring results, including a comparison of current year and historical results for each site, as well as a tabular summary of compliance with the dustfall standard.

Any person that had exceeded the dustfall standard must, within three months after submission of the dustfall monitoring report, develop and submit a dustfall management plan to the air quality officer for approval. This management plan must identify all possible sources of dust within the affected site, detail the best practicable measures to be undertaken to mitigate dust emissions, identify the line management responsible for implementation and incorporate the dust fallout monitoring plan.Such a plan would need to be implemented within a month of the date of approval and an implementation progress report must be submitted to the air quality officer at agreed time intervals.

Legislation for Local Government

The Local Government: Municipal Systems Act 32 of 2000, together with the Municipal Structures Act 117 of 1998, establishes local government as an autonomous sphere of government with specific powers and functions as defined by the Constitution. Section 155 of the Constitution provides for the establishment of Category A, B and C municipalities each having different levels of municipal executive and legislative authorities. According to Section 156(1) of the Constitution, a municipality has the executive authority in respect of, and has the right to, administer the local government matters (listed in Part B of Schedule 4 and Part B of Schedule 5) that deal with air pollution.

Ambient Air Quality Guidelines and Standards

Guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and well-being (WHO, 2000). Once the guidelines are adopted as standards, they become legally enforceable. The South African Bureau of Standards (SABS), in collaboration with DEA, established ambient air quality standards for gravimetric dust fallout and is listed in the table below.

South African National Standard – SANS1929:2011

Ambient air quality – Limits for common pollutants

Table 10: Limits for SO2

1	2	3
Average period	**Concentration** µg/m^3	**Frequency of exceedances**
10 min	500	526
1 h	350	88
24 h	125	4
1 year	50	0

Table 11: Limits for NO2

1	2	3
Average period	**Concentration** µg/m^3	**Frequency of exceedances**
1 hour	200	88
1 year	40	0

Table 12: Limits for PM10

1	2	3
Average period	**Concentration** µg/m^3	**Frequency of exceedances**
Interim		
24 h	120	4
1 year	50	0
Target		
24 h	75	4
1 year	40	0

Table 13: Limits for PM2.5

1	2	3
Average period	**Concentration** µg/m^3	**Frequency of exceedances**
24 h	65	
24 h	40	
24 h	25	
1 year	25	
1 year	20	
1 year	15	

Table 14: Four-band scale evaluation criteria for dust deposition

1	2	3	4
Band number	**Band description label**	**Dustfall rate, *D* (mg/m^{-2}·day^{-1}, 30-day average)**	**Comment**
1	Residential	*D* < 600	Permissible for residential and light commercial
2	Industrial	*D* ≤ 1 200	Permissible for heavy commercial and industrial.
3	Action	1 200 < *D* ≤ 2 400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year
4	Alert	D >2 400	Immediate action and remediation required following the first incidence of the dustfall rate being exceeded. Incident report to be submitted to the relevant authority

Table 15: Target, action and alert thresholds for dust deposition

1	2	3	4
Level	**Dustfall rate, *D* (mg/m^{-2}·day^{-1}, 30-d average)**	**Average period**	**Permitted frequency of exceeding dustfall rate**
Target	300	Annual	
Action residential	600	30 days	Three within any year, no two sequential months
Action industrial	1 200	30 days	Three within any year, not sequential months
Alert threshold	2 400	30 days	None. First incidence of dustfall rate being exceeded requires remediation and compulsory report to the relevant authorities

6. METHODOLOGY

For the purpose of the baseline investigation samples were taken on site for gravimetric dust fallout and particulate matter PM 10 and PM 2.5. The samples will be compared to the guidelines and standards while attention will also be given to relevant referencing sites of a similar nature in the vicinity of the proposed project area to determine the impacts that have been experienced before. Passive and active sampling techniques were used for the baseline determination as explained below.

Passive Sampling

Site layout for the sampling points was carried out according to the four main compass directions; the site layout and equipment placement is done in accordance with the ASTM standard, D 1739 – 2010, thereafter relevant sampling reference numbers were allocated to the receptors accordingly. At each gravimetric dust fallout gauge/receptor point there is a stand built according to specification containing the dust sample collection bucket. Samples were collected after a 1 month running period (+-30days exposure). After sample collection the samples are taken to the relevant SANAS accredited laboratory as required. A visual site investigation is done where after correlations and drawn and findings are identified and reported on.

Dust buckets of a standard size and shape are prepared and set up at locations related to the eight main compass points (currently limited to six sampling points due to sampling site in process of obtaining two more monitoring guages) on the borders of the property so that dust can settle in them for periods of 30+/-2 days. The dust buckets is then sealed and replaced with new empty ones and send away to the SANAS accredited laboratory for analysis. The masses of the water-soluble and –insoluble components of the material collected are then determined and results are reported as mg/m^2/day. This methodology is described according to South African National Standards 1929:2004 and the American Society for Testing and Materials (ASTM) Designation: D 1739-98 (2010). The results for this method of testing are obtained by gravimetrical weighing. The apparatus required include open top buckets/containers not less than 150mm in diameter with a height not less than twice its diameter. The buckets must be placed on a stand at a height of 2+/-0.2m above the ground.

Active Sampling

The ARW-9880 instrument that was used is 4 in 1 Particle Counter with 2.8" color TFT LCD display & a microSD memory card for capturing images(JPEG) or video(3GP) for viewing on a PC. This Particle counter is known for providing fast, easy and accurate readings for particle counter, air temperature & relative humidity, most surface temperature measurements. It is the first combination of these measurements globally and would therefore be the best instrument for environment protection and energy saving studies or investigations. It is a good tool for industrial and mining measurements and data analysing. The real scene and time can be displayed on colour TFT LCD.

Figure 15: CEM 9880 Particulate Sampler

Table 16: CEM 9880 Particle Sampler Specifications

Specifications	
Particle Counter	
Channel	0.3, 0.5, 1.0,2.5, 5.0, 10µm
Flow Rate	0.1ft^3(2.83L/min) controlled by internal pump
Count Modes	Totalize, Concentration, Audio
Coincidence Loss	5%, 2000000 particles per ft^3
Air Temperature Measure	
Air Temp Range	0 to 50ºC/32 to 122ºF; Basic Accuracy:±0.5ºC/1ºF
Humidity Range	0 to 100%RH; Basic Accuracy:±2.5%RH(20%~80%RH)
Dew Point Temp. Range	-30~100ºC/ -22~199ºF
Wet Bulb Temp. Range	0~80ºC/ 32~176ºF

Table 17: Air quality measurements locality descriptions

Site Reference	Location Description	GPS Coordinates
N	North	26° 0'6.30"S 29°34'43.05"E
E	East	26° 0'21.97"S 29°35'3.45"E
S	South	26° 0'34.28"S 29°34'50.15"E
W	West	26° 0'19.59"S 29°34'34.41"E

Figure 16: Air quality measurement locations

7. BASELINE AIR QUALITY MEASUREMENT RESULTS

The results from the air quality recordings which was taken for the month of April 2014 for all the sampled points are listed in the tables below.

Table 18: Gravimetric dust fallout measurement results

Gravimetric Dust Fallout (mg/m2/day)	
N	739
E	584
S	896
W	633

Table 19: Particulate Matter PM10 results

PM 10 ug/m3	
N	104
E	82
S	92
W	57

Table 20: Particulate Matter PM2.5 results

PM 2.5 ug/m3	
N	53
E	47
S	51
W	39

8. DISCUSSION OF THE BASELINE AIR QUALITY MEASUREMENT RESULTS

Sensitive receptors

Sensitive receptors which have been identified in the immediate vicinity of the study area and proposed project area have been listed in the table below.

Sensitive Receivers	Locality	Distance from project area
Agricultural lands under cultivation	West of project area	20m
Channelled wetland system	Parallel to site on eastern boundary	100m
Pullenshope residential area	South east of study area	500m
Closest farming homestead	South west of study area	2500m

Current air quality impacts

Baseline air quality samples have been taken for a 30day exposure period which would serve as emission inventory and reference once mining commence. It should however be noted that this exercise is only applicable to the time period when sampling took place during April 2014 and does not take into account seasonal and other local various that might occur during other months. However, it is still a good general overview of the existing air quality climate.

From the site visits, aerial photographs and background site description have the following sources been identified as potential pollution causes;

- **Vehicle exhaust gases**

Vehicle exhausts contain a number of pollutants including carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbons, oxides of nitrogen (NO_x), sulphur and PM10. Tiny amounts of poisonous trace elements such as lead, cadmium and nickel are also present. The quantity of each pollutant emitted depends upon the type and quantity of fuel used, engine size, speed of the vehicle and abatement equipment fitted. Once emitted, the pollutants are diluted and dispersed in the ambient air. Pollutant concentrations in the air can be measured or modelled and then compared with ambient air quality criteria.

- **Veldt fires**

Veld fires are widespread across the world, occurring in autumn, winter and early spring. In addition to controlled burning for fire-breaks and veld management, many fires are set deliberately for mischievous reasons. Some are accidental, notably those started by motorists throwing cigarettes out of car windows. Emissions from veld fires are similar to those generated by coal and wood combustion. Whilst veld fire smoke primarily impacts visibility and landscape aesthetic quality, it also contributes to the degradation of regional scale air quality. Dry combustible material is consumed first when a fire starts. Surrounding live, green material is dried by the large amount of heat that is released when there are veld fires, sometimes this material can also burn. The major pollutants from veld burning are particulate matter, carbon monoxide, and volatile organics. Nitrogen oxides are emitted at rates from 1 to 4 g/kg burned, depending on combustion temperatures. Emissions of sulphur oxides are negligible (USEPA, 1996).

- **Agricultural activities**

Little information is available with respect to the emissions generated due to the growing of crops. The activities responsible for the release of particulates and gasses to atmosphere would however include:

  - Particulate emissions generated due to wind erosion from exposed areas;
  - Particulate emissions generated due to the mechanical action of equipment used for tilling and harvesting operations;
  - Vehicle entrained dust on paved and unpaved road surfaces;
  - Gaseous and particulate emissions due to fertilizer treatment; and
  - Gaseous emissions due to the application of herbicides and pesticides.

- **Current mining activities North East of the project area**

Mining operations like drilling, blasting, hauling, collection, and transportation are the major sources of emissions and air pollution. Coal left in the ground can catch fire, and mine fires are difficult to control, with some burning for decades or even centuries, creating a major source of air pollution. The use of explosives releases carbon monoxide (CO). Dust and coal particles stirred up during the mining process, as well as soot released during coal transport, contributes to emissions and respiratory problems.

- **Vehicle use of the gravel road transecting the study area**

Dust emissions occur when soil is being crushed by a vehicle, as a result of the soil moisture level being low. Vehicles used on the roads will generate PM-10 emissions throughout the area and they carry soils onto the paved roads which would increase entrainment PM-10 emissions. The quantity of dust emissions from unpaved roads varies linearly with the volume of traffic.

- **Eskom Hendrina power station South East of the study area**

The coal fired combustion process in power stations produces large quantities of gaseous and solid waste that are mainly released into the air, or disposed of in large ash dumps or sludge and slurry ponds. The gaseous emissions contain a potent mixture of pollutants. Various studies have shown these pollutants to have adverse effects through air pollution (Pope, III et al., 2009; Dominici et al., 2006; Van Horen, 1996). To add fuel to the fire, so to speak, burning coal produces one and a half times the CO2 emissions of oil combustion and twice the amount of CO2 emissions from natural gas combustion, while producing the same amount of energy (Epstein et al., 2011). This difference holds true for many other pollutants produced during the electricity generation process. With regards to solid waste, ash dumps have been found to contribute to air pollution, particularly in the form a particulate matter (PM) when fly ash from ash dumps is carried into the atmosphere by the wind.

9. FINDINGS

9.1. PREDICTED IMPACTS

9.1.1. CONSTRUCTION PHASE

It is assumed that the construction activities will only take place during daylight hours. The following activities during the construction phase are identified as possible emission sources and may impact on the ambient air quality of the area:

- Site Clearing: Stripping and removal of topsoil & vegetation;
- Construction of any surface infrastructure e.g. haul roads, pipes, stormwater diversion berms (including transportation of materials & stockpiling); and
- Blasting and development of initial boxcut for mining (incl. stockpiling from initial cuts)

During the construction assessment phase it is expected that, the main sources of impact will result due to the construction of haul roads, the plant area and the initial box cut associated with open pit mining. These predicted impacts cannot be quantified, primarily due to the lack of detailed information related to scheduling and positioning of construction related activities. Instead a qualitative description of the impacts will be provided. This will involve the identification of possible sources of emissions and the provision of details related to their impacts. Construction is commonly of a temporary nature with a definite beginning and end. Construction usually consists of a series of different operations, each with its own duration and potential for dust generation. Dust emission will vary from day to day depending on the phase of construction, the level of activity, and the prevailing meteorological conditions (USEPA, 1996).

Possible sources of fugitive dust that have been identified that can result during the construction phase include;

- Construction and Grading of Haul Roads
  - Scraping;
  - Overburden handling;
  - Overburden stockpiles; and
  - Truck transport and dumping of debris.
- Preparation of plant (crushing and screening) area
  - Clearing of area for infrastructure;
  - Overburden handling;
  - Overburden stockpiles; and
  - Truck transport and dumping of debris.
- Establishment of mining operations
  - Removal of overburden; and
  - Setting up of site offices and workshop

Construction and grading of haul roads

The construction of haul roads take place through removing the topsoil and then grading the exposed surface in order to achieve a smooth finish for vehicles to move on. Temporary stockpiles will be created close to the edge of the road in order to be backfilled easily once the road has expired or need to be rehabilitated. Haul trucks generate the majority of dust emissions from surface mining sites. Observations of dust emissions from haul trucks show that if the dust emissions are uncontrolled, they can be a safety hazard by impairing the operator's visibility. Substantial secondary emissions may be emitted from material moved out from the site during grading and deposited adjacent to roads (USEPA, 1996). Passing traffic can thus loosen and re-suspend the deposited material again into the air. In order to minimize these impacts the stockpiles should be vegetated for the duration that it is exposed. Hydroseeding applications are very useful for this purpose. Dust suppressants could also be considered to be added to the water trucks in order to lower the impacts. Regular watering and application of chemical dust suppressants are the only alternatives in controlling mine haul road dust emissions.

Preparation of plant (crushing and screening) area

Material will be removed by using a bulldozer and then storing this material seperatly for use during rehabilitation at end of life of mine when the operation cease. These construction sites are ideal for dust suppression measures as land disturbance from clearing and excavation generates a large amount of soil disturbance and open space for wind to pick up dust particles and deposit it elsewhere (wind erosion). Issues with dust can also arise during the transportation of the extracted material, usually by truck and shovel methods, to the stock piles. The dust can further be created by the entrainment from the vehicle itself or due to dust blown from the back of the bin of the trucks during transportation of material to and from stockpiles. Stockpiles should not be left for prolonged periods as wind energy generates erosion and causes more dust to form. It should be noted that emissions generated by wind are also dependent on the frequency of disturbance of the erodible surface and therefore covering the stockpiles with vegetation would reduce the negative erosion effect. Any crusting of the surface binds the erodable material (USEPA, 1996). All stockpiles should be damped down, especially during dry weather or re-vegetated (hydroseeding is a good option for slope revegetation).

Establishment of mining operations

Opencast mining will commence with the clearing of the site and stripping of the vegetation for the initial boxcut. Topsoil and overburden need to be removed and stockpiled separately by means of truck and shovel methods (front end loaders, excavators and haul trucks). Once the rock has been reached will blasting be required to further remove material to the point where the mineral can be extracted. Bulldozing, excavation, drilling and blasting operations will result in the emission of dust to atmosphere. Dust emitted during bulldozing activity can be reduced by increasing soil dampness by watering the material being removed thus increasing the moisture content. Another option would be to time the blasting with wind to ensure the dust will not be blown to the sensitive receptors or especially the community. Blasting should also not take place when poor atmospheric dispersion are expected i.e. early morning and late evening. Material need to be removed to dedicated stockpiles to be used during rehabilitation. This hauling of materials should take place on roads which is being watered and/or sprayed with dust suppressant. To reduce the amount of dust being blown from the load bin in the haul roads, the material being transported can be watered or the back of the vehicles can be covered with plastic tarpaulin covers.

Table 21: Recommendations for the control of fugitive dust emissions during the construction phase (USEPA, 1996).

Emission Source	Recommended Control Methods
Discard handling and discard piles	Wind speed reduction Wet suppression [1]
Truck transport [2]	Wet suppression Paving Chemical stabilisation [3]
Bulldozers	Wet suppression
Pan scrapers	Wet suppression of travel routes
Cut/fill material handling	Wind speed reduction Wet suppression
Cut/fill haulage	Wet suppression Paving Chemical stabilisation
General construction	Wind speed reduction Wet suppression Early paving of permanent roads
Note: [1] Dust control plans should contain precautions against watering programs that generate excessive mud. [2] Loads could be covered to avoid loss of material in transport, especially if material is transported offsite. [3] Chemical stabilisation is usually cost-effective for relatively long-term or semi-permanent unpaved roads.	

Wet suppression is one of the common methods used to control open dust sources at construction sites. It is possible for water to be combined with a surfactant as wetting agent. Surfactants increase the surface tension of water, reducing the quantity of water required. The Dust-A-Side (DAS) product binds with the aggregate used to build on-site roads. However the treatment with chemical stabilizer can have an effect on plant and animal life and the contamination of the treated material (USEPA, 1996).

Dust and mud should be controlled at vehicle exit and entry points to prevent the dispersion of dust and mud beyond the site boundary. Daily removal of mud and dirt carried out from the site to adjacent paved roads. Facilities for the washing of vehicles could be provided at the entry and exit points. Vehicles should travel at a speed of 40km/ hr at over exposed areas and where stockpiles are situated (USEPA, 1996).

All stockpiles should be maintained for as short a time as possible and a water spray system should be operated at any gravel stockpile and should be shielded from wind. During the transfer of material to stockpiles, drop heights should be minimised to control the dispersion of materials being transferred (USEPA, 1996).

9.1.2. OPERTIONAL PHASE

The following activities during the operational phase are identified as possible fugitive emission sources and may impact on the ambient air quality at the relevant environmental sensitive receivers:

- Removal of overburden and backfilling when possible (including drilling/blasting hard overburden & stockpiling);
- Use and maintenance of haul roads (incl. transportation of coal to washing plant off site);
- Removal of coal (mining process) and ROM coal Stockpile; and
- Concurrent roll-over backfill rehabilitation and replacement of overburden, topsoil and revegetation.

Mining methods vary widely and depend on the location, type and size of mineral resources. Surface mining methods are most economical in situations where mineral deposits occur close to the surface (e.g. coal, salts and other evaporite deposits or road quarry material) or form part of surface deposits (e.g. alluvial gold and diamonds, and heavy mineral sands). For this specific project the mining of coal by means of surface mining methods are viable due to the fact that the resource is situated close enough to the surface to make it economically mineable. Typical surface mining methods include: strip mining and open pit mining, as well as dredge, placer and hydraulic mining in riverbeds, terraces and beaches. The Kebrafield Roodepoort Colliery will be mined by means of open pit or also known as opencast mining methods following a roll over rehabilitation sequence. These activities always disrupt the surface and this, in turn, affect soils, surface water and near-surface ground water, fauna, flora and all alternative types of land-use (Fuggle & Rabie, 1996; Ashton, 1999).

Besides the rate and method of mining, the location, variety and scale of mine infrastructure also influences the nature and extent of impacts. The Kebrafield Roodepoort Colliery will be mined relatively quickly in a period of one year compared to other mining operations that could last for several years and/or even decades. The fast mining sequence will ensure impact duration during mining is short. Typical mine infrastructure includes: haul roads and spoil dumps; surface facilities (e.g. offices, workshops, car parks and warehouses); tailings and waste rock disposal areas; transport and service corridors (e.g. railway lines, roads, pipelines, conveyers, power and water corridors); product stockpiles; chemicals and fuel storage and housing facilities (Australian Environmental Protection Agency, 1995-1996; Fuggle & Rabie, 1996; Ashton, 1999; Weaver & Caldwell, 1999).

The most economical method of coal extraction from coal seams depends on the depth and quality of the seams, and also the geology and environmental factors of the area being mined. The impact of coal mining processes is generally differentiated by whether they operate on the surface or underground. In this instance the mineral will be won by means of opencast surface mining methods as indicated in the figures above. Coal is mined only where technically feasible and economically justifiable. Evaluation of technical and economic feasibility of a potential mine requires consideration of many factors: regional geologic conditions, overburden characteristics, coal seam continuity, thickness, structure, quality, and depth; strength of materials above and below the seam for roof and floor conditions; topography (especially altitude and slope); climate; land ownership as it affects the availability of land for mining and access; surface drainage patterns; ground water conditions; availability of labour and materials; coal purchaser requirements in terms of tonnage, quality, and destination; and capital investment requirements.

The Kebrafield Roodepoort Colliery operation proposes to use the rollover mining and rehabilitation method. Roll-over opencast mining is typical of small scale opencast mining operations in the Mpumalanga coal fields. The proposed mining entails only opencast methods for this stage of the project. The opencastable reserves will be mined in conventional truck and shovel mining methods using the lateral roll-over technique in a single direction. This would mean mining from the one side of the development footprint in a linear fashion towards the opposite side while backfilling and rehabilitating the area that has already been mined, thus creating the effect that the mining cuts are rolling over in a single direction. Sustainable development applied to mining works necessarily includes rehabilitation with the aim of either restoring the land to its original use, or eliminating or reducing adverse environmental impacts to a long-term acceptable condition. The process is driven primarily by legislation which ensures that the mine owner must comply with the intention of achieving those end conditions, which are defined in broad terms by guidelines.

An initial box cut as well as an access pit ramp into the box will be constructed first. A double box cut has been planned to enable mining in both a northerly and southerly direction, thereby increasing the face length and production rates. The ramp will have a maximum slope of 12˚. Topsoil from the initial box cut will be stripped, where after the subsoil and hard overburden will be drilled, blasted and removed. Topsoil, subsoil and hard overburden will each be stockpiled separately. After removal of the coal from the initial box cut, subsequent box cuts will be made and the initial void filled with the stockpiled hard overburden, subsoil and finally topsoil which will then be seeded and grasses to re-establish vegetation coverage to grazing capability.

The primary procedures that will be implemented during the mining process include;

- Removing and stockpiling of topsoil;
- Construction of the pollution control evaporation dam(s) also used for dust suppression;
- Trenching around the mining footprint to ensure stormwater is diverted away from the open cast pit;
- Blasting, stripping and stockpiling of overburden;
- Excavation of the initial strip of the box-cut;
- Excavation of coal (ROM);
- Crushing, screening and stockpiling coal;
- Backfill rehabilitation concurrently as mine progress forward.

Possible mitigation measures / best practices

- **Drilling and Blasting**
    - Use of pre-blast environmental checklists, real-time weather monitoring data and stringent controls on blasts carried out in sensitive areas
    - A no-blast arc is automatically calculated for the nearest private residence based on the latest relevant weather conditions, including wind speed and direction, temperature inversions and amount of atmospheric turbulence (i.e. stability category) before the blast can be fired

- **Material Extraction**
    - Low or in-pit dumping of overburden during high wind conditions

- **Transport and Transfer of Material**
    - Use of a global positioning system as a tool to track the locations of mining and dust suppression equipment (e.g. water carts) and cross-referencing this information with real-time weather monitoring to assist with dust control
    - Use of water sprays at each contact or transfer point along the conveyance system which have adjustable rates of application (low, medium and high) depending on dust levels
    - Automatic water sprays installed at the ROM hopper bin that produce a fine mist to suppress dust generated with the triggering of sensors when a truck enters the dump zone and automatic sprays activated until a set time following the departure of the truck
    - Use of a reclaim tunnel at the product coal stockpile and an enclosed conveyor to transfer coal to the rail loader, both of which minimise dust generation

- Use of a retractable telescopic chute with curtains to load coal into train carriages

- **Storage of Material**
  - Automatic sprays installed around the perimeter of the ROM stockpile activated when the wind speed is >6 mm/sec (averaged over 15 minutes)
  - Finished product stockpiles formed on an as-needs basis with stockpiled coal loaded out by rail within 24 hours
  - A tree windbreak located downwind of the prevailing wind direction to minimise dust from the finished product stockpiles
  - Topsoil handling and storage procedures including stockpile inventory, vegetative cover and signage to optimise rehabilitation and minimise wind erosion
  - Successful trialling of a chemical dust suppressant on haul roads resulting in a considerable reduction in the amount of water used for dust suppression on haul roads

- **Exposed Areas**
  - Successful trialling of broadacre temporary rehabilitation of unshaped overburden emplacement areas by aerial sowing of a cover crop, providing an established vegetative stabilisation to minimise the potential for windblown dust generation
  - Constricting the areas and time of exposure of pre-strip clearing in advance of mining development

9.1.3. DECOMMISSIONING/CLOSURE PHASE

It is assumed that the decommissioning activities will only take place during daylight hours. The following activities during the decommissioning phase are identified as possible air impacting sources and may impact on the ambient air quality at the relevant sensitive receivers:

- Demolition & Removal of all infrastructure (incl. transportation off site); and
- Rehabilitation (spreading of soil, revegetation & profiling/contouring);

The decommissioning phase is associated with activities related to the demolition of infrastructure and the rehabilitation of disturbed areas. The following activities are associated with the decommissioning phase (US-EPA, 1996):

- Existing buildings and structures demolished, rubble removed and the area levelled;
- Remaining exposed excavated areas filled and levelled using overburden recovered from stockpiles;
- Stockpiles to be smoothed and contoured;
- Topsoil replaced using topsoil recovered from stockpiles; and

- Disturbed land prepared for revegetation.

Possible sources of fugitive dust emission during the closure and post-closure phase include:

- Smoothing of stockpiles by bulldozer;
- Grading of sites;
- Transport and dumping of overburden for filling;
- Infrastructure demolition;
- Infrastructure rubble piles;
- Transport and dumping of building rubble;
- Transport and dumping of topsoil; and
- Preparation of soil for revegetation – ploughing and addition of fertiliser, compost etc.

Exposed soil is often prone to erosion by water. The erodability of soil depends on the amount of rainfall and its intensity, soil type and structure, slope of the terrain and the amount of vegetation cover (Brady, 1974). Revegetation of exposed areas for longterm dust and water erosion control is commonly used and is the most cost-effective option. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for revegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

10. MONITORING PROGRAMME

Monitoring Aspect	Receptors	Frequency
Gravimetric Dust Fallout	8 main wind directions border of property	Monthly
Particulate Matter PM10	8 main wind directions border of property and at fugitive dust sources	Monthly
Sulphur Dioxide	4 sample points, border of property	Quarterly
Noise	8 sampling points, border of property and at sensitive receptors as required	Quarterly

- **Gravimetrical Dust Fallout – (milligram/square meter/day) or (mg/m^2/day) (monthly 8 samples)**

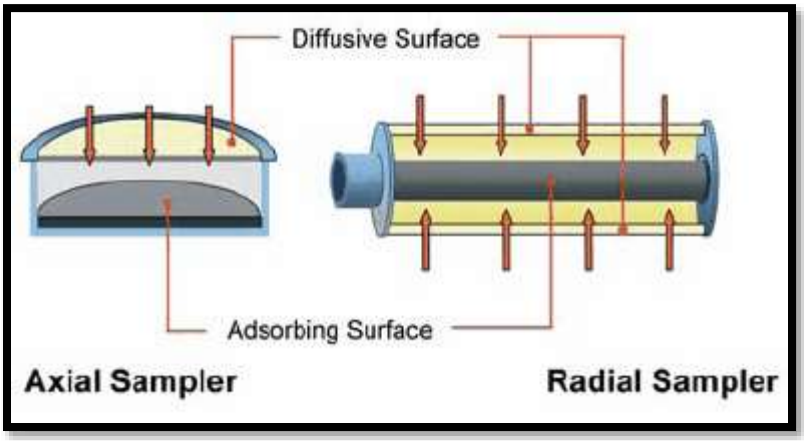
Site layout for the sampling points will be carried out according to the eight main compass directions; the site layout and equipment placement is done in accordance with the ASTM standard, D 1739 – 2010, thereafter relevant sampling reference numbers will be allocated to the receptors accordingly. At each gravimetric dust fallout gauge/receptor point there is a stand built according to specification containing the dust sample collection bucket. Samples will be collected after a 1 month running period (+-30days exposure). After sample collection the samples are taken to the relevant SANAS accredited laboratory as required. A visual site investigation is done where after correlations and drawn and findings are identified and reported on.

Dust buckets of a standard size and shape are prepared and set up at locations related to the eight main compass points (currently limited to six sampling points due to sampling site in process of obtaining two more monitoring gauges) on the borders of the property so that dust can settle in them for periods of 30+/-2 days. The dust buckets is then sealed and replaced with new empty ones and send away to the SANAS accredited laboratory for analysis. The masses of the water-soluble and –insoluble components of the material collected are then determined and results are reported as mg/m^2/day. This methodology is described according to South African National Standards 1929:2004 and the American Society for Testing and Materials (ASTM) Designation: D 1739-98 (2010). The results for this method of testing are obtained by gravimetrical weighing. The apparatus required include open top buckets/containers not less than 150mm in diameter with a height not less than twice its diameter. The buckets must be placed on a stand at a height of 2+/-0.2m above the ground.

- **Particulate matter PM10 & PM 2.5 sampling (monthly 8 samples)**
  - Handheld particulate sampling equipment will be utilised as indicated in the image below and specified in the accompanying table.

Specifications:	
Particle Counter	
Channel	0.3, 0.5, 1.0, 2.5, 5.0, 10µm
Flow Rate	0.1ft3(2.83L/min) controlled by internal pump
Count Modes	Totalize, Concentration, Audio
Coincidence Loss	5%, 2000000 particles per ft3
IR Temperature Measure	
IR Temp. Range	-20.0°C to 500.0°C/-4.0°F to 916°F ; Basic Accuracy: ±1.5% of reading
Optical Resolution	8:1 Distance to Spot size
Emissivity Adjustable	0.10~1.0 Adjustable
Response Time	500mS
Air Temperature Measure	
Air Temp Range	0 to 50°C/32 to 122°F; Basic Accuracy:±0.5°C/1°F
Humidity Range	0 to 100%RH; Basic Accuracy:±2.5%RH(20%~80%RH)
Dew Point Temp. Range	-30~100°C/ -22~199°F
Wet Bulb Temp. Range	0~80°C/ 32~176°F

- **Sulphur Dioxide (4 samples quarterly)**
    - Gas sampling will be conducted quarterly to determine the risk of coal burning due to spontaneous combustion contributing to air quality deterioration
    - Radiello passive diffuse sampling badges as illustrated below will be utilised for this purpose;



11. CONCLUSION

Based on the results presented the following recommendations are outlined:

- It is recommended that ambient air quality monitoring be undertaken to establish the baseline condition prior to the onset of operations on-site and in order to establish the level at which the proposed operations are noted to impact on the ambient air quality.
- Fallout monitoring should be included to assess the level of nuisance dust associated with both mining and process related operations. Sampling of fallout should be undertaken within the neighbouring areas as well as on-site. Dust fallout monitoring should ideally be located on-site, around the pit and shafts, at the crusher and in the vicinity of major storage piles, with the more sensitive areas to the south and south-eat due to predicted levels of exceedance and due to the proximity of sensitive receptors of the site being focused on.
- Indicative PM10 and PM2.5 dust monitoring must also be undertaken at the same sites as mentioned under the previous bullet but also in and around potential fugitive emission sources to determine mitigation measures and focus management efforts
- Ambient gas monitoring must also be conducted as a risk management precaution to determine whther spontaneous combustion of coal occurs

Due to emissions being generated from roads and storage piles it is recommended that all piles should be maintained for as short a time as possible and all permanent stockpiles should be vegetated. The use of a water spray system at transitional stockpiles is also recommended. Wind breaks can similarly be used in close proximity to stockpile areas in order to reduce the potential erosive forces of the wind. During the transfer of material to piles, drop heights should be minimised to control the dispersion of materials being transferred (USEPA, 1996).

Wet suppression is one of the common methods used to control open dust sources at sites and on roads, because a source of water is readily available on a construction and mine site. Water may also be combined with a surfactant as wetting agent. Hydroseeding of exposed surfaces and especially stockpiles must also be carried out to ensure potential particulate displacement is minimized as a result of the vegetation cover binding the soil particles together and also serving as dissipating structures to reduce the velocity and energy of wind.

The study area is situated in a region which already experience affected air quality as a result of current mining activities and other industrial activities (Eskom Hendrina Power Stations) in relative close proximity to the proposed site. From the baseline data could it be gathered that the main direction of impact will luckily not be in the direction of Pullenshope mainly as wind rose diagrams indicate that during summer and autumn the main wind directions are from east to west away from the town. Although, winter and spring conditions does indicate more potential pollution towards the direction of the town. During these periods dust suppression and on-site management and mitigation measures as proposed in this report must especially be thoroughly implemented in order to assure the potential impact is minimised and controlled.

Through implementation of the management and mitigation measures and continuous compliance monitoring are we of the opinion that the potential impact the proposed Kebrafield Roodepoort Colliery will have on the receiving environment can be mitigated to an extent where the significance will be low and that the proposed project could go forward without a detrimental impact on the environment.

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