Chapter J: Groundwater

The following methodology was applied in support of the groundwater specialist study:

- A desktop study of all available and relevant baseline environmental information.
- Surface geophysical investigation to identify secondary structures and suitable drilling targets for characterisation boreholes.
- Drilling of percussion boreholes to refine the understanding of local groundwater flow dynamics, i.e. understanding of the hydrostratigraphic units, their water-bearing characteristics and linkages between source(s) and receptor(s). Successfully completed boreholes were equipped for long-term groundwater monitoring purposes.
- Aquifer testing and groundwater sampling for purpose of determining aquifer characteristics such as aquifer type and groundwater flow characteristics, aquifer parameters and water quality.
- Geohydrological baseline description and formulation of conceptual models for the study area.
- Numerical modelling to simulate and predict potential impacts from the proposed infrastructure development and operation.
- Assessing the potential impacts of the proposed activities on groundwater.

A field investigation programme was initiated in order to confirm the geohydrological baseline conditions and to refine the conceptual understanding of the site.

1 Regional Hydrogeology

1.1 Aquifer Classification

The study area is directly underlain by rocks of the Vryheid Formation occurring in the Ecca Group of the Karoo Supergroup. The Vryheid Formation consists predominantly of thick beds of yellowish to white cross-bedded sandstone and grit alternating with beds of soft sandy shale. The Vryheid Formation also contains coal seams and is widely intruded by dolerite sills. The Ecca Group overlies the Dwyka Group (tillites) of rocks.

According to the regional aquifer classification map of South Africa, the surrounding Karoo aquifer has been identified as a minor aquifer with good groundwater quality (<300 mg/l TDS), a medium to high vulnerability and a medium to high susceptibility towards contamination. Based on the underlying hydrogeology the aquifers can be classified per Parsons Classification System as follows:

i) Perched/wetland aquifer (0 ~ 2 m)
    a. Non-aquifer
ii) Shallow weathered aquifer of the Vryheid Formation (5 ~ 20 m)
    a. Minor aquifer
iii) Fractured confined or semi-confined sandstone aquifer in the Vryheid Formation (20 ~ 150 m)
    a. Minor aquifer

1.2 Aquifer Characterisation

A fundamental concept in hydrogeology is that of the origin, shape and interconnectivity of interstices – the open spaces that form conduits for storage and flow of groundwater. From a water-bearing point of view, geological formations can be divided into two categories; those that are water bearing on account of primary openings and those that are water bearing on account of secondary openings. Significant primary openings occur in unconsolidated sediments such as alluvium and in consolidated sediments such as sandstone. These are termed intergranular aquifers (also known as primary aquifers). Secondary openings occur in compacted sedimentary, igneous, metamorphic and volcanic rocks. These are termed fractured aquifers (also known as secondary aquifers). Secondary openings also occur in the weathered zone of rocks.

The DWS has characterised South African aquifers based on the rock formations in which it occurs together with its capacity to transmit water to boreholes drilled into specific formations. The water bearing properties of rock formations in South Africa can be classified into four classes defined as:

1. **Class A - Intergranular**
    - Aquifers associated either with loose and unconsolidated formations such as sands and gravels or with rock that has weathered to only partially consolidated material.
2. **Class B - Fractured**
    - Aquifers associated with hard and compact rock formations in which fractures, fissures and/or joints occur that are capable of both storing and transmitting water in useful quantities.
3. **Class C - Karst**
    - Aquifers associated with carbonate rocks such as limestone and dolomite in which groundwater is predominantly stored in and transmitted through cavities that can develop in these rocks.
4. **Intergranular and fractured**
    - Aquifers that represent a combination of Class A and B aquifer types. This is a common characteristic of South African aquifers. Substantial quantities of water are stored in the intergranular voids of weathered rock but can only be tapped via fractures penetrated by boreholes drilled into the fractured aquifer.

Each of these classes is further subdivided into groups relating to the capacity of an aquifer to transmit water to boreholes, typically measured in l/s. The groups therefore represent various ranges of borehole yields.

The 2526 Johannesburg Hydrogeological map (map not shown) indicates that the study area is located in a **d2 aquifer class** region. The groundwater yield potential is classed as low to medium on the basis that most of the boreholes on record in vicinity of the study area produce between 0.5 and 2.0 l/s.

However, higher yields do sporadically occur where groundwater is held in good water yielding fractures.

The different modes of groundwater occurrences associated with the Vryheid Formation are (Barnard, 2000):

i) weathered and fractured sedimentary rocks not associated with dolerite intrusions;
ii) indurated and jointed sedimentary rocks alongside dykes;
iii) narrow weathered and fractured dolerite dykes;
iv) basins of weathering in dolerite sills and highly jointed sedimentary rocks enclosed by dolerite;
v) weathered and fractured upper contact zones of dolerite sills;
vi) weathered and fractured lower contact zones of dolerite sills; and
vii) minor groundwater occurrences are often encountered in association with coal seams.

2 Aquifer vulnerability

Tables 10 - 13 in Annexure H5 (geohydrological report) summarizes the aquifer classification vulnerability scores for the aquifer/s in vicinity of the project area. The final DRASTIC score of 120 indicates that the aquifer/s in the region has a medium to high susceptibility to pollution and a medium to high level of aquifer protection is therefore required.

Table 42: DRASTIC vulnerability scores

Factor	Range/Type	Weight	Rating	Total
D	0 - 15 m	5	8	40
R	10 - 50 mm	4	6	24
A	Fractured	3	6	18
S	Sandy-clay-loam	2	4	8
T	0-2%	1	10	10
I	Karoo (northern)	5	4	20
C	-	3	-	-
DRASTIC SCORE = 120				

3 Hydrocensus

A total of 49 boreholes were surveyed during September and October 2016. Most of the boreholes are privately owned and used for domestic use and livestock watering. Five boreholes surveyed in the study area were drilled as monitoring boreholes that formed part of previous mining related groundwater impact assessments. One borehole surveyed is an open exploration borehole.

Information obtained from the surveyed boreholes where possible included, i) static water level, ii) collar height, iii) XYZ coordinates, and iv) water quality.

A contour map was created by interpolating the hydraulic heads of the boreholes and superimposing it on an aerial map of the study area. Groundwater elevations and 5 m contours (both in mamsl) with probable regional groundwater flow directions can be viewed in Figure39. The flow vectors clearly indicate that the surface water divide also influences on the groundwater flow patterns and directions. North of the water divide the groundwater generally follows the topography in the north-eastern direction whereas south from the divide a similar mimicking of the topography is noted with flow being predominantly south.

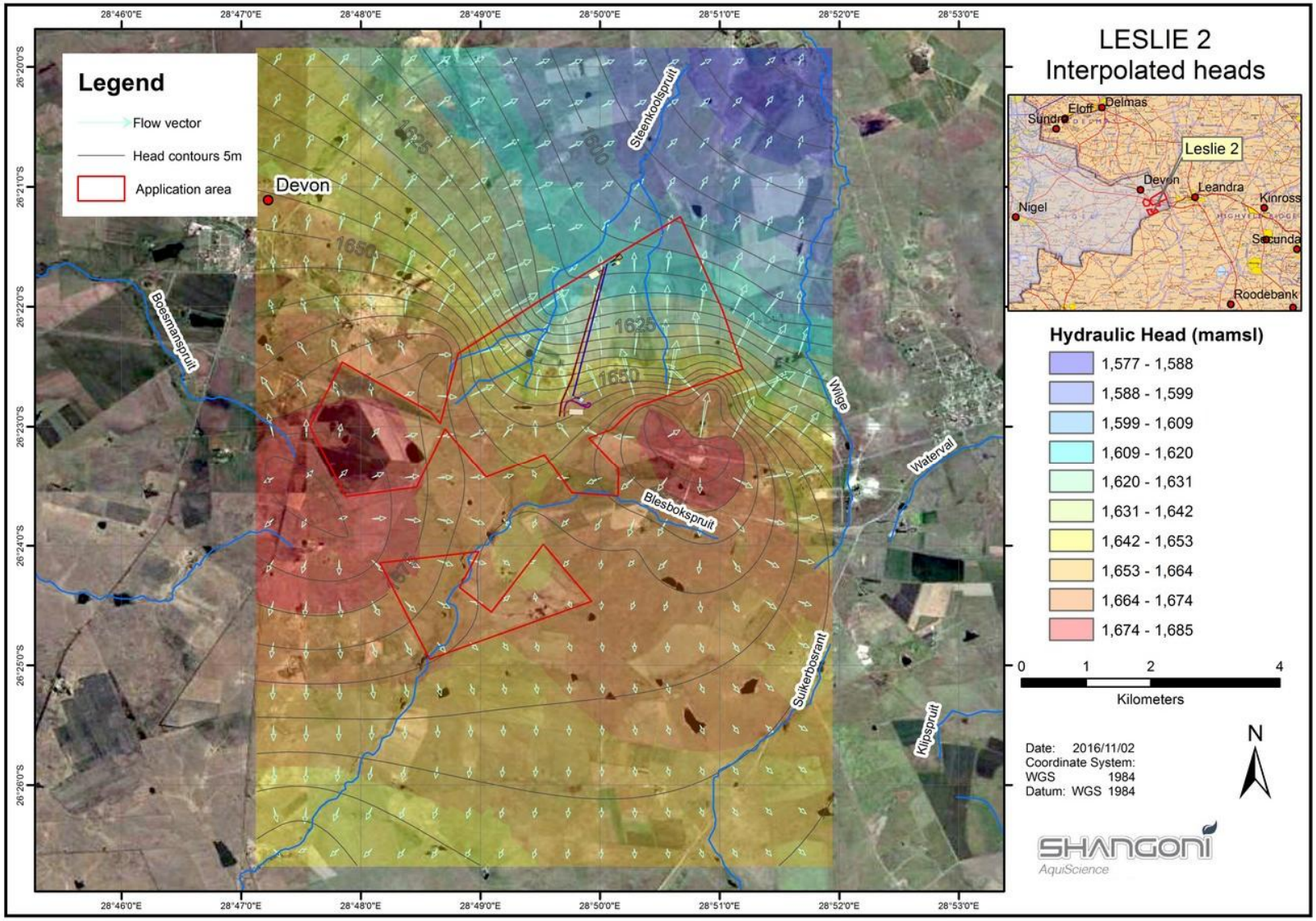

Figure 39: Groundwater elevation map (mamsl) interpolated from static water levels

Table 43: Surveyed water resource localities during the Leslie 2 hydrocensus (September 2016)

Borehole ID	Coordinates		Elevation (mamsl)	Depth (m)	Water level (mbcl)	Collar height (m)	Hydraulic head (mamsl)	Owner	Equipment	Application
Boreholes										
H/BH01	-26.37592	28.82290	1648	-	2.25	0.35	1645.75	Kruger Boerdery	Submersible	Stock water
H/BH02	-26.37658	28.81581	1671	-	11.73	0.00	1659.27	Kruger Boerdery	Submersible	Stock water
H/BH03	-26.36702	28.82640	1626	-	14.37	0.25	1611.63	Kruger Boerdery	Not equipped	Stock water
H/BH04	-26.37258	28.81131	1676	-	0.31	0.27	1675.69	Kruger Boerdery	Submersible	Stock water
H/BH05	-26.36726	28.81133	1663	-		-		Kruger Boerdery	Windpump	Stock water
H/BH06	-26.36586	28.81578	1647	-	2.87	0.28	1644.13	Kruger Boerdery	Not equipped	Not in use
H/BH07	-26.39238	28.83028	1671	-	3.72	0.00	1667.28	Kruger Boerdery	Not equipped	Not in use
H/BH08	-26.39902	28.83919	1681	-	15.54	0.12	1665.46	Kruger Boerdery	Submersible	Stock water
H/BH09	-26.38790	28.78772	1690	-	3.89	0.12	1686.11	Barbara Lang	Submersible	Stock water
H/BH10	-26.38441	28.84714	1682	-	9.36	0.66	1672.64	Thomas Mologwane	Submersible	Domestic
H/BH11	-26.38418	28.84669	1681	-	9.32		1671.68	Thomas Mologwane	Submersible	Domestic
H/BH12	-26.38442	28.84789	1680	-	9.96	0.00	1670.04	Thomas Mologwane	Submersible	Not in use
H/BH13	-26.36816	28.85736	1614	-	5.24	0.00	1608.76	Johan Schoeman	Windpump	Domestic
H/BH14	-26.36262	28.87574	1616	-		-		D.Malaza	Windpump	Stock water
H/BH15	-26.33156	28.86257	1583	-	5.44	0.10	1577.56	D.Malaza	Submersible	Not in use
H/BH16	-26.33083	28.86243	1582	-	5.52	0.29	1576.48	Johan Schoeman	Submersible	Not in use
H/BH17	-26.33083	28.86243	1582	-	9.44	0.00	1572.56	Johan Schoeman	Not equipped	Stock water
H/BH18	-26.38647	28.85023	1686	-	5.42	0.27	1680.58	Sam	Not equipped	Domestic

Borehole ID	Coordinates		Elevation (mamsl)	Depth (m)	Water level (mbcl)	Collar height (m)	Hydraulic head (mamsl)	Owner	Equipment	Application
H/BH19	-26.38614	28.85186	1686	-	6.07	0.00	1679.93	Sam	Not equipped	Not in use
H/BH20	-26.38414	28.85451	1675	-	45.20	0.00	1629.80	Sam	Not equipped	Domestic
H/BH21	-26.38614	28.84764	1689	-	6.10	0.15	1682.90	Sam	Submersible	Domestic
H/BH22	-26.38030	28.78620	1676	-	5.44	0.30	1670.56	J. Du Plessis	Not equipped	Domestic
H/BH23	-26.37840	28.78660	1681	-	14.00	0.38	1667.00	J. Du Plessis	Not equipped	Domestic
H/BH24	-26.40894	28.82442	1671	-	7.00	0.00	1664.00	Micheal Pedro	Submersible	Domestic
H/BH25	-26.40201	28.81950	1666	-	4.40	0.00	1661.60	Micheal Pedro	Submersible	Domestic
Handpump Louw	-26.41184	28.79220	1671	-		1.00		Kobus Louw	Handpump	Domestic
LGM85	-26.38132	28.84049	1685	-	3.06	0.30	1681.94	Unknown	Not equipped	Monitoring
LGM89	-26.37881	28.84910	1684	-	6.86	0.29	1677.14	Unknown	Not equipped	Monitoring
LGM-B10	-26.38011	28.85466	1647	-	4.23	0.35	1642.77	Unknown	Not equipped	Monitoring
Louw BH01	-26.44451	28.78554	1646	25	2.06	0.50	1643.94	Kobus Louw	Open Hole - equipment stolen	Not in use
Louw BH02	-26.44029	28.79174	1647	25-30	3.60	0.50	1643.40	Kobus Louw	Submersible pump	Stock water/domestic
Louw BH03	-26.43199	28.79835	1649	30		0.30		Kobus Louw	Windmill	Stock water
Louw BH04	-26.41956	28.78290	1680	30		0.20		Kobus Louw	Windmill	Stock water
Louw BH05	-26.39987	28.79897	1688	20	2.75	0.30	1685.25	Kobus Louw	Windmill	Stock water
Louw BH06	-26.39655	28.80862	1670	50		0.25		Kobus Louw	Windmill	Stock water
Louw BH07	-26.40941	28.79908	1679	25		0.50		Kobus Louw	Windmill	Stock water
Louw BH08	-26.41715	28.79040	1668	15		0.10		Kobus Louw	Submersible pump	Stock water/domestic
Louw BH09	-26.41708	28.79052	1668	25		0.10		Kobus Louw	Submersible pump	Domestic/garden
Muller BH01	-26.37578	28.83729	1665	30		0.25		Lucas Muller	Mono pump	Stock water
Muller BH02	-26.37454	28.83756	1655	60		0.25		Lucas Muller	Mono pump	Stock water/domestic

Borehole ID	Coordinates		Elevation (mamsl)	Depth (m)	Water level (mbcl)	Collar height (m)	Hydraulic head (mamsl)	Owner	Equipment	Application
Muller BH03	-26.37577	28.83461	1667	30	17.97	0.20	1649.03	Lucas Muller	Old Mono pump - equipment removed	Not in use
Muller BH04	-26.37692	28.83838	1664	-		0.50		Lucas Muller	Open Hole - BEES	Not in use
Muller Expl.	-26.35572	28.84220	1609	>150		0.05		Unknown	Not equipped Exploration borehole	Exploration
Muller MonBH1	-26.37446	28.83951	1650	30	8.68	0.40	1641.32	Unknown	Monitoring borehole (Ingwe Colliery)	Monitoring
Muller MonBH2	-26.37661	28.84468	1658	30	9.81	0.25	1648.19	Unknown	Monitoring borehole	Monitoring
Muller WM01	-26.37290	28.84349	1644	30		0.40		Lucas Muller	Windmill	Stock water
Muller WM02	-26.36963	28.83822	1634	30		0.30		Lucas Muller	Windmill	Stock water
Muller WM03	-26.36452	28.84388	1642	30		0.40		Lucas Muller	Windmill	Stock water
S32BH01	-26.36154	28.86555	1603.00	-	4.47		1598.53	Johan Schoeman	Not equipped	Monitoring

Refer to Figure 35 above for the borehole locations.

4 Groundwater quality and hydrochemistry

Groundwater samples were collected for chemical analysis during the hydrocensus. A total of 62 localities were surveyed during the hydrocensus which included boreholes (49), fountains/streams/rivers (10) and dams/ponds (3). Due to inaccessibility to some of the boreholes only 49 localities were sampled.

The samples were submitted to Aquatico Laboratories, a SANAS accredited testing laboratory in Pretoria (T0685) for major cation/anion and selected trace metal analysis. An overview of the groundwater quality will be given in the following paragraphs at the hand of tabulated data, interpretations based on relevant South African Standards (SANS 241: 2011 and WRC) and the conventional Durov, Piper and Stiff diagrams. The hydrochemical data generated can be viewed in Table 15 to -19 in Annexure H5 (geohydrological report).

The hydrochemistry can in general be regarded as good. Some waters did however record EC/TDS, manganese, nitrate and/or fluoride exceeding the SANS 241: 2015 guidelines. In terms of the WRC classification (based on drinking water) the following is interpreted:

1. 18% of samples recorded in the *Ideal* (*class 0*) ranges.
2. 61% of samples recorded in the *Good* (*class 1*) ranges.
   a) Downgrading from Ideal is mostly due to EC/TDS exceeding 70 mS/m/1200 mg/l.
3. 10% of samples recorded in the *Marginal* (*class 2*) ranges.
   b) Classification is mostly due to nitrogen (nitrate or ammonia) and/ manganese.
4. 10% of samples recorded in the *Poor* (*class 3*) ranges.
   c) Classification mostly due to elevated manganese, nitrate and/ or fluoride.

From the hydrogeochemical diagrams the following can be concluded:

- The groundwater zone is influenced by what is referred to as a shallow Karoo type aquifer. Locally, these aquifers can be extremely complex due to the heterogeneity and nature of depositional and structural characteristics of the host rock in which the groundwater occurs and moves.
- Two broad types of aquifer types can be distinguished.
  I. Groundwater that is dominated by the calcium cation and to a lesser extent magnesium and the bicarbonate anion. Groundwater is of Ca(Mg)-HCO_3 type.
     - These waters can be regarded as fresh and recently recharged that has started to undergo magnesium ion exchange.
  II. Groundwater that is dominated by the sodium cation and the bicarbonate anion. Groundwater is of Na-HCO_3 type.
     - These waters can be regarded as fresh and recently recharged that has started to undergo sodium ion exchange typically located in or with an igneous signature.

The fountains sampled typically have a similar signature compared to the weathered aquifer being of a Mg(Ca)-HCO_3 type while the deeper fractured aquifer generally display a Na-HCO_3 signature (Figure 27 in Annexure H5 (geohydrological report).

Table 44: Groundwater hydrochemistry of boreholes as sampled during the Leslie 2 hydrocensus

Site Name	SANS 241: 2015	H/BH01	H/BH02	H/BH03	H/BH04	H/BH05	H/BH08	H/BH09	H/BH10	H/BH11	H/BH12	H/BH14
pH	≥5 to ≤9.7	8.40	7.70	8.53	7.85	7.66	7.91	7.99	7.75	7.70	7.81	8.58
EC (mS/m)	≤170	74.90	109.00	65.90	81.30	152.00	157.00	137.00	71.30	74.10	82.20	75.40
TDS (mg/l)	≤1200	451	675	400	516	991	1009	814	483	498.0	541	501
Ca (mg/l)	-	72.80	130.00	26.10	84.70	159.00	180.00	139.00	76.70	85.50	85.20	0.59
Mg (mg/l)	-	55.00	60.70	18.50	59.80	114.00	108.00	83.70	42.50	50.60	51.70	<0.08
Na (mg/l)	≤200	22.50	38.90	105.00	23.20	38.30	36.50	50.60	34.70	19.50	30.80	**207.00**
K (mg/l)	-	0.74	1.63	0.62	0.95	1.02	0.96	0.95	0.35	0.25	0.51	0.56
MALK (mg/l)	-	280.00	353.00	283.00	340.00	517.00	389.00	376.00	310.00	338.00	283.00	443.00
Cl (mg/l)	≤300	12.60	79.90	23.90	12.60	109.00	174.00	175.00	8.66	6.89	41.80	15.30
SO_4 (mg/l)	≤500	100.00	115.00	48.70	107.00	228.00	196.00	91.70	122.00	120.00	127.00	3.75
NO_3-N (mg/l)	≤11	3.66	7.62	0.45	4.44	5.90	**17.00**	9.71	1.93	1.88	6.81	<0.19
N_Ammonia (mg/l)	≤1.5*	0.08	0.09	0.14	0.08	0.08	0.11	0.09	0.11	0.11	0.13	0.15
PO_4 (mg/l)	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.02	0.04	0.04	0.04	0.04
F (mg/l)	≤1.5	<0.263	0.30	**2.30**	<0.263	<0.263	<0.263	<0.263	<0.263	0.27	0.38	**3.25**
Al (mg/l)	≤0.3#	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.127
Fe (mg/l)	≤2	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.023
Mn (mg/l)	≤0.3*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu (mg/l)	≤2.0	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.068	<0.002	<0.002	<0.002
Ni (mg/l)	≤0.07	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zn (mg/l)		<0.002	<0.002	<0.002	<0.002	0.110	<0.002	<0.002	<0.002	<0.002	<0.002	0.018
Pb (mg/l)	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WRC Classification		Good (class01)		Poor (class03)	Good (class01)		Marginal (class02)	Good (class01)	Good (class01)		Good (class01)	Poor (class03)
Classification based on:		EC/TDS		F	EC/TDS		NO_3	EC/TDS/NO_3	EC/TDS		EC/TDS/NO_3	F

Table 45: Groundwater hydrochemistry of boreholes as sampled during the Leslie 2 hydrocensus

Site Name	SANS 241: 2015	H/BH15	H/BH17	H/BH18	H/BH19	H/BH20	H/BH21	H/BH22	H/BH23	H/BH24	H/BH25
pH	≥5 to ≤9.7	7.76	7.70	8.02	7.75	8.45	8.29	7.89	7.81	7.74	7.92
EC (mS/m)	≤170	87.90	79.60	71.60	75.80	50.80	124.00	87.30	78.30	134.00	99.00
TDS (mg/l)	≤1200	634	545	479	503	323	869	570	470	870	648
Ca (mg/l)	-	109.00	97.70	40.00	87.20	1.17	133.00	90.20	86.90	138.00	106.00
Mg (mg/l)	-	45.20	43.70	13.30	53.00	-0.08	88.50	56.90	42.00	108.00	65.30
Na (mg/l)	≤200	49.50	34.30	113.00	24.90	129.00	28.80	48.00	50.80	27.80	44.30
K (mg/l)	-	2.29	3.07	1.21	0.61	0.54	0.76	1.86	2.93	0.37	0.30
MALK (mg/l)	-	448	412	270	432	244	441	389	445	383	337
Cl (mg/l)	≤300	38.00	44.00	7.65	11.40	13.30	75.60	11.20	13.20	88.30	42.30
SO_4 (mg/l)	≤500	114.00	68.00	137.00	61.30	22.10	155.00	96.00	-0.14	211.00	153.00
NO_3-N (mg/l)	≤11	0.61	0.55	<0.19	<0.19	0.75	**26.50**	6.21	0.31	**14.00**	6.95
N_Ammonia (mg/l)	≤1.5*	0.13	0.14	1.48	0.36	0.48	0.09	0.05	0.38	0.04	0.04
PO_4 (mg/l)	-	0.03	0.05	0.18	0.04	0.04	0.04	0.05	0.04	0.05	0.05
F (mg/l)	≤1.5	0.38	0.39	0.41	0.33	**3.75**	<0.263	<0.263	0.27	<0.263	0.27
Al (mg/l)	≤0.3#	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fe (mg/l)	≤2	<0.004	<0.004	0.235	<0.004	<0.004	<0.004	<0.004	0.075	<0.004	<0.004
Mn (mg/l)	≤0.3*	0.030	<0.001	0.028	0.172	<0.001	<0.001	0.113	0.114	<0.001	<0.001
Cu (mg/l)	≤2.0	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ni (mg/l)	≤0.07	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zn (mg/l)		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pb (mg/l)	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WRC Classification		Good (class01)				Poor (class03)	Poor (class03)	Good (class01)		Marginal (class02)	Good (class01)
Classification based on:		EC/TDS				F	NO_3	EC/TDS		NO_3	EC/TDS

Table 46: Groundwater hydrochemistry of boreholes as sampled during the Leslie 2 hydrocensus

Site Name	SANS 241: 2015	Louw BH01	Louw BH02	Louw BH03	Louw BH04	Louw BH05	Louw BH06	Louw BH07	Louw BH08	Louw BH09	Handpump Louw
pH	≥5 to ≤9.7	8.28	8.71	8.76	8.61	8.55	8.79	8.65	8.64	8.60	8.61
EC (mS/m)	≤170	127.00	87.80	61.50	94.20	58.60	103.00	74.40	126.00	107.00	106.00
TDS (mg/l)	≤1200	828.00	571.00	356.00	680.00	407.00	707.00	494.00	822.00	694.00	672.00
Ca (mg/l)	-	108.00	60.00	7.44	91.70	63.70	49.60	75.70	124.00	112.00	99.40
Mg (mg/l)	-	53.50	28.90	1.61	62.20	40.70	44.30	62.70	91.10	71.80	89.70
Na (mg/l)	≤200	140.00	123.00	145.00	45.00	22.30	151.00	18.80	41.20	49.60	26.20
K (mg/l)	-	2.90	1.29	0.78	8.61	1.77	0.63	0.19	1.89	1.78	0.28
MALK (mg/l)	-	482.00	365.00	235.00	443.00	282.00	556.00	405.00	529.00	394.00	361.00
Cl (mg/l)	≤300	102.00	39.00	41.40	16.10	16.40	23.30	13.50	95.90	66.40	64.90
SO_4 (mg/l)	≤500	122.00	86.80	10.90	166.00	78.90	94.90	72.50	83.40	119.00	131.00
NO_3-N (mg/l)	≤11	1.36	2.13	0.61	4.33	2.42	0.73	0.75	**13.90**	7.21	8.92
N_Ammonia (mg/l)	≤1.5*	0.08	0.10	0.14	0.09	0.14	0.11	0.11	0.12	0.12	0.13
PO_4 (mg/l)	-	0.04	0.04	0.06	0.05	0.04	0.04	0.04	0.03	0.04	0.03
Al (mg/l)	≤0.3#	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fe (mg/l)	≤2	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Mn (mg/l)	≤0.3*	0.144	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu (mg/l)	≤2.0	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ni (mg/l)	≤0.07	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zn (mg/l)		<0.002	<0.002	<0.002	<0.002	0.156	<0.002	<0.002	<0.002	<0.002	<0.002
Pb (mg/l)	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WRC Classification		Good (class01)		Good (class01)	Good (class01)	Ideal (class0)	Good (class01)	Good (class01)	Marginal (class02)	Good (class01)	
Classification based on:		EC/TDS/Na		Na	EC/TDS	-	EC/TDS/Na	EC/TDS	NO_3	EC/TDS	

Table 47: Groundwater hydrochemistry of boreholes as sampled during the Leslie 2 hydrocensus

Site Name	SANS 241: 2015	Muller MonBH1	Muller MonBH2	Muller BH02	Muller BH03	Muller WM01	LGM85	LGM89	LGM-B10	S32BH01
pH	≥5 to ≤9.7	8.28	8.12	8.55	8.56	8.50	8.96	8.37	8.23	7.83
EC (mS/m)	≤170	16.30	14.20	78.80	52.00	67.90	90.50	49.90	51.50	61.40
TDS (mg/l)	≤1200	84.00	71.00	440.00	293.00	419.00	580.00	343.00	303.00	396.00
Ca (mg/l)	-	8.00	12.40	85.30	23.50	73.60	4.70	51.20	28.30	65.70
Mg (mg/l)	-	7.58	6.20	40.60	5.17	35.50	<0.08	18.90	47.10	22.90
Na (mg/l)	≤200	14.90	8.01	32.90	95.50	41.70	221.00	38.80	18.10	56.20
K (mg/l)	-	0.90	0.53	1.37	0.95	1.62	0.65	0.30	0.18	2.12
MALK (mg/l)	-	55.10	60.70	285.00	247.00	294.00	244.00	186.00	222.00	388.00
Cl (mg/l)	≤300	12.20	2.80	64.80	8.89	4.47	17.10	8.53	15.70	4.33
SO_4 (mg/l)	≤500	4.73	2.20	38.00	3.72	79.70	180.00	112.00	57.60	7.62
NO_3-N (mg/l)	≤11	0.46	0.41	0.48	0.53	0.53	1.73	<0.19	<0.19	<0.19
N_Ammonia (mg/l)	≤1.5*	0.12	0.18	0.26	1.18	0.23	0.07	0.11	0.12	0.48
PO_4 (mg/l)	-	0.03	0.03	0.03	0.20	0.03	0.01	0.04	0.04	0.04
Al (mg/l)	≤0.3#	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fe (mg/l)	≤2	<0.004	<0.004	<0.004	0.046	<0.004	0.067	<0.004	<0.004	<0.004
Mn (mg/l)	≤0.3*	<0.001	0.042	<0.001	<0.001	0.032	<0.001	<0.001	<0.001	0.079
Cu (mg/l)	≤2.0	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ni (mg/l)	≤0.07	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zn (mg/l)		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pb (mg/l)	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WRC Classification		Ideal (class0)		Good (class01)	Good (class01)	Ideal (class0)	Good (class01)	Ideal (class0)		
Classification based on:		-		EC/TDS	Ammonia	-	EC/TDS	-		

5 Groundwater levels and gradients

Groundwater levels were measured as a first step to determine the depth to water table, flow direction and the regional groundwater gradients. The water levels are relatively similar across the study area with the exception of a few abstracting boreholes that displayed pumping/dynamic water levels.. The average static depth to groundwater table for the study area as recorded during the hydrocensus is 6.90 mbs and average hydraulic head elevation is 1650 mamsl.

6 Aquifer testing

The newly drilled and selected existing boreholes were subjected to aquifer tests to determine the hydraulic parameters and performance of the aquifers.

6.1 Aquifer test results

A pump test summary of boreholes subjected to aquifer tests are displayed in Table 48 with the hydraulic parameters displayed in Table 49.

The geohydrological parameters calculated with the aquifer test data revealed very low permeable to virtually impermeable formations (dolerite).

Water samples were taken at the end of each pump test and sent for hydrochemical analyses.

Table 48: Pump test summary and relevant information

Borehole ID	Borehole depth	Type of test	Test duration (min)	Pump level (mbs)	Observation borehole ID
L2 BH1	100	Constant rate	1440	90	Muller Mon BH1
L2 BH1	100	Constant rate	240	30	Muller Mon BH1
L2 BH2	30	Constant rate	10	25	-
		Slug	250	N/A	-
Muller Mon BH1	30	Constant rate	240	25	L2 BH1
Muller Mon BH2	30	Constant rate	10	25	-
		Slug	108	N/A	-

Table 49: Hydraulic Parameters calculated

	Transmissivity (m^2/d)				Storativity	Estimated yield (l/s)	Observation borehole drawdown (m)
Site ID	Early T (m^2/d)	Late T (m^2/d)	Recovery T (m^2/d)	Average T (m^2/d)			
L2 BH1 (90m)	0.61	3.4	1.3	1.77	0.0044	0.86	3.6
L2 BH1 (30m)	0.4	≥5	2	2.5	0.0045	1.0	N/A
L2 BH2 (pump)	0.36	0.13	0.5	0.33	-	<0.10	N/A
L2 BH2 (slug)	-	-	-	-	-	<0.10	N/A
Muller Mon BH1	1.2	1.9	1.5	1.5	0.0015	0.20	N/A
Muller Mon BH2 (pump)	0.90	0.28	0.6	0.60	-	0.10	N/A
Muller Mon BH2 (slug)	-	-	-	-	-	0.10	N/A

7 Geochemical characterisation and classification of mine residue

The main aim of the geochemical investigation was to characterise the mine residue deposits in terms of its potential environmental impact/s and to assess and quantify the risks posed during the operational phases of mining. A classification procedure in terms of GNR635 and GNR636 was also performed to propose a pollution control barrier system compliant with the following norms and standards:

- National Norms and Standards for the Assessment of Waste for Landfill Disposal, 2013 (GNR635); and
- National Norms and Standards for Disposal of Waste to Landfill, 2013 (GNR636).

The results of the organic and inorganic analyses for the classification procedure as per GNR635 are shown in Table 24 – 26 of Annexure H5 (geohydrological report).

The total inorganic concentration assays indicate that various trace metals/metalloids are above detection limits but only barium (Ba) and copper (Cu) recorded above the TCT0 limits. Barium (Ba) concentrations in the shallow dolerite and in the coal sample marginally exceed the TCT0 limits but are well within the TCT1 limits, while the dolerite at both horizons and the coal sample exceed the TCT0 with regards to Cu. None of these parameters as mentioned above or the elements that were undetected, recorded in above-detection limits in the leachate assays. Only arsenic, a metalloid that is potentially mobile under neutral or alkaline conditions (depending on species) recorded a concentration of 0.029 mg/l within the coal sample, exceeding the LCT0 of 0.01 mg/l.

With regards to the organic analyses, the coal sample recorded a benzene concentration of 12 mg/l exceeding the TCT1 level of 10 mg/l.

The classification results based on GNR635 are shown in Table 48.

Table 50: Waste classification (GNR635)

Lithology	Classification
Sandstone (softs)	Type 4
Dolerite (hards)	Type 4
Coal & carbonaceous	Type 3

8 Numerical groundwater model

The numerical flow and mass transport groundwater models were constructed to simulate current aquifer conditions and impacts in addition to providing a tool for evaluating different long-term management options. A three-dimensional numerical groundwater flow model was developed using the modelling software package PMWIN Pro (Processing Modlfow Professional for Windows).

The calibrated groundwater elevations were exported from the flow model and used to construct a contour map of the current hydraulic heads (Figure 40). Groundwater flow will mainly occur towards the north-east and south in the Leslie2 mining area with the largest portion draining to the north-east. Average groundwater gradients were calculated from the head elevation data. The general groundwater gradient and direction is as follows:

- North-east: 1.8%
- South: 1%

8.1 Drawdown cones of depression

With the 51 to 53% extraction ratio bord-&-pillar mining planned for Leslie 2, no subsidence or cracking is expected. Together with the presence of dolerite sills (very limited permeability/hydraulic conductivity), that separate the shallow aquifer from the deeper aquifer, limited water level drawdown is therefore expected for the shallow weathered aquifer. Based on an absolute worst case scenario however, a maximum of approximately 7 meters of drawdown in the shallow, weathered aquifer may potentially occur (Figure 40).

The maximum extent of the worst-case scenario dewatering cone of depression in the shallow, weathered aquifer is expected to be limited in lateral extent to approximately 900 meters from the mine workings. The 900 meters seems significant but it should be noted that most that distance represents a drawdown of less than 1 meter. The intensity of the drawdown is thus expected to be limited and it is expected that groundwater users above the mine will in all probably not feel the effect of the drawdown. It is still recommended that a groundwater level monitoring program be implemented from before mining commences and throughout the LOM to ensure that early estimations are verified.

Dewatering is however expected in the deeper, secondary aquifer in which the mining will occur. It is expected that the deep aquifer will be dewatered locally down to the 2 seam mine floor. With no groundwater users exploiting the deep aquifer, no adverse impact from this localised dewatering is expected.

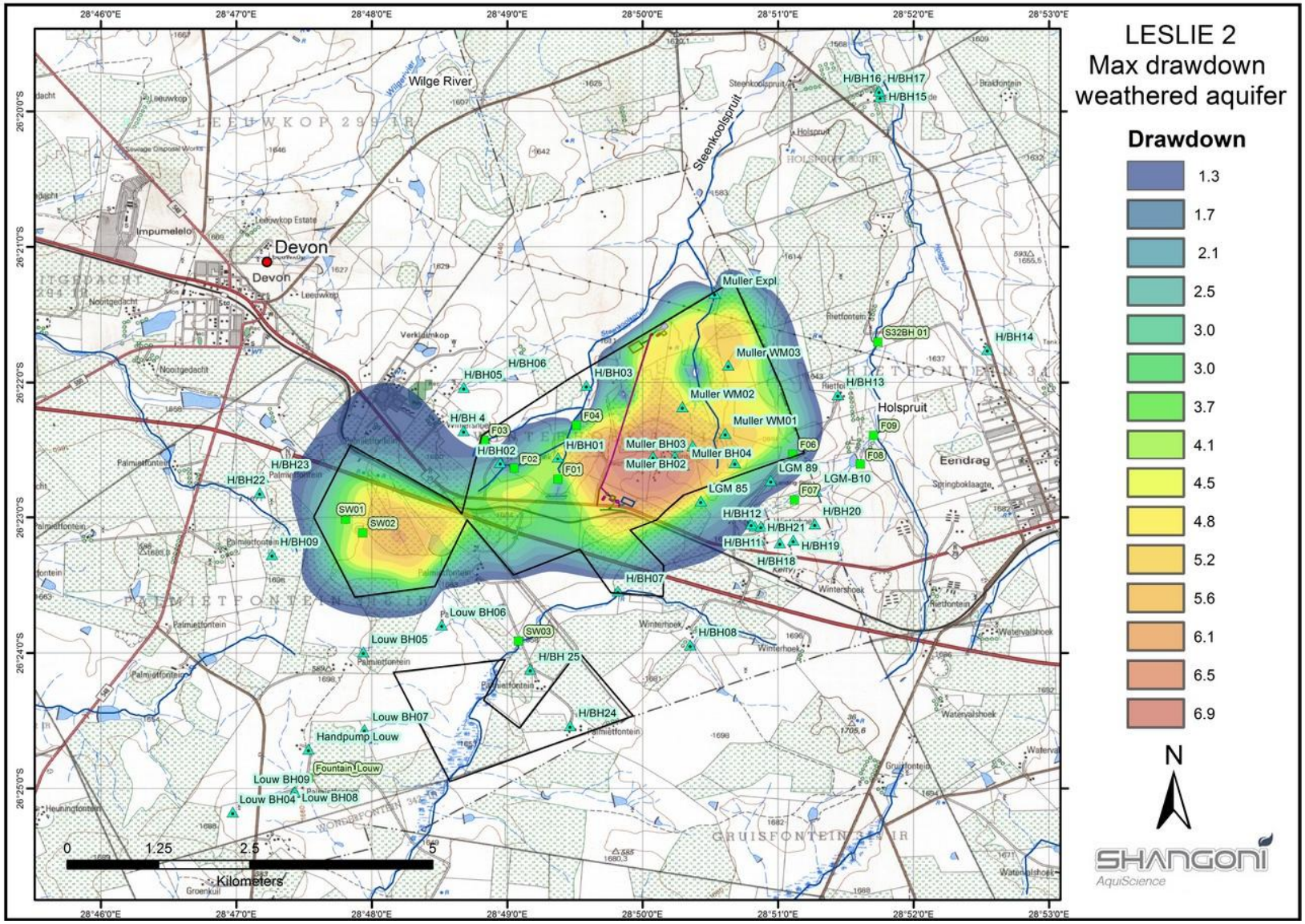

Figure 40: Simulated drawdown in the shallow aquifer at LoM (worst case)

8.2 Time-to-fill and decant estimations

From the numerical modelling exercise and volume/recharge calculations it is concluded that the water level will not recover fully within 100 years post-closure due to the low recharge to the mine voids.

Decant is not expected for the Leslie 2 project since no roof collapse with associated cracking/fracturing of roof strata or subsidence is expected because of the proposed bord-&-pillar mining. Decant only occurs when the mining activities cause such an increase in recharge that the aquifer(s) downgradient from the mine cannot accommodate the increased volumes of water generated because of the mine.

The effective recharge to the deep aquifer at Leslie 2 project is not expected to increase and horizontal groundwater flow is expected to resume through the receiving aquifer(s) once the water levels have recovered to near surface elevations.

Should the system behave totally different than expected and the shallow aquifer cannot assimilate the rising water level, worst case decant from the proposed Leslie 2 project mine workings is estimated to be in the order of 80 m^3/day. The elevation of the decant region will be at approximately 1613 mamsl. This will be the position where decanting will *theoretically* occur in the case of cracking to the surface due to subsidence or any other feature connecting the underground mine with the surface. With the roof designed to remain intact at Leslie 2 project, decant should not occur through the impervious roof but rather though another opening such as a borehole or shaft.

The decant figure of 80 m^3/day should be verified and adapted as the project progresses and actual data is generated. Because the calculations are based on numerous variables that have heterogeneous distribution, it is strongly recommend that:

- The environmental water balance – with focus on groundwater seepage to the mine workings be measured accurately throughout the life-of-mine; and
- At least one monitoring point be positioned in every compartment of the mine void near the theoretical decant area to determine the actual recharge rate and use it for post-closure planning.

The total volume of groundwater that is required to fill up the mine void is estimated at approximately *16.6 million cubic meters* (Table 51). This volume includes the 2 and 4 seam workings. The time to fill the mine voids is estimated to be in the order of *570 years* after closure.

Table 51: Time-to-fill estimations

	2 seam	4 Seam
Annual Rainfall (m)	0.615	0.615
Fill Elevation (mamsl)	1500	1543
Combined Mined Area (m^2)	7851300	

	2 seam		4 Seam
Total void Volume Below Fill Elevation (m^3)	31838540		
Decant from underground areas (m^3/annum)			
Low recharge 0.3%	14486		
Most Probable recharge 0.6%	**28971**		
High recharge 0.9%	43457		
Voids (m3):			
	51%	**52%**	**53%**
51 - 53% extraction	16237655	16556041	16874426
Average Time to Fill (Years):	**560**	**571**	**582**

The theoretical decant point is indicated in Figure 41.

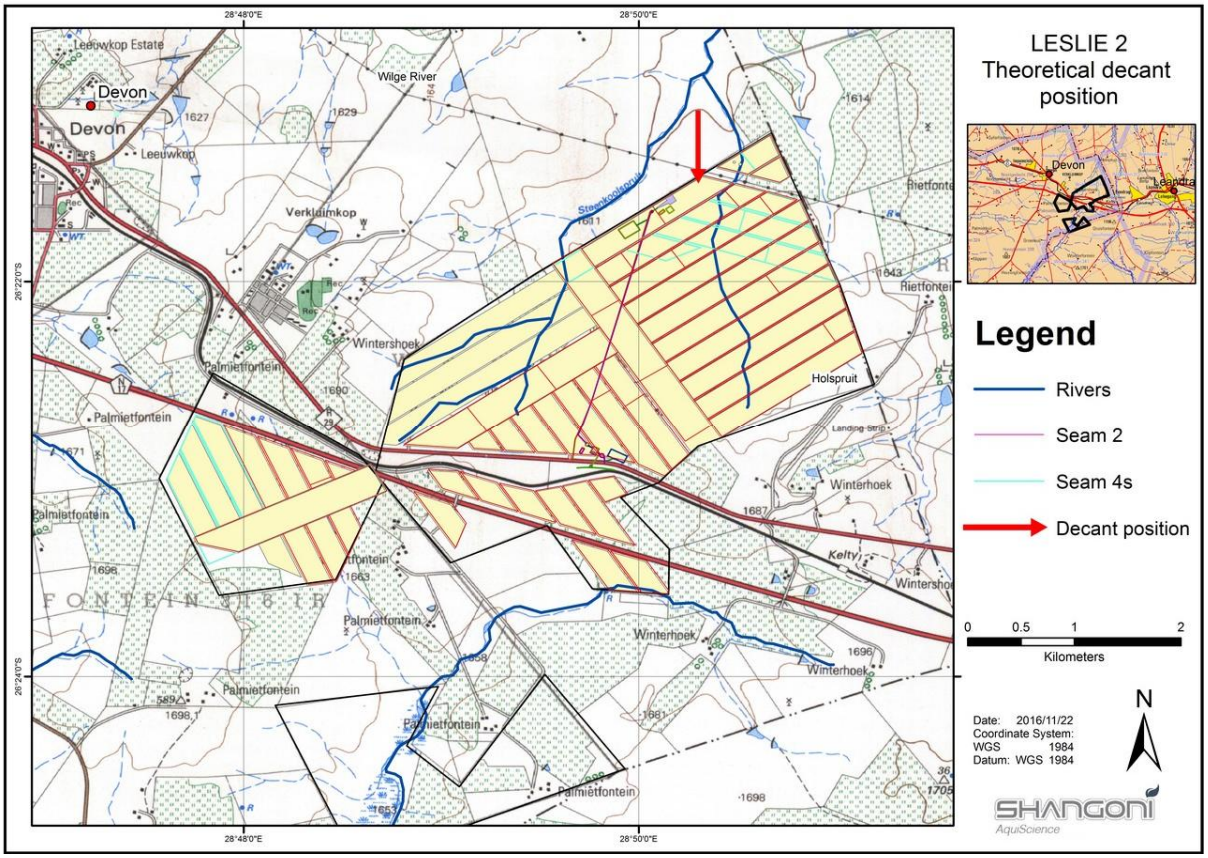

Figure 41: Theoretical decanting point for the proposed Leslie2 project

8.3 Mass transport model – simulated pollution plumes and movement

8.3.1 Pollution plume in the weathered aquifer

The simulated pollution plumes from the surface infrastructure area are indicated in Figure 42**.** Any pollution from the infrastructure will start moving downgradient of the source as soon as contamination occurs. During the life of mine any pollution from the surface infrastructure area will not migrate more than 150 meters away from the source.

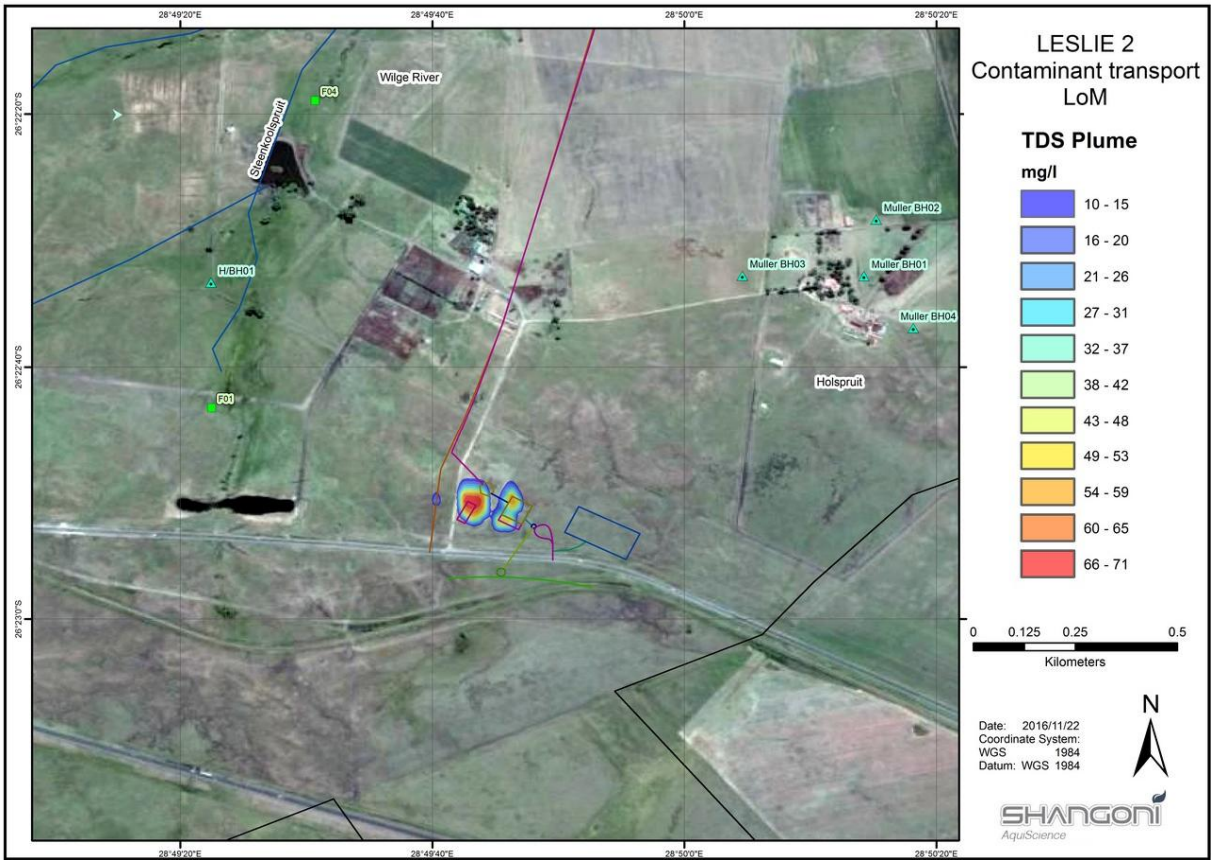

Figure 42: Mass transport (plume movement) in the shallow, weathered aquifer at mine closure

It is clear from Figure 42 that none of the current user boreholes will be affected by plume movement from the surface infrastructure area during the operational phase.

The surface infrastructure will be removed in the closure phase of the mine, therefore removing any continuous contamination source. During the 100 years post-closure simulation of the surface infrastructure, the concentration source was removed in the mass transport model. It is clear from Figure 43 that the TDS concentrations will decrease significantly 100 years post-closure due to dilution with clean aquifer recharge and water in storage.

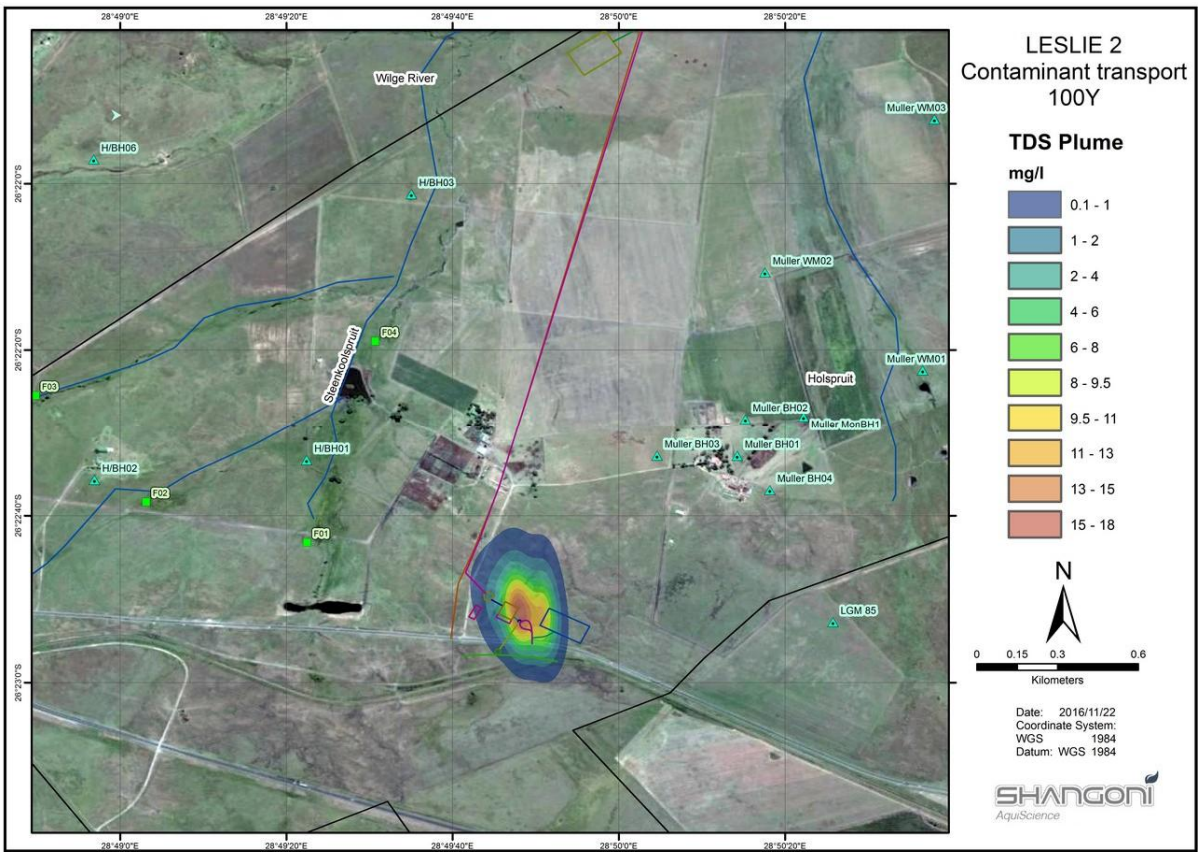

Figure 43: Mass transport (plume movement) in the shallow, weathered aquifer 100 years post closure

8.3.2 Pollution plume in the deeper fractured aquifer

The simulated plume from source at the end of 14 years mining in the deep aquifer is indicated in Figure 44. Since dewatering occurs up until mine closure, the pollution plume will not move away from the source as the groundwater flow gradients are still towards the mine workings.

The simulated plume dilution from source at 100 years after closure in the deep aquifer is indicated in Figure 45. The simulation indicates that a pollution plume in the deeper aquifer is expected to remain relatively constraint to the mine boundaries. The plume will not migrate as the mine workings act as a groundwater sink. The water levels are expected to take more than a century to recover and pollution movement away from the mine will only start to occur once the mine has filled to near surface/pre-mining elevations. The TDS concentrations within the void are however expected to increase as time progresses post-closure.

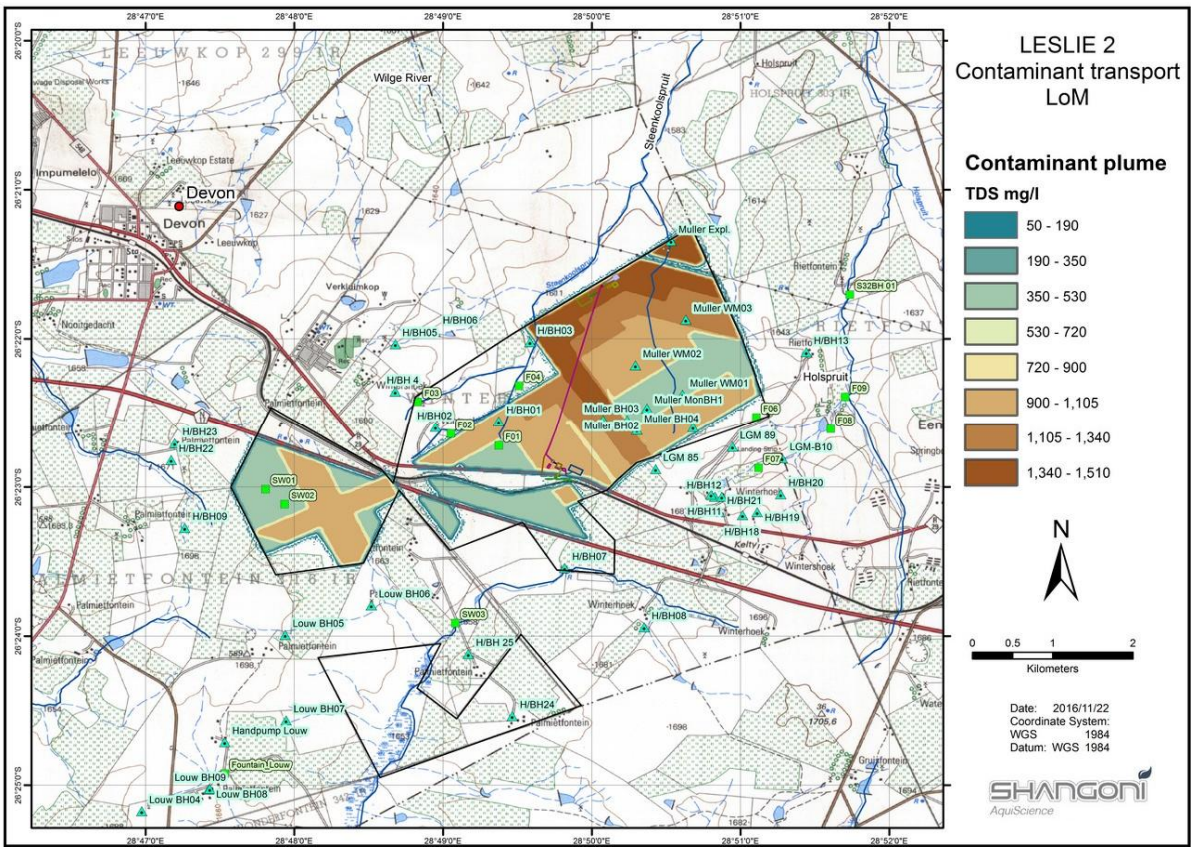

Figure 44: Mass transport (plume movement) in the deeper aquifer at the end of mining

Note that the plume concentrations in Figures 44 and 45 represent the simulated TDS concentrations at mine closure and 100 years post-closure as a result of mining influence and does not include the ambient/baseline groundwater TDS.

Although several user boreholes and springs are recorded on top of the proposed workings the deteriorating water quality in the underground workings is not expected to have an adverse effect on the users. The boreholes are not drilled down to the depth of the coal seams and exploit groundwater from the shallower aquifer mostly less than 60 mbs with. As such, little or no effect is expected on the existing users. This should however be confirmed through detailed and ongoing groundwater monitoring over the life of the project.

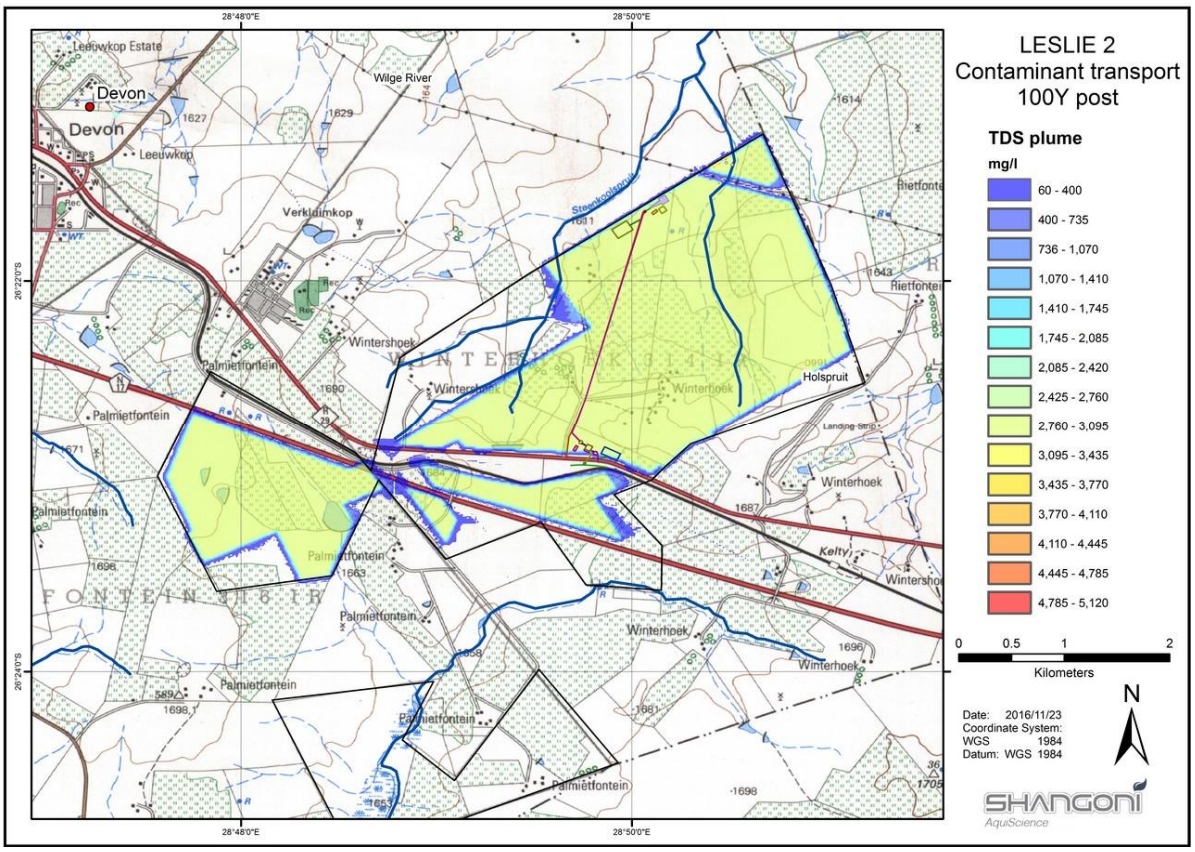

Figure 45: Mass transport (plume movement) in the deeper aquifer 100 years post operation

8.4 Numerical modelling summary

The following conclusions can be made from the calculations and numerical model for the proposed Leslie 2 project:

- The bord-and-pillar mining will be at least 115 meters deep.
- The surface is underlain by a continuous dolerite sill over most the project area.
- Measured data obtained from mining activities to the south of the proposed Leslie2 project indicates zero groundwater inflow to the deep mine workings during the early operational phase.
- Based on these factors an estimated effective recharge to the deep (down to 210 mbs) underground workings is well less than 1% of MAP.
- Decant is not expected since no roof collapse with associated cracking/fracturing of roof strata or subsidence is expected because of the proposed bord-&-pillar mining.
- Should the system behave totally different than expected and the shallow aquifer cannot assimilate the rising water level, decant from the proposed Leslie2 project mine workings is estimated to be in the order of 80 m^3/day.
- The elevation of the decant region will be at 1613 mamsl.
- The total volume of groundwater that is required to fill up the mine void is estimated at approximately 16.6 million cubic meters. This volume includes the 2 and 4 seam workings.

- The time to fill the mine voids is estimated to be in the order of 570 years after closure.
- The general groundwater gradient and direction is as follows:
    - North-east: 1.8%
    - South: 1%
- Limited water level drawdown is expected for the shallow weathered aquifer because of the low permeable dolerite sill/s that separate the weathered aquifer from the deeper aquifer that will be dewatered. The little drawdown that were calculated in the model within the weathered aquifer (based on absolute worst case scenarios) could take more than a century to recover.
- Significant dewatering is expected in the deeper, secondary aquifer in which the mining will occur.
- Maximum extent of the dewatering cone of depression in the shallow, weathered aquifer is expected to be limited in lateral extent to approximately 900 meters from the mine workings.
- The drawdown in the shallow, weathered aquifer is expected to be between 1 and 7 m.
- The TDS concentrations within the void are expected to increase as time progresses post-closure.
- Simulation indicates that a pollution plume in the deeper aquifer is expected to remain relatively constraint to the mine boundaries. The plume will not migrate as the mine workings act as a groundwater sink which will take more than a century to attain equilibrium in terms of water levels and recovery.

Chapter K: Air Quality

Information in this section of this report has been obtained from the following documents:

- The report titled: "*Anglo Operations (Pty) Ltd: Leslie 2 – Air quality impact assessment*", dated January 2017 and compiled by Shangoni Management Services (Annexure H6).

1 Background setting

The proposed Leslie 2 project falls within the Highveld Priority Area (Refer to Figure 46). The ambient air quality standards for Sulphur dioxide (SO_2), Particulate Matter (PM10) and ozone (O_3) are exceeded in nine areas within this airshed priority area (Refer to Figure 47). The hot spot areas result from a combination of emissions from the different industrial sectors and residential fuel burning, with motor vehicle emissions, mining and cross-boundary transport of pollutants into the Highveld Priority Area. Industrial sources in total are by far the largest contributor of emissions Highveld Priority Area, accounting for 89% of PM10, 90% of NOx and 99% of SO_2 (Refer to Figure 48).

The proposed project falls outside the hotspot areas, however, graphs illustrating daily ambient PM10 concentrations at Phola, Secunda, Balfour and Leandra ambient air quality monitoring stations show that the PM10 concentrations in these areas exceed the national ambient air quality standards for daily PM10 (refer from Annexure H6).

South 32 SA Coal Holdings (Pty) Limited is currently also in the process of applying for a mining right for the prospecting of the Leandra coal reserve. This forewarns of a potential increase in mining related activities in the area surrounding proposed Leslie 2 project.

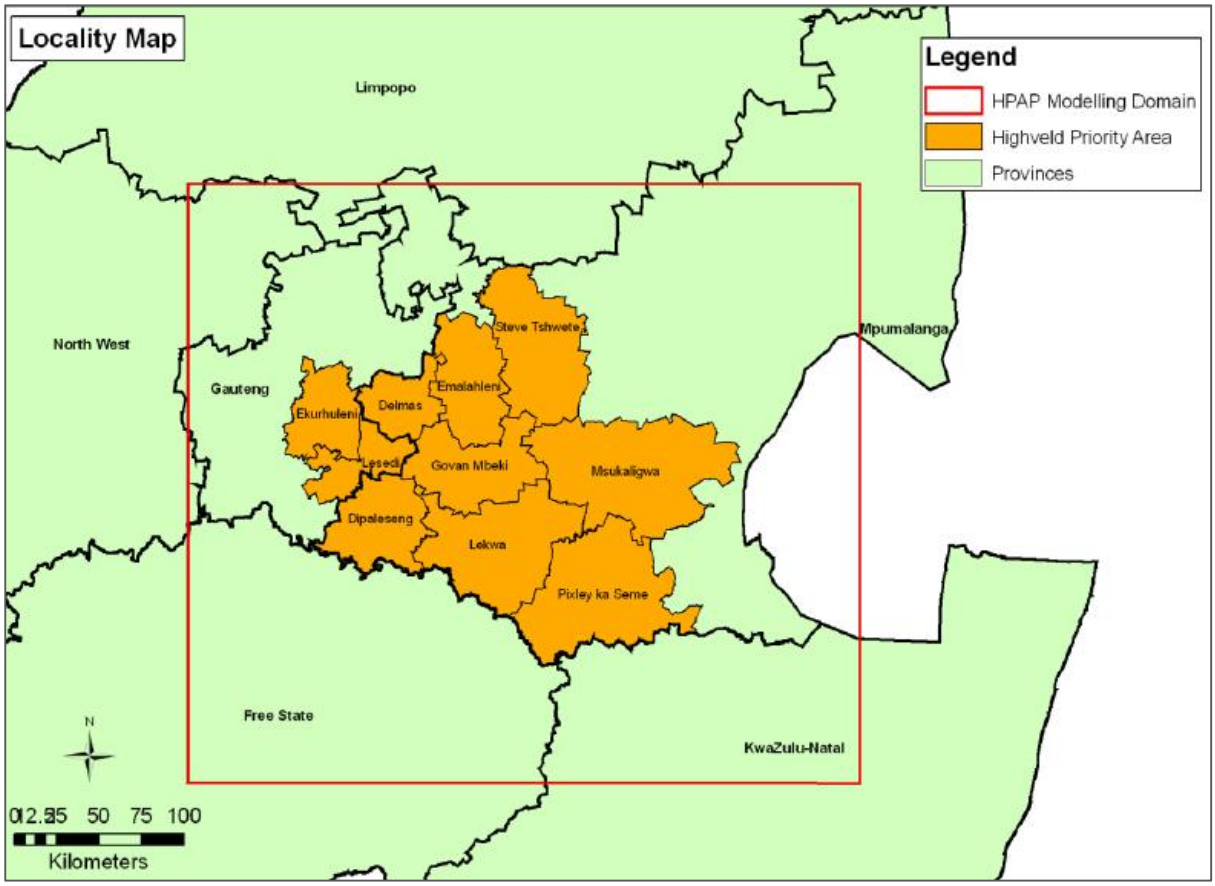

Figure 46: Highveld Priority Area (DEA, 2011).

Hot Spot	PM_{10}	SO_2	NO_2
Emalahleni	✓	✓	
Kriel		✓	
Steve Tshwete	✓	✓	✓
Ermelo	✓	✓	
Secunda	✓	✓	✓
Ekurhuleni	✓	✓	
Lekwa	✓	✓	
Balfour	✓		
Delmas		✓	

Figure 47: Hotspot areas in HPA (DEA, 2011).

Source category	PM_{10} t/a	%	NO_x t/a	%	SO_2 t/a	%
Ekurhuleni MM Industrial (incl Kelvin)	8 909	3	15 636	2	25 772	2
Mpumalanga Industrial	684	0	590	0	5 941	0
Clay Brick Manufacturing	9 708	3	-		9 963	1
Power Generation	34 373	12	716 719	73	1 337 521	82
Primary Metallurgical	46 805	17	4 416	0	39 582	2
Secondary Metallurgical	3 060	1	229	0	3 223	0
Petrochemical	8 246	3	148 434	15	190 172	12
Mine Haul Roads	135 766	49	-		-	
Motor vehicles	5 402	2	83 607	9	10 059	1
Household Fuel Burning	17 239	6	5 600	1	11 422	1
Biomass Burning	9 438	3	3 550	0	-	
TOTAL HPA	**279 630**	**100**	**978 781**	**100**	**1 633 655**	**101**

Figure 48: Total emissions of PM, NO_x and SO_2 from different sources in HPA (DEA, 2011).

2 Sensitive receptors

When identifying sensitive receptors in an area it is important to consider the type of activity associated with the facility (work, recreation, transport, residential, transportation) and whether it is in constant or occasional use. The sensitivity of the facility is influenced by the interaction and relative relation people have with the location and operation. When people are confined to the territorial region of the facility they have fewer options to extract themselves from the impact of the facility. An inverse relationship exists between the options people have and the sensitivity of the facility. Susceptible groups include the elderly, infants, persons with chronic cardiopulmonary disease, -pneumonia, -influenza and -asthma. Sensitive receptors include, amongst others: residential dwellings, hospitals, nursing homes, schools, churches.

Table 52: Susceptible groups within a 10km radius of the site.

Schools	**Distance from Plant**	**Direction from Plant**	**Latitude (°)**	**Longitude (°)**
Zikhethele Secondary School	6.85 km	300.80°	-26.350738°	28.768441°
Zikhethele Tertiary School	7.29 km	305.35°	-26.344954°	28.767800°
Sithembiso Primary School	4.58 km	309.90°	-26.355909°	28.792403°
Vukuqhakaze Secondary School	8.23 km	91.64°	-26.384220°	28.910093°
Petrus Maziya Primary School (1)	9.28 km	80.40°	-26.368432°	28.919341°
Petrus Maziya Primary School (2)	9.46 km	91.89°	-26.384925°	28.922289°
Chief Ampie Mayisa Secondary School	9.06 km	89.20°	-26.381280°	28.918430°
Hospitals/Clinics	**Distance from Plant**	**Direction from Plant**	**Latitude (°)**	**Longitude (°)**
Usizolwethu clinic	6.00 km	304.50°	-26.351823°	28.777862°

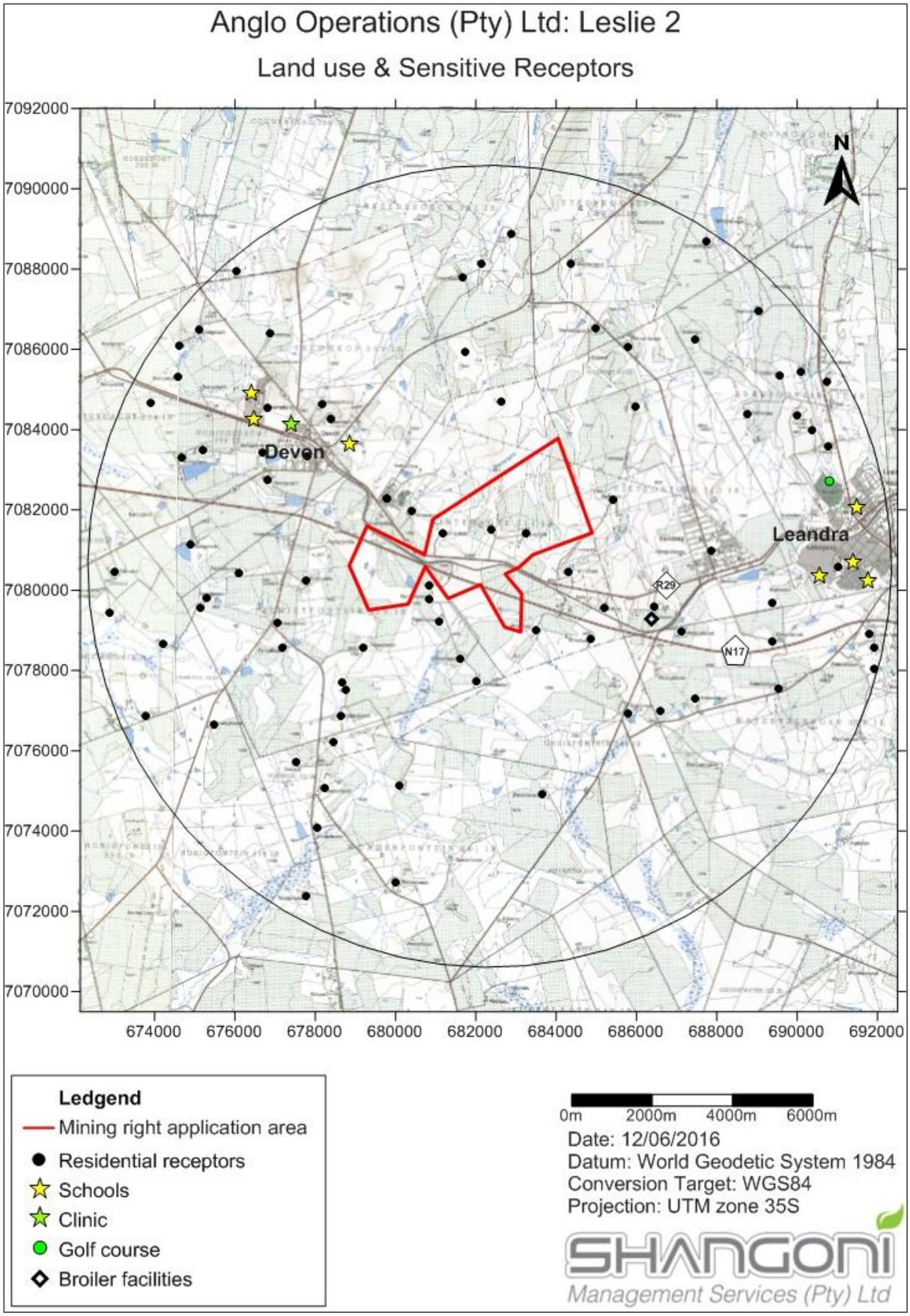

Figure 49: Land use and sensitive receptors map

Chapter L: Noise

Information contained in this section of this report was sourced from:

- The report titled: "*Anglo Operations (Pty) Ltd. Leslie 2 Underground Coal Mine Environmental noise impact assessment report*", dated October 2016 and compiled by Varicon cc (Annexure 7)

1 Noise measurement locations

A total of 18 measurement positions were selected around the perimeters of the affected farm portions. The actual sampling positions are displayed on a Google image shown as Figure 50.

Figure 50: Noise sampling positions

2 Results

The results of the environmental noise surveys at the 18 positions around the proposed mining area are tabulated below in Table 53. Measurement results are representative of both daytime and night time conditions.

The reflected values in the table below represent the noise levels of the relevant sampling positions as described. Any substandard readings will be presented in Table 53 below in **Bold and *Italic*.** All the

readings were measured below the recommended levels as indicated. In the tabulation below, indication will be provided whether the readings are compliant or non-compliant for ease of understanding.

The focus of this survey was to pre-empt the effect of the proposed surface operations, which are linked to the underground operations, on the community and the fauna. A number of measurements were done around the area of responsibility as part of the EIA/EMPR, but the readings taken in close proximity of the proposed surface operations will be considered when the actual impact assessment and the risk ratings are done.

Table 53: Environmental Noise levels measures around the perimeter of the proposed mining application area at various locations

Measuring Positions	Approximate Google Co-ordinates	AMBIENT NOISE (dB(A))						Remarks
		Day-time Levels *(outdoors)*			Night-time Levels *(outdoors)*			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	
Position A: Entrance gate to the Kruger farm and the Muller farm, just off the R29 main road. Close to the proposed office complex and the Kruger farmhouse	26^{0}21'52.77" S 28^{0}49'39.51" E	36.2 (compliant)	60	23.8	34.2 (compliant)	50	15.8	**Day-time:** - At the entrance to the Kruger and Muller farm, the only significant noise sources are some traffic on the main road. This position was close to the Kruger farm house and the proposed conveyor system and proposed shaft complex as well as the plant will have an impact on any workers or families that may reside on these premises. **Night-time:** – Normal night time activities and road traffic moving past the sampling position.
Position B: Close to the Muller farmhouse and Western fence of Portion 22	26^{0}22'23.13" S 28^{0}50'05.69" E	37.1 (compliant)	60	22.9	35.7 (compliant)	50	14.3	**Day-time:** - Some noise from the farm equipment. This sampling positions was close to the Muller farm house and the proposed shaft complex will have an impact on this family. **Night-time:** – Normal night time activities and some road traffic noise as this position was very remote from the main road.
Position C: Southern fence of Portion 22, South of the Muller farmhouse	26^{0}22'46.69" S 28^{0}50'26.67" E	38.2 (compliant)	60	21.8	37.0 (compliant)	50	13.0	**Day-time:** - Some road traffic and general farming activities. **Night-time:** –Traffic on the main roads and the normal veld noises.

Measuring Positions	Approximate Google Co-ordinates	AMBIENT NOISE (dB(A))						Remarks
		Day-time Levels *(outdoors)*			Night-time Levels *(outdoors)*			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	
Position D: Eastern corner of Portion 22.	26^{0}22'15.41" S 28^{0}51'05.48" E	36.2 (compliant)	60	23.8	34.0 (compliant)	50	16.0	**Day-time:** - Some road traffic and general farming activities. **Night-time:** –Traffic on the main roads and the normal veld noises.
Position E: North-Eastern Corner of Portion 22	26^{0}21'15.20" S 28^{0}50'40.09" E	35.4 (compliant)	60	24.6	33.0 (compliant)	50	17.0	**Day-time:** - General farming noises and some wind noise through the veld. The proposed shaft complex will be close to this position and the noise levels will increase at this position. **Night-time:** –Normal veld noises and some distant road traffic noise.
Position F: Close to the proposed Shaft Complex position	26^{0}21'32.14" S 28^{0}50'12.35" E	36.4 (compliant)	60	23.6	35.4 (compliant)	50	14.6	**Day-time:** - General farming noises and some wind noise through the veld. The proposed shaft complex will be at this position and the noise levels will increase at this position. **Night-time:** –Normal veld noises and some distant road traffic noise. Evening noises will increase with the shaft activities.
Position G: Western fence of Portion 9	26^{0}22'22.79" S 28^{0}48'49.51" E	36.5 (compliant)	60	23.5	36.0 (compliant)	50	14.0	**Day-time:** - General farming noises and some wind noise through the veld. **Night-time:** –Normal veld noises and some distant road traffic noise. Evening noises will increase with the shaft activities.

Measuring Positions	Approximate Google Co-ordinates	AMBIENT NOISE (dB(A))						Remarks
		Day-time Levels *(outdoors)*			Night-time Levels *(outdoors)*			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	
Position H: Southern corner Portion 24, closer to the Main Roads	26^{0}23'25.06" S 28^{0}49'02.88" E	41.4 (compliant)	60	18.6	40.4 (compliant)	50	9.6	**Day-time:** - Close to the main road and road traffic is the main noise contributor. This position is close to the proposed plant positions will the noise levels will increase once the plant activities commence. **Night-time:** – Road traffic from the main road. Some general evening noise.
Position I: Joining position of Portions 23, 13 and 26, next to the N17 Main Road	26^{0}23'14.16" S 28^{0}49'32.40" E	52.4 (compliant)	60	7.6	50.0 (compliant)	50	0.0	**Day-time:** - Close to the main road and road traffic is the main noise contributor. This position is close to the proposed plant positions and the noise levels will increase once the plant activities commence. **Night-time:** – Road traffic from the main road. Some general evening noise.
Position J: South-Eastern corner of Portion 13, next to the N17 Main Road	26^{0}23'21.24" S 28^{0}50'08.87" E	49.2 (compliant)	60	10.8	48.6 (compliant)	50	1.4	**Day-time:** - Close to the main road and road traffic is the main noise contributor. This position is close to the proposed plant position and the noise levels will increase once the plant activities commence. **Night-time:** – Road traffic from the main road. Some general evening noise.

Measuring Positions	Approximate Google Co-ordinates	AMBIENT NOISE (dB(A))						Remarks
		Day-time Levels *(outdoors)*			Night-time Levels *(outdoors)*			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	
Position K: South fence of Portion 20, close to the Pedro farmhouse	26^{0}24'32.44" S 28^{0}49'28.12" E	39.2 (compliant)	60	20.8	38.4 (compliant)	50	11.6	**Day-time:** - The noise activities on this Pedro farm are limited to the cattle and general farming noise activities. The proposed plant and mine processes should not have any significant impact on these farming communities. **Night-time (B):** – General night time noises and some distant road traffic noises.
Position L: Western corner of Portion 20, South-Eastern fence of Portion 3, Pedro farm	26^{0}24'33.42" S 28^{0}49'05.60" E	36.4 (compliant)	60	23.6	35.5 (compliant)	50	14.5	**Day-time:** - The noise activities on this Pedro farm are limited to the cattle and general farming noise activities. The proposed plant and mine processes should not have any significant impact these farming communities. **Night-time (B):** – General night time noises and some distant road traffic noises.
Position M: Northern fence of Portion 20, close to the Pedro farmhouse	26^{0}24'17.69" S 28^{0}49'17.66" E	38.5 (compliant)	60	21.5	37.6 (compliant)	50	12.4	**Day-time:** - The noise activities on this Pedro farm are limited to the cattle and general farming noise activities. The proposed plant and mine processes should not have any significant impact on these farming communities. **Night-time (B):** – General night time noises and some distant road traffic noises.
Position N: Joining corner of Portion 3 and 19, Pedro farm.	26^{0}24'20.90" S 28^{0}48'49.28" E	36.3 (compliant)	60	23.7	35.9 (compliant)	50	14.1	**Day-time:** - The noise activities on this Pedro farm are limited to the cattle and general farming noise activities. The proposed plant and mine processes should not have any significant impact on these farming communities.

Measuring Positions	Approximate Google Co-ordinates	AMBIENT NOISE (dB(A))						Remarks
		Day-time Levels *(outdoors)*			Night-time Levels *(outdoors)*			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	
								Night-time (B): – General night time noises and some distant road traffic noises.
Position O: Western corner Portion 32, Lang farm	26^{0}22'58.75" S 28^{0}47'35.30" E	36.8 (compliant)	60	23.2	35.4 (compliant)	50	14.6	**Day-time:** - The noise activities on this Lang farm Portions are limited to the cattle and general farming noise activities. The proposed plant and mine processes should not have any significant impact on these farming communities. **Night-time (B):** – General night time noises and some distant road traffic noises.
Position P: Southern corner Portion 32, Lang farm	26^{0}23'35.02" S 28^{0}47'52.75" E	36.4 (compliant)	60	23.6	35.0 (compliant)	50	15.0	**Day-time:** - The noise activities on this Lang farm Portions are limited to the cattle and general farming noise activities. The proposed plant and mine processes should not have any significant impact on these farming communities. **Night-time (B):** – General night time noises and some distant road traffic noises.
Position Q: Southern corner Portion 6, Muller farm	26^{0}23'30.36" S 28^{0}48'27.24" E	42.5 (compliant)	60	17.5	40.7 (compliant)	50	9.3	**Day-time:** - The noise activities on this Muller farm Portions are limited to the cattle and general farming noise activities as well some road noise from the main roads. The proposed plant and mine processes should not have any significant impact on these farming communities. **Night-time (B):** – General night time noises and some distant road traffic noises.

Measuring Positions	Approximate Google Co-ordinates	AMBIENT NOISE (dB(A))						Remarks
		Day-time Levels *(outdoors)*			Night-time Levels *(outdoors)*			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess $_{\Delta}L_{Req,T}$ (dBA)	
Position R: North-Eastern corner Portion 6, Next to the N17 Main Road, Muller farm	26^{0}23'01.20" S 28^{0}48'41.74" E	52.3 (compliant)	60	7.7	49.9 (compliant)	50	0.1	**Day-time:** - The noise activities on this Muller farm Portions includes traffic noise from the main road and some general farm noise activities. The proposed plant and mine processes should have some impact on these farming communities as these positions are closer to the proposed plant positions. **Night-time (B):** – General night time noises and some road traffic noises.

Ambient Noise: ***The totally encompassing sound in a given situation at a given time and usually composed of sound from many sources both near and far***

Chapter M: Blasting and Vibration

Information contained in this section of this report was sourced from:

- The report titled: "*Report: Blast Impact Assessment. Leslie 2 Mining Operations",* dated October 2016 and compiled by Blast Management and Consulting (Annexure H8)

The evaluation of effects yielded by blasting operations was evaluated over an area as wide as 1500 m.

1 Baseline information

The mine is not operational and do not have any specific influence currently. No specific monitoring was done. The project is not currently active with any blasting operations being done. Baseline data is considered at zero level.

2 Sensitivity

A review of the project and the surrounding areas is done before any specific analysis is undertaken and sensitivity mapping is done, based on typical areas and distance from the proposed box-cut area. This sensitivity map uses distances normally associated where possible influences may occur and where influence is expected to be very low or none. This sensitivity analysis was done prior to site visit. The sensitivity mapping concentrates mainly on the possible influence from ground vibration, air blast and fly rock regarding people and structures. Two different areas were identified in this regard:

- A highly sensitive area of 500 m around the mining area. Normally, this 500 m area is considered an area that should be cleared of all people and animals prior to blasting. Levels of ground vibration and air blast are also expected to be higher closer to the box-cut area.
- An area 500 m to 1500 m around the box-cut area can be considered as being a medium sensitive area. In this area, the possibility of impact is still expected, but it is lower. The expected level of influence may be low, but there may still be reason for concern, as levels could be low enough not to cause structural damage but still upset people.
- An area greater than 1500 m is considered low sensitivity area. In this area it is relatively certain that influences will be low with low possibility of damages and limited possibility to upset people.

Figure 51 shows the sensitivity mapping with the identified points of interest (POI) in the surrounding areas for the proposed Leslie 2 project. The specific influences will be determined through the work done for this project in this report.

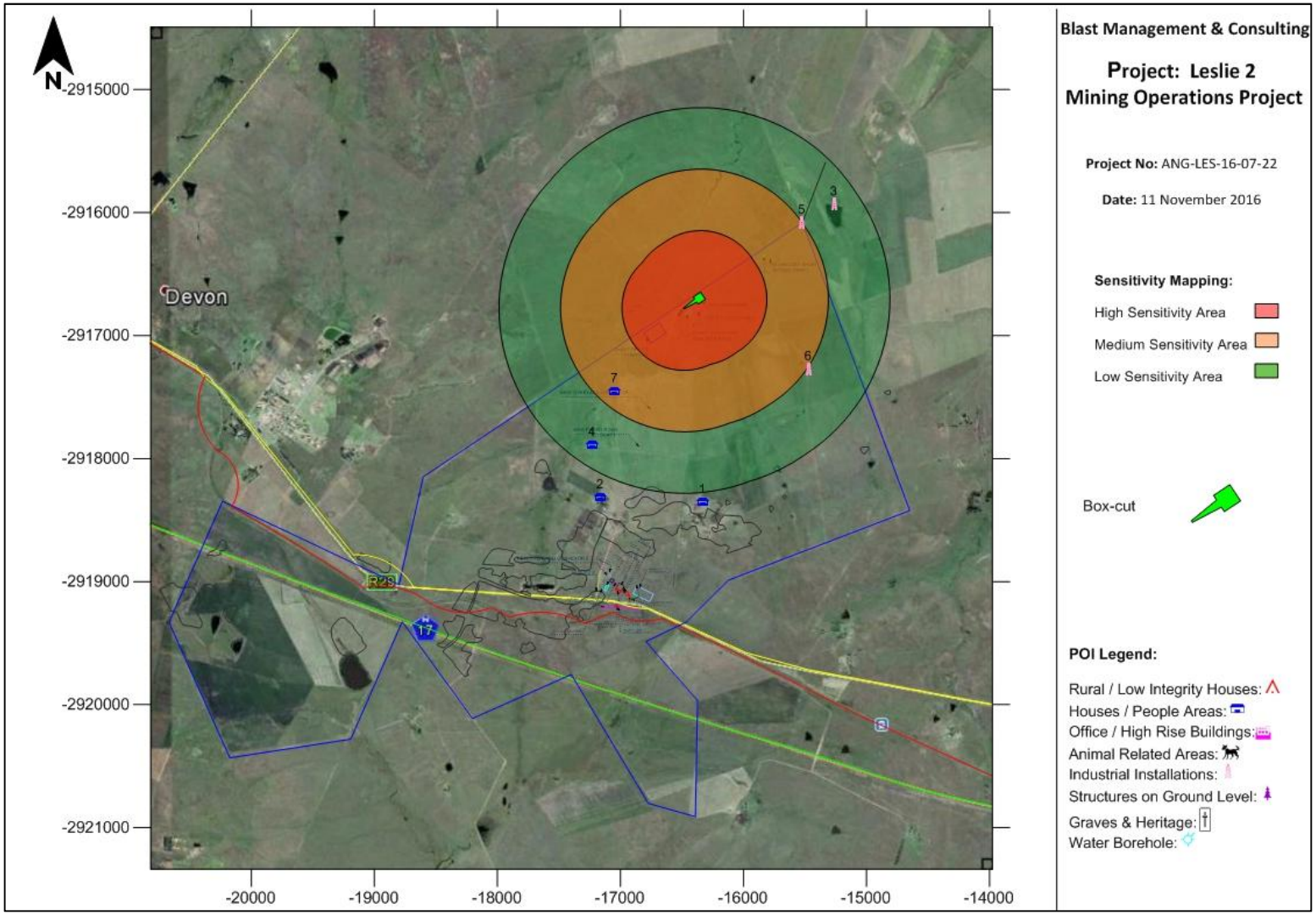

Figure 51: Identified sensitive areas (Blast Management and Consulting, 2016)

3 Site description

The project area is mainly on Portion 21 of the farm Winterhoek 314 IR. The farm area consists mainly of the main farmstead, offices, farm building / workshops, cattle and sheep feedlot buildings, recreational Lapa and a dam. The farm operations consist of cattle and sheep feedlots – up to 2000 cattle are fed at times. The farming operations also include a buffalo camp with several buffalo and all species of grass eating antelope. The buffalo are mainly a breeding station. Indications were given that there is planned expansion in the wildlife breeding operations.

4 Structure profile

As part of the baseline, all possible structures in a possible influence area are identified. The site review is detailed here. The site was reviewed using Google Earth imagery and during site visit. Information sought during the review was to identify surface structures present in a 1500 m radius from the proposed mine boundary (the box-cut), which will require consideration during modelling of blasting operations, e.g. houses, general structures, power lines, pipe lines, reservoirs, mining activity, roads, shops, schools, gathering places, possible historical sites, etc. A list was prepared of all structures in the vicinity of the Leslie 2 Mining Operations box-cut area. The list includes structures and points of interest (POI) within the 1500 m boundary. A list of structure locations was required in order to determine the allowable ground vibration limits and air blast limits. Figure 52 shows an aerial view of the box-cut area and surroundings with POIs. The type of POIs identified is grouped into different classes. These classes are indicated as “Classification” in Table 55. The classification used is a BM&C classification and does not relate to any standard or national or international code or practice. Table 54 shows the descriptions for the classifications used.

Table 54: POI Classification used

Class	Description
1	Rural Building and structures of poor construction
2	Private Houses and people sensitive areas
3	Office and High rise buildings
4	Animal related installations and animal sensitive areas
5	Industrial buildings and installations
6	Earth like structures – no surface structure
7	Graves & Heritage
8	Water Borehole

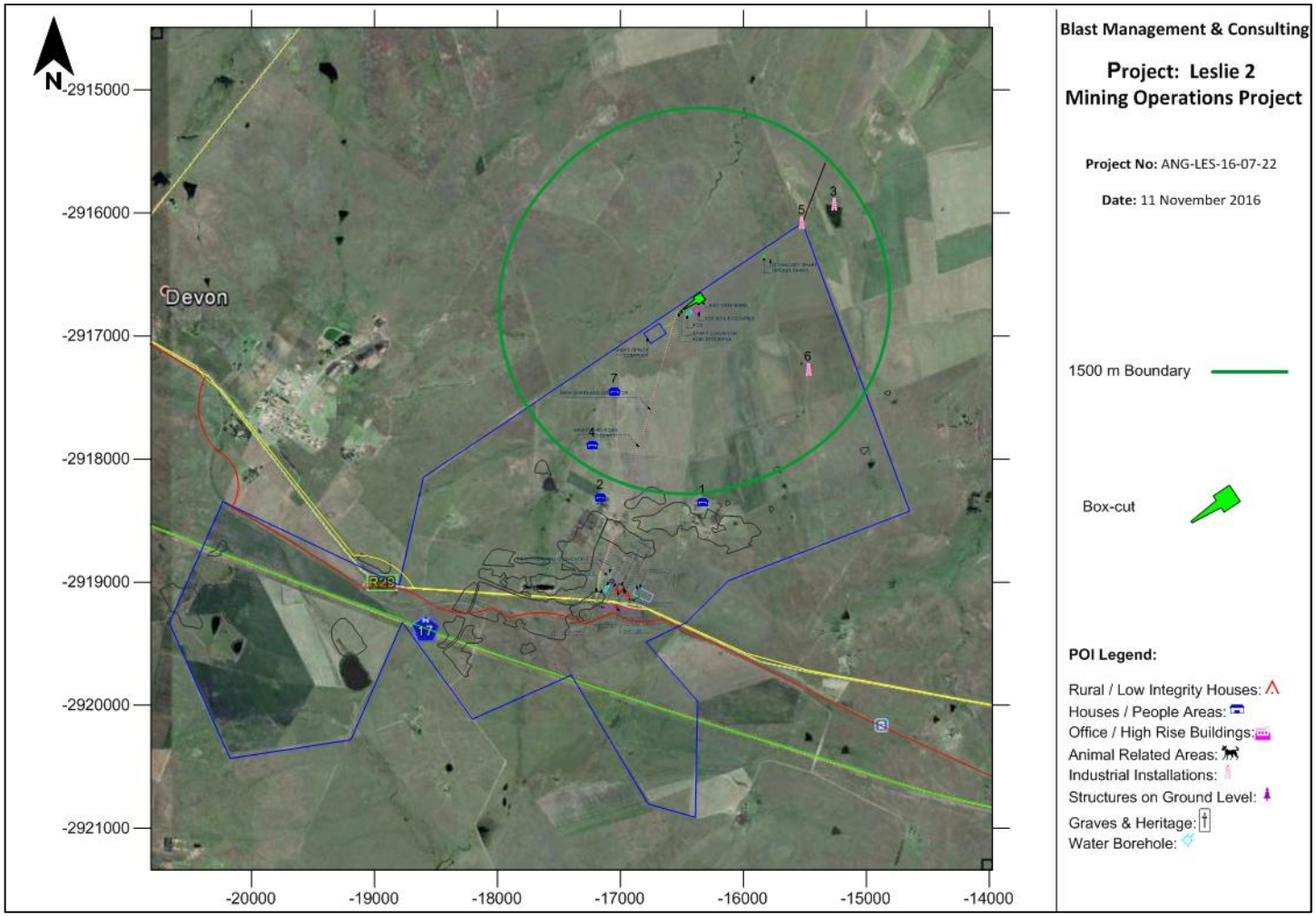

Figure 52: Aerial view and surface plan of the proposed mining area with points of interest identified

Table 55: List of points of interest identified (WGS – LO 29°)

Tag	Description	Classification	Y	X
1	Farm Buildings/Structures	2	16328.18	2918350.87
2	Farm Buildings/Structures	2	17160.28	2918313.01
3	Dam	5	15260.64	2915929.69
4	Building/Structure	2	17226.54	2917885.46
5	Pipeline	5	15521.61	2916080.36
6	Cement Dam	5	15468.62	2917269.13
7	Building/Structure	2	17044.55	2917449.66

During the site visit the structures were observed and the initial POI list ground-truthed and finalised as represented in this section. Structures ranged from well-built structures to informal building styles.

Chapter N: Visual aspects

Information contained in this section of this report was sourced from:

- The report titled: "*Visual impact assessment as part of the Environmental Assessment and authorisation process for the proposed Leslie 2 mining project, Gauteng Province",* dated November 2016, compiled by Scientific Terrestrial Services (Annexure H9).

1 Description of the receiving environment

In order to holisticacally describe the receiving environment, this section of the report aims to determine the intrinsic value of the receiving landscape including aspects of the natural, cultural and scenic landscape, taking both tangible and intangible factors into account.

General views of the landscape associated with the MRA and surrounds as assessed during the October 2016 field assessment are shown in Figure 5 below.

The dominant land use within the MRA itself and associated with the plant and conveyor infrastructure footprint areas, is grazing activities and small sections of crop cultivation. The portion of the MRA in the vicinity of the proposed plant complex are characterised by wetland, rocky and moist grassland habitat. Residential farm houses and scenic dams are also present within the MRA.

Figure 53: General views of the MRA and the surrounding region (STS, 2016)

A number of main roads are present in the vicinity of the MRA, including:

- The N17 highway traversing the MRA in a west-east direction;
- The R29 roadway, to the north of and roughly parallel to the N17, traversing the MRA in a west-east direction;
- The R50 roadway located approximately 8km to the east and 15km to the north of the MRA; The R548 and the R550 to the west of the MRA, joining the R29 at Devon;
- The R23 roadway running 40km to the south of the MRA; and
- Numerous local gravel roads traversing the MRA.

The MRA in its present state has not been directly affected by mining and industrial activities and therefore the proposed mining activities will lead to a noticeable change in current land use. It is important to note that the larger region surrounding the MRA, towards the towns of Springs in the west, Delmas in the north and Evander in the east is strongly associated with mining and the communities in

the area are likely to be somewhat accustomed to the presence of mining infrastructure. In addition, the majority of mining will take place underground, with surface infrastructure

2 Landscape character

Landscape character, from an aesthetic perspective, is mainly defined by natural determinants, such as vegetation, geology and topography, as well as cultural factors including land use, settlement patterns and the manner in which humans have transformed their natural surroundings. According to Swanwick (2002), landscape character may be defined as a distinct, recognisable and consistent pattern of elements in the landscape that makes it unique and provides it with a particular sense of place. Individual “landscape elements” that contribute to landscape character include hills, rolling plains, valleys, woods, trees, water bodies, as well as buildings and roads. “Landscape features” are those elements that are prominent or eye-catching.

Figure 54: Landscape character of the MRA, indicating the gently undulating topography, which is the dominant landscape elem ent present in the MRA (STS, 2016)

3 Visual absorption Capacity (VAC)

Through applying the scoring categories as outlined in Appendix D, the following scores have been calculated for the MRA:

Table 56: VAC scores achieved

Factor	Score obtained	Motivation
Vegetation	2	Vegetation is low and continuous with overall good cover. Bare soils are periodically present where cultivated fields are cleared, where vegetation is impacted by drought conditions or where excessive grazing has taken place.

Factor	Score obtained	Motivation
Soil contrast	2	Due to bare soils being periodically visible, surface disturbance and soil contrast would be less detracting within such area than within natural grassland areas.
Visual variety	2	The vegetation within MRA is largely homogeneous when viewed from a distance, but visual variety is present due to local natural features such as wetland and rocky outcrops.
Topographical diversity	1	The topography within the MRA is relatively homogeneous and is considered to be undulating.
Recovery time	2	Due to the dominant vegetation within the MRA comprising grassland, the recovery time of the environment is considered to be of medium duration.
Total:	9	Medium

Scores, when added, amounting to between 5 and 7 are categorised as Low, scores between 8 and 11 as Medium and between 12 and 15 as High. The total score for the MRA added to 9, which defines the VAC of the MRA as being 'medium'.

Due to the nature of the project and its location within an area currently unaffected by mining activities, the proposed project, with specific reference to the Leslie 2, will lead to a high level of visual intrusion on the landscape and is expected to be clearly noticeable in relation to its surroundings. However, the undulating landscape and screening from existing vegetation, will serve to somewhat limit such intrusion from certain receptor sites.

4 Landscape quality

Through applying the scoring categories as outlined in Appendix E of Annexure H9, the following scores have been calculated for the MRA:

Table 57: Scenic Quality – Results and motivation.

Factor	Score obtained	Motivation
Landform	1	The MRA contains no prominent hills, steep slopes or vertical areas, but is characterised by gently undulating topography.
Vegetation	1	Little variety in vegetation is present as land cover is dominated by grasslands, pasture/ grazing land and cultivated fields. Wetlands and other freshwater features are also present, as well as rocky outcrop areas, with alien tree stands present in the vicinity of farm houses and occasionally near freshwater features.

Factor	Score obtained	Motivation
Water	3	Water is present within the landscape in the form of drainage line and dams, but do not visually dominant the MRA.
Colour	3	Some seasonal intensity or variety in colours and contrast of the soil, rock and vegetation is present, but this does not constitute not a dominant scenic element.
Adjacent Scenery	0	Adjacent scenery is not considered to contribute significantly towards the visual quality associated with the MRA.
Scarcity	1	The overall landscape character type is representative of the larger region and is not considered to be particularly scarce.
Cultural Modifications	2	Modifications add favourably to visual variety while promoting visual harmony.
Total:	11	Low to Medium

Scores, when added, amounting to less than 11, are categorised as Low, scores between 12 and 18 as Medium and scores more than 19 as High. The total score for the MRA calculated as 11, and thus the overall landscape is considered to have low to moderate scenic quality. It is however considered to exhibit an overall positive landscape character, with a recognisable landscape structure and sense of place.

5 Landscape value

With reference to Appendix F of Annexure H9, the landscape within the MRA and the surrounding region is likely to be most valued by local residents, farmers and farm workers and, as far as is known to the visual specialists at the current stage, does not contain specific value for special interest groups, apart from birders. The area is not known to be of specific provincial, national or international cultural historical importance.

6 Sense of place

Sense of place is the unique value that is allocated to a specific place or area through the cognitive experience of the user or viewer. It is created by the land use, character and quality of a landscape, as well as by the tangible and intangible value assigned thereto. The landscape character type defined as rural, undulating open grassland, with cultivated fields, freshwater features and associated wetland and rocky area present, is not unique to the MRA and can also be found within the larger region. The sense of place associated with the MRA and in particular with the MRA, is therefore not particularly significant when compared to its surroundings but it is recognisable, supported by the presence of a variety of wildlife particularly and the particular landscape structure on the Farm Winterhoek 314IR where the majority of the proposed surface infrastructure is located. The sense of place of the MRA may be considered to be moderate due the aforementioned combined with its passive and calm nature and rural, undeveloped and agricultural character.

7 Visual receptors

With reference to Appendix G of Annexure H9, and as pertaining to the proposed Leslie 2 project, the following potential sensitive receptors have been identified for the proposed Leslie 2 Project:

- Residential areas, including towns, farm houses, informal settlements and labour houses;
- Education structures;
- Agricultural infrastructure and facilities, including feedlots and broilers;
- Infrastructure associated with existing mining activities located further than 10km from the MRA;
- Road users; and
- Graves may also potentially be sites of increased sensitivity.

The main visual receptors associated with the proposed project include local residents, farmers and workers on farms within the immediate vicinity of the MRA, as well as residents, farmers and workers on farms located further away from the MRA within areas from where the proposed project will also be visible. Farms from where the proposed surface mining infrastructure is likely to be highly visible include the following:

- Winterhoek 314IR;
- Palmietfontein 316IR;
- Steenkoolspruit 303IR;
- Enkeldebosch 301IR
- Rietfontein 313IR;
- Holspruit 303IR;
- Gruisfontein 344IR; and
- Wonderfontein 342IR.

Farms from where the proposed surface mining infrastructure is likely to be somewhat visible include the following:

- Wonderfontein 341IR;
- Watervalshoek 350IR;
- Brakfontein 310IR;
- Springboklaagte 306IR;
- Hawerklip 265IR;
- Leeukop 299IR; and
- Groenkuil 318IR.

The immediate region associated with the MRA is not specifically known to be a tourist area, however, birders are known to frequent the area. Other potential sensitive receptors are people travelling on the N17, R29 traversing the MRA centrally. The proposed Leslie 2 project will be highly visible from both the N17 and R29 main roads for an extended section (up to 7km) of these roads, while the infrastructure will not be visible from the R548.

The proposed project is expected to be highly visible to receptors present within 5km thereof, as these areas fall within the high visibility zone and the proposed project will form part of the foreground–middleground of their viewing experience. The proposed project will be moderately visible to receptors within 5 – 10 km of the MRA, particularly from areas with a clear line of sight towards the proposed project infrastructure.

It is important to note that the project infrastructure will not be visible from any protected areas such as the Marievale Bird Sanctuary Provincial Nature Reserve, the Suikerbosrand Provincial Nature Reserve or the Alice Glöckner Provincial Nature Reserve due to the distance (over 20km) of these areas from the MRA and screening provided by intervening local topography.

8 Key observation points

Key Observation Points (KOPs) were identified based on prominent viewpoints, where uninterrupted views of the proposed development may occur and at points where positive viewshed areas intersect with potential visual receptors identified for the Leslie 2 project (Figure 55). The majority of KOPs were also selected within 10km of the proposed project infrastructure, as receptors beyond this distance are unlikely to be significantly affected. KOPs were also selected to be representative of a larger area, a larger section of a gravel road or a grouping of residential dwellings where required. The KOP analyses have been conducted by investigating the visual influence of proposed mine infrastructure as per the available site layout. Major routes, such as the N17, the R29, the R50 and the R548 that carry increased amounts of traffic, as well as local gravel roads, have also been considered during the assessment as well as the location of residential areas and agricultural infrastructure.

Conceptual visual simulations were rendered from several of the key locations selected for the proposed mining infrastructure. Viewpoints are mostly representative of a larger number of houses within a town or chosen to represent views from various public roads (IEMA, 2013). All visual simulations are presented as the project is envisioned in its pre-mitigated state. With appropriate mitigation and management measures put in place as outlined at the end of this report, the visual impact may be reduced.

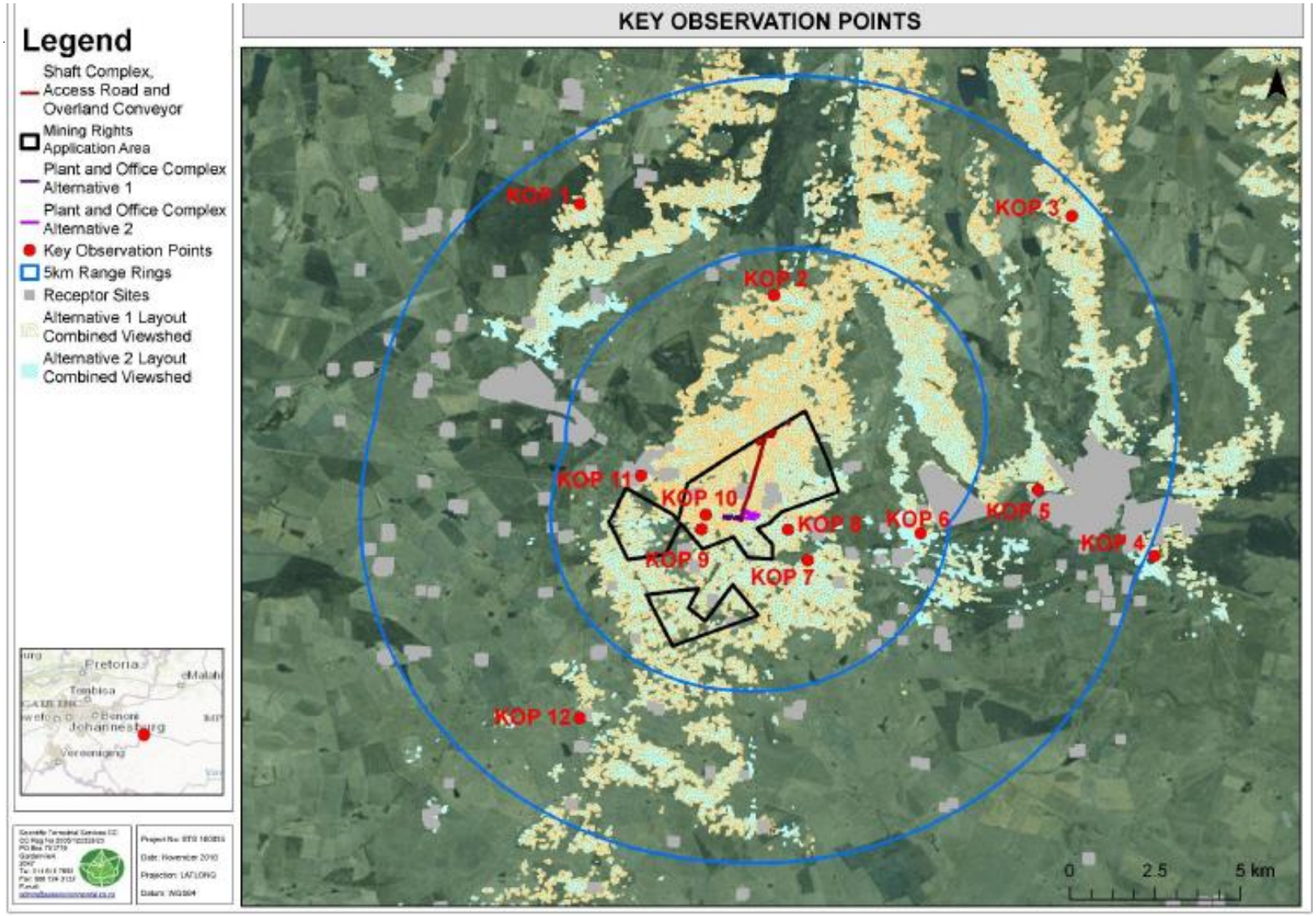

Figure 55: Combined viewsheds of the proposed Leslie 2 mine infrastructure area (both layout Alternative 1 and 2) overlaid onto the map of potential visual receptors in the area. The selected Key Observation Points (KOPs) are also indicated. (STS, 2016)

KEY OBSERVATION POINT 1 – Gravel Road north of Devon

KOP 1 is located approximately 8.2km to the northwest of the proposed mining infrastructure on an unnamed gravel road 5.6km north of the town of Devon. From this location, both the plant layouts associated with Alternatives 1 and 2 will be slightly visible in the middleground. However, the distance is somewhat significant, some topographical and vegetation screening of lower infrastructure components will take place and the proposed plant complex and main office and stores complex is not expected to be easily distinguishable from the background. Local topography serves to screen the proposed shaft complex and conveyor route from view.

Residents and workers of farms in the vicinity of KOP 1, as well as people travelling on the gravel road towards Devon from the north are considered moderately sensitive visual receptors.

KEY OBSERVATION POINT 2 – Gravel Road north of MRA

KOP 2 is situated 4km to the north of the proposed Leslie 2 mining infrastructure on an unnamed secondary/ gravel road. From this KOP both the proposed shaft complex, as well as the northern extent of the conveyor route and the upcast and downcast ventilation shafts will be visible with the foreground. Some screening is afforded by seasonal vegetation cover provided by cultivated land and alien tree stands. The plant and main office/ stores complexes of both Alternative 1 and Alternative 2 will not highly visible as these areas will mostly be screened by the proposed shaft infrastructure. Receptors within the vicinity of KOP 2 are regarded to be highly sensitive viewers, although it should also be noted that this gravel road does not carry large amounts of traffic.

KEY OBSERVATION POINT 3 – R50 Roadway north of Leandra

KOP 3 is located approximately 9.3km to the northeast of the proposed surface infrastructure on the R50 roadway. From this KOP the proposed infrastructure will only be moderately visible, with the shaft complex being mostly screened by local topography. Receptors will only be exposed to the project for a limited period of time due to the R50 being a main road, and the infrastructure being some distance away. These receptors are therefore considered to be moderately sensitive.

KEY OBSERVATION POINT 4 – R50 Roadway south of Leandra

KOP 4 is located approximately 10.5km to the east of the proposed infrastructure on the R50 roadway immediately to the south of the town of Leandra. The shaft will mostly be screened from view, however both layout alternatives for the plant and offices/ stores complexes will be visible in the background. From this location these components will however be obscured by existing development and man-made infrastructure in the middleground and will therefore not contrast significantly with the environment.

Receptors will only be exposed to the project for a limited period of time due to the R50 being a main road, and the infrastructure being some distance away will further reduce the impact on these receptors,

who are considered to be only moderately sensitive. These receptors are therefore not considered to be visually sensitive.

KEY OBSERVATION POINT 5 – R29 west of Leandra

KOP 5 is located 7.4km to the east of the surface infrastructure on the R29 roadway immediately to the west of the town of Leandra. The shaft complex Alternative 1 plant and office/ stores complexes will be mostly screened from view by topography and existing vegetation, while the Alternative 2 layout will be visible in the middleground and partially obscured by the town of Eendracht. Receptors within this area are considered to be moderately visually sensitive.

KEY OBSERVATION POINT 6 – R29 west of Eendracht

KOP 6 is located around 4.3km to the east of the surface infrastructure on the R29, west of the town of Eendracht. Both the shaft and conveyor infrastructure will be screened from view by local undulating topography, but the plant and main office/ stores complexes within both the Alternative 1 and 2 locations will be visible within the foreground, with possible skylining occurring. Receptors on the R29 in tis locations are regarded as being highly sensitive.

KEY OBSERVATION POINT 7 – N17 between Devon and Leandra

KOP 7 is located approximately 2km to the southeast of the surface infrastructure on the N17. The shaft complex and conveyor infrastructure will be hardly visible due to local screening effects, however both layout alternatives for the shaft and main office/ stores complex will be prominently visible within the foreground. These receptors can therefore be considered highly sensitive from a visual perspective.

KEY OBSERVATION POINT 8 – R29 between Devon and Leandra

KOP 8 is situated just over 1km to the east of the infrastructure area on the R29 roadway between the towns of Devon and Leandra. Both plant and main offices/ stores complexes will be highly visible within the viewer's foreground from this location, with the shaft complex being mostly screened from view and hardly visible. Road users utilising the R29 roadway in the immediate vicinity of the proposed plant and main offices/ stores complexes can therefore be considered highly sensitive from a visual perspective, as the proposed conveyor bridge across the R29 and several stockpiles will also be highly visible from this location.

KEY OBSERVATION POINT 9 – N17 between Devon and Leandra

KOP 9 is located less than 1km to the southwest of the proposed infrastructure areas on the on the N17 roadway between the towns of Devon and Leandra. Both alternative locations of the plant and main offices/ stores complexes will be highly visible within the viewer's foreground from this location, with the shaft complex being mostly screened from view and hardly visible. Portions of the conveyor route will also be visible within the fore- to middleground and therefore road users of the N17 to the south of the proposed infrastructure are considered highly sensitive visual receptors.

KEY OBSERVATION POINT 10 – R29 between Devon and Leandra

KOP 10 is located less than 1km to the west of the proposed infrastructure areas on the on the R29 roadway between the towns of Devon and Leandra. From this location the majority of the proposed infrastructure, including the shaft complex, conveyor route and both plant complex and main offices/ stores complexes will be highly visible, with the Alternative 1 layout being more prominent. Road users utilising the R29 roadway within this area can therefore be considered highly sensitive from a visual perspective.

KEY OBSERVATION POINT 11 – Devon

KOP 11 is located approximately 2.5km to the northwest of the surface infrastructure on the boundary of the eastern portion of the town of Devon, in the vicinity of the Devon Correctional Facility. The shaft infrastructure will be screened by existing development from this location, but both the plant and main offices/ stores complexes, as well as the southern portion of the conveyor belt will be highly visible. Visual receptors in this area are considered to be highly sensitive.

The viewsheds and line of sight analyses completed for the project as part of the VIA indicate that the surface infrastructure will not be visible from the western portion and majority of the town of Devon.

KEY OBSERVATION POINT 12 – Gravel Road

KOP 12 is located around 7km to the southeast of the project on a gravel road, carrying low levels of vehicular traffic, within the vicinity of farms used mainly for cultivation and grazing. The proposed infrastructure will be hardly visible from this location as screening is afforded by existing vegetation and topography. Receptors in this area are therefore not considered to be sensitive visual receptors.

Figure 56: KOP 1 and KOP 2 – conceptual illustration of the visibility of the proposed Leslie 2 mine infrastructure area after development.

Figure 57: KOP 3 and KOP 4 – conceptual illustration of the visibility of the proposed Leslie 2 mine infrastructure area after development.

Figure 58: KOP 5 and KOP 6 – conceptual illustration of the visibility of the proposed Leslie 2 mine infrastructure area after development.

Figure 59: KOP 7 and KOP 11 – conceptual illustration of the visibility of the proposed Leslie 2 mine infrastructure area after development.

9 Night time lighting

The majority of the northern portion of the MRA is generally free from the effects of night lighting sources, with low-level light sources coming from farm houses, surrounding local gravel roads and the Devon correctional centre, approximately 1km to the northwest. Within the central and southern portions of the MRA higher lighting levels are however expected due to the close proximity of busy roads such as the N17 and the R29 connecting the towns as Devon and Leandra, located beyond the MRA. The lighting environment of the MRA is therefore considered to border between Environmental Zone E2 (Rural) and Zone E3 (Suburban) with Low to Medium District Brightness, with the proposed infrastructure and nigh time mining operations expected to significantly increase night-time lighting levels in this area (the operations will occur in two nine-hour shifts per day, 5 days a week). The ILP (2011) recommend that, in order to maintain the night-time setting, lighting within the identified zone should have limited illumination into the sky as well as to adjacent viewpoints.

Chapter O: Traffic

Information contained in this section of this report was sourced from:

- The report titled: "*Traffic Impact Assessment. Environmental impact evaluation of the proposed Leslie 2 mining operation located on Palmietfontein 316 IR and Winterhoek 314 IR near Leandra, Gauteng,* dated 2016 and compiled by WSP (Annexure H10).

The external road network is classified with reference to Figure 2 attached:

- The N17 is a Class 1 Principal Arterial (Freeway) and runs in an east west direction to the south of the site
- The R29 is classified as a Rural Highway with a speed limit of 120km/hr. The traffic counts indicate that the average daily traffic along this road is in the order of 3400 vehicles per day.

Chapter P: Protected areas and conservation planning

Information in this section of this report has been obtained from the following documents:

- The report titled: "*Faunal and Floral Ecological Assessment as part of the Environmental Assessment and Authorisation process for the proposed Leslie 2 Underground Coal Mining operation, Gauteng Province",* dated January 2017 and compiled by Scientific Terrestrial Services (STS) (Annexure H2).

The table below provides a summary of the conservation characteristics of the study area.

Table 58: Summary of the conservation characteristics for the study area.

Legislation / Plans / Policies	Description	Reference to Figure
National Threatened Ecosystems (2011)	The majority of the threatened ecosystems associated with the southern portion and western section of the northern portion of the MRA, is considered to be Critically Endangered (Boesmanspruit Highveld Grassland), while threatened ecosystems located within the eastern section of the northern portion is considered to be Vulnerable (Soweto Highveld Grassland)	Figure 60
NPAES59 (2009) & SAPAD60 (2016)	There are no protected areas located within the MRA or the immediate surrounding area (within 10km)	-
IBA61 (2015)	The southern section and western portion of the northern section is located within the Devon Grassland IBA	Figure 61
Critical Biodiversity Area (CBA)	Multiple CBAs are located within the MRA A CBA is an area considered important for the survival of threatened species and includes valuable ecosystems such as wetlands, untransformed vegetation and ridges.	Figure 63
Ecological Support Areas (ESA)	The areas within the MRA immediately adjacent to the CBAs are considered to be ESAs (Figure 8). An ESA provides connectivity and important ecological processes between CBAs and is therefore important in terms of habitat conservation.	

[59] **National Protected Areas Expansion Strategy;**

[60] **South Africa Protected Areas Database**

[61] **Important Bird Area**

Legislation / Plans / Policies	Description	Reference to Figure
Importance of the MRA according to the Mining and Biodiversity Guidelines (2013)	*Highest Biodiversity Importance* Various areas within the MRA are considered to be of Highest Biodiversity Importance. Highest Biodiversity Importance areas include areas where mining is not legally prohibited, but where there is a very high risk that due to their potential biodiversity significance and importance to ecosystem services (e.g. water flow regulation and water provisioning) that mining projects will be significantly constrained or may not receive necessary authorisations	Figure 62
	High Biodiversity Importance The remaining areas within the southern portion and western section of the northern portion of the MRA not considered to be of Highest Biodiversity Importance is classified as High Biodiversity Importance. High Biodiversity Importance Areas are important for conserving biodiversity, for supporting or buffering other biodiversity priority areas, for maintaining important ecosystem services for particular communities or the country as a whole.	
	Moderate Biodiversity Importance The majority of the eastern section of the northern portion is considered to be of Moderate Biodiversity Importance. These areas are of moderate biodiversity value and therefore pose a moderate risk to mining. EIAs and associated specialist studies should focus on confirming the presence and significance of these biodiversity features, identifying features (e.g. threatened species) not included in the existing datasets, and on providing site-specific information to guide the application of the mitigation hierarchy. Authorisations may set limits and specify biodiversity offsets that would be written into licence agreements and/or authorisations.	
Gauteng Environmental Management Framework (GPEMF) Zones	The proposed Leslie 2 project area falls within Environmental Management Zones (EMF's) 3 and 4 – as per the GPEMF.	Figure 64

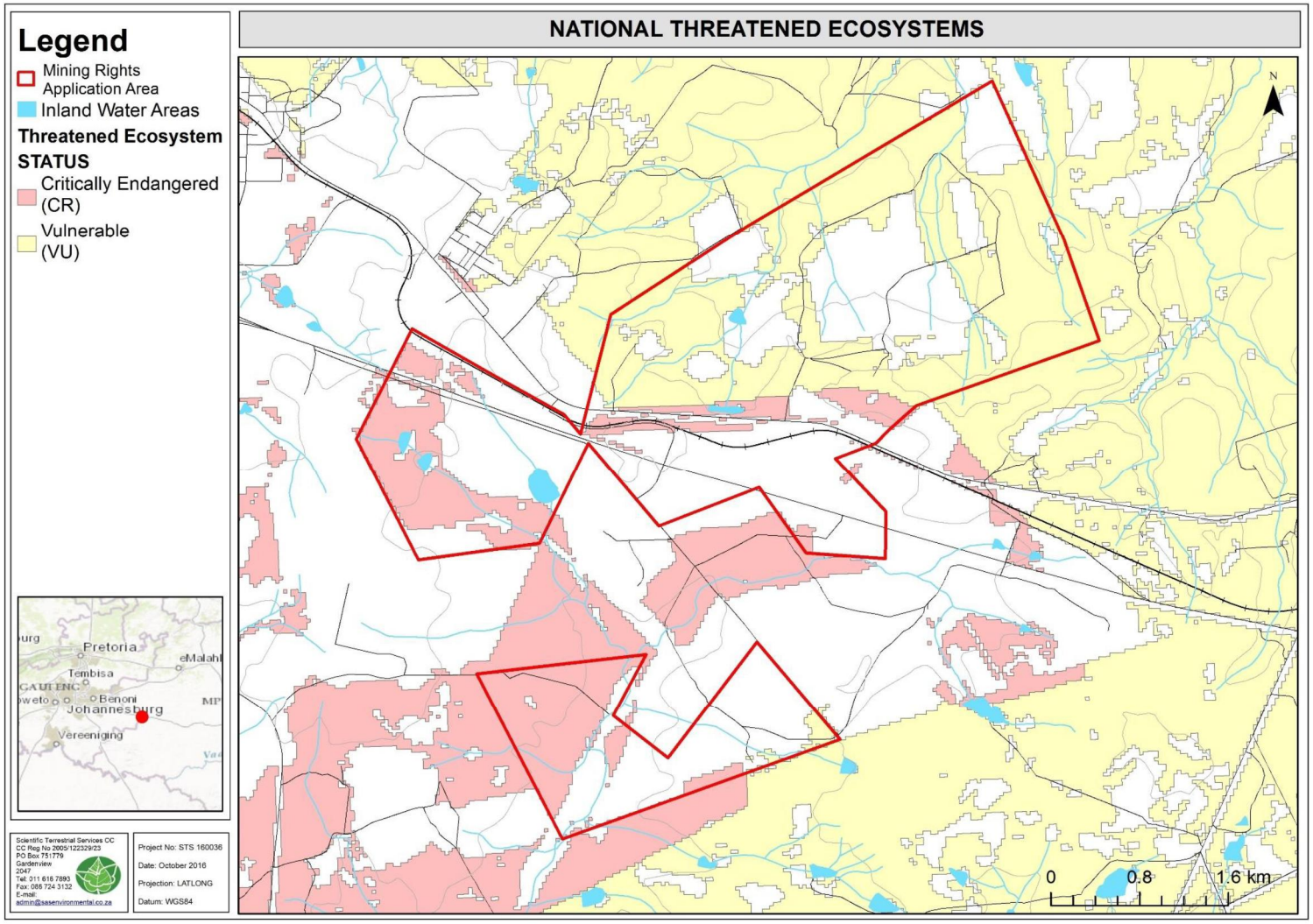

Figure 60: Remaining extent of the Boesmanspruit Highveld Grassland (CR) and Soweto Highveld Grassland (VU) threatened ecosystems associated with the MRA according to the National Threatened Ecosystems Database (2011)

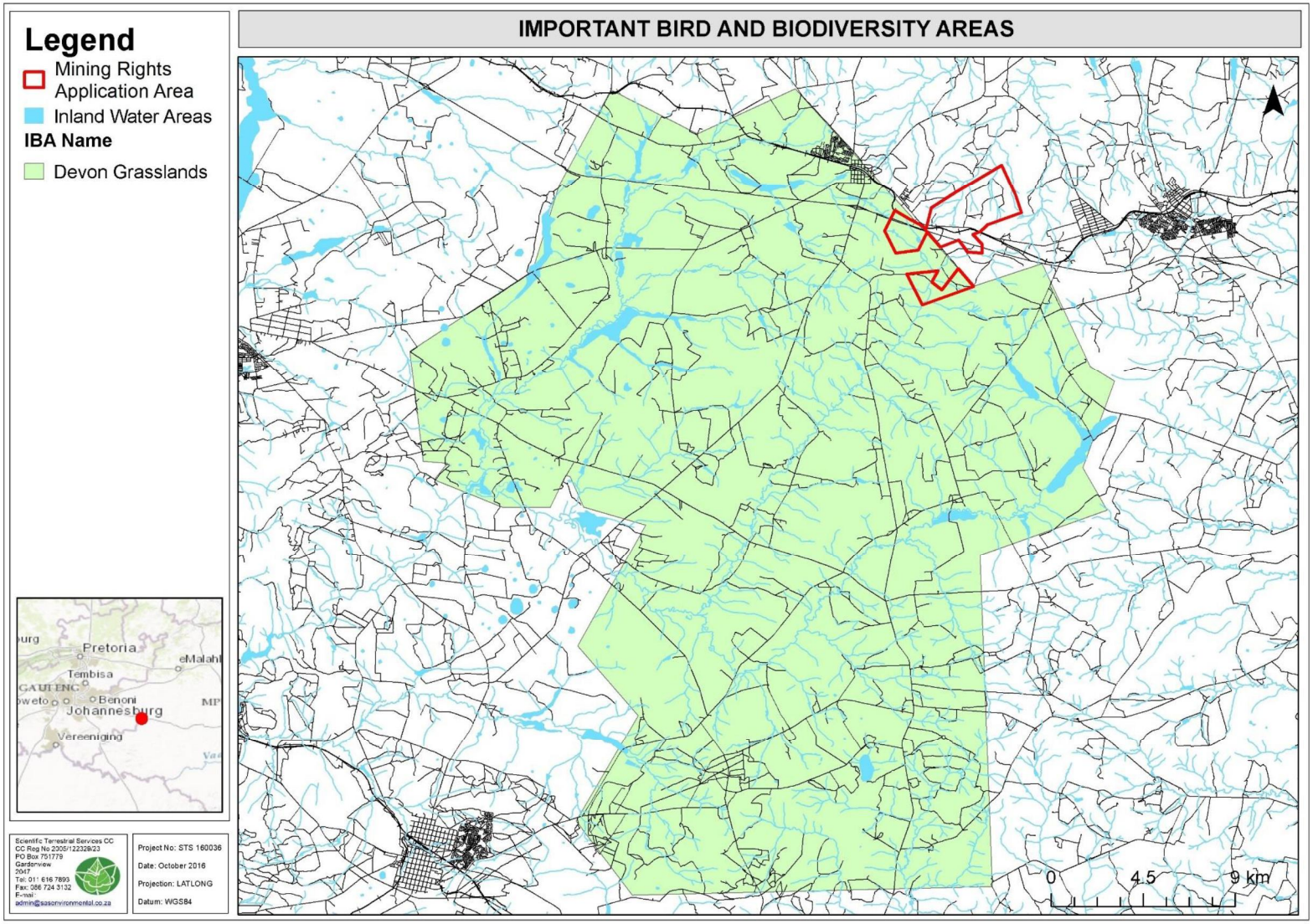

Figure 61: Important Bird and Biodiversity Areas associated with the MRA (IBA, 2013).

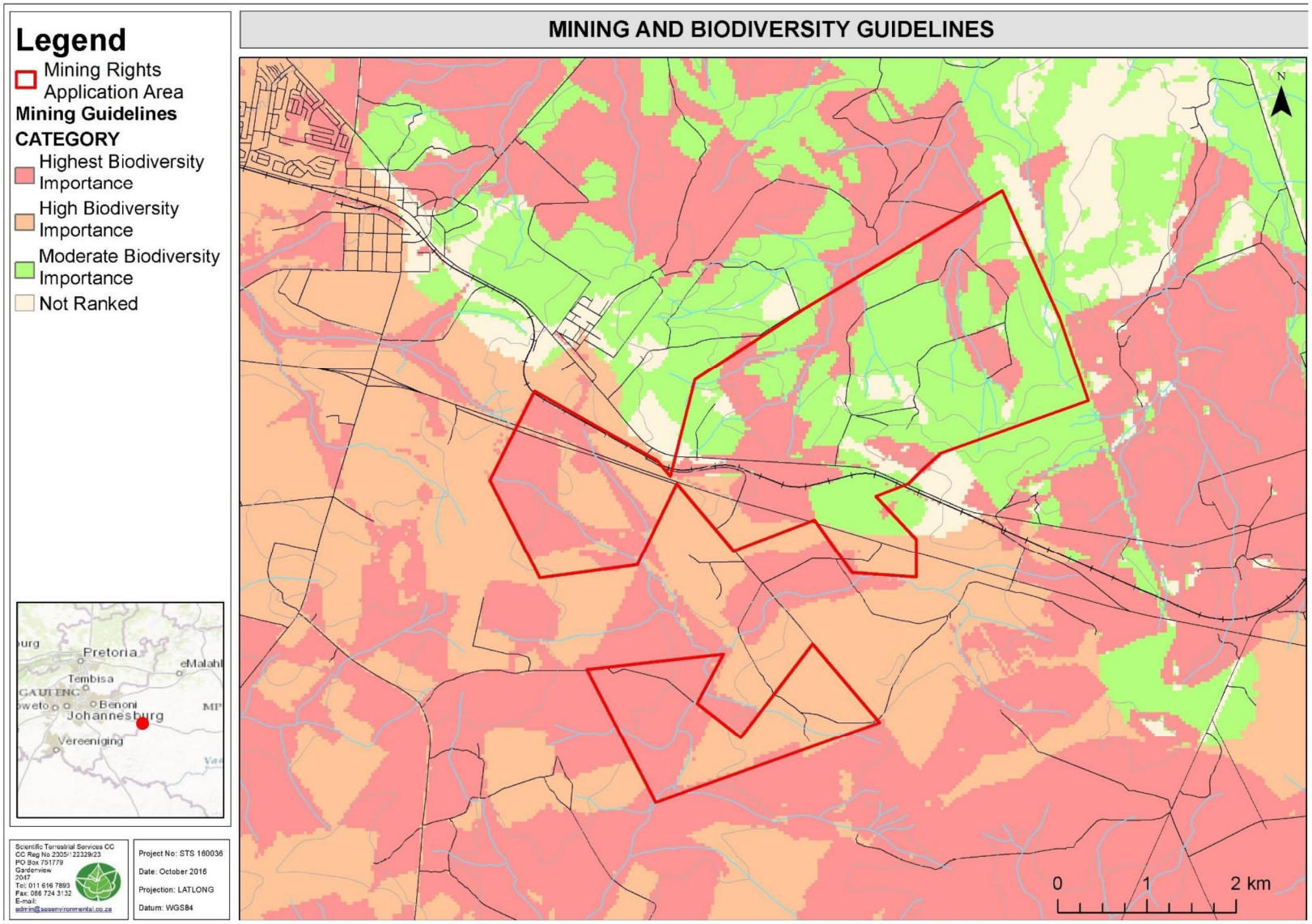

Figure 62: Importance of the MRA according to the Mining and Biodiversity Guidelines (2013)

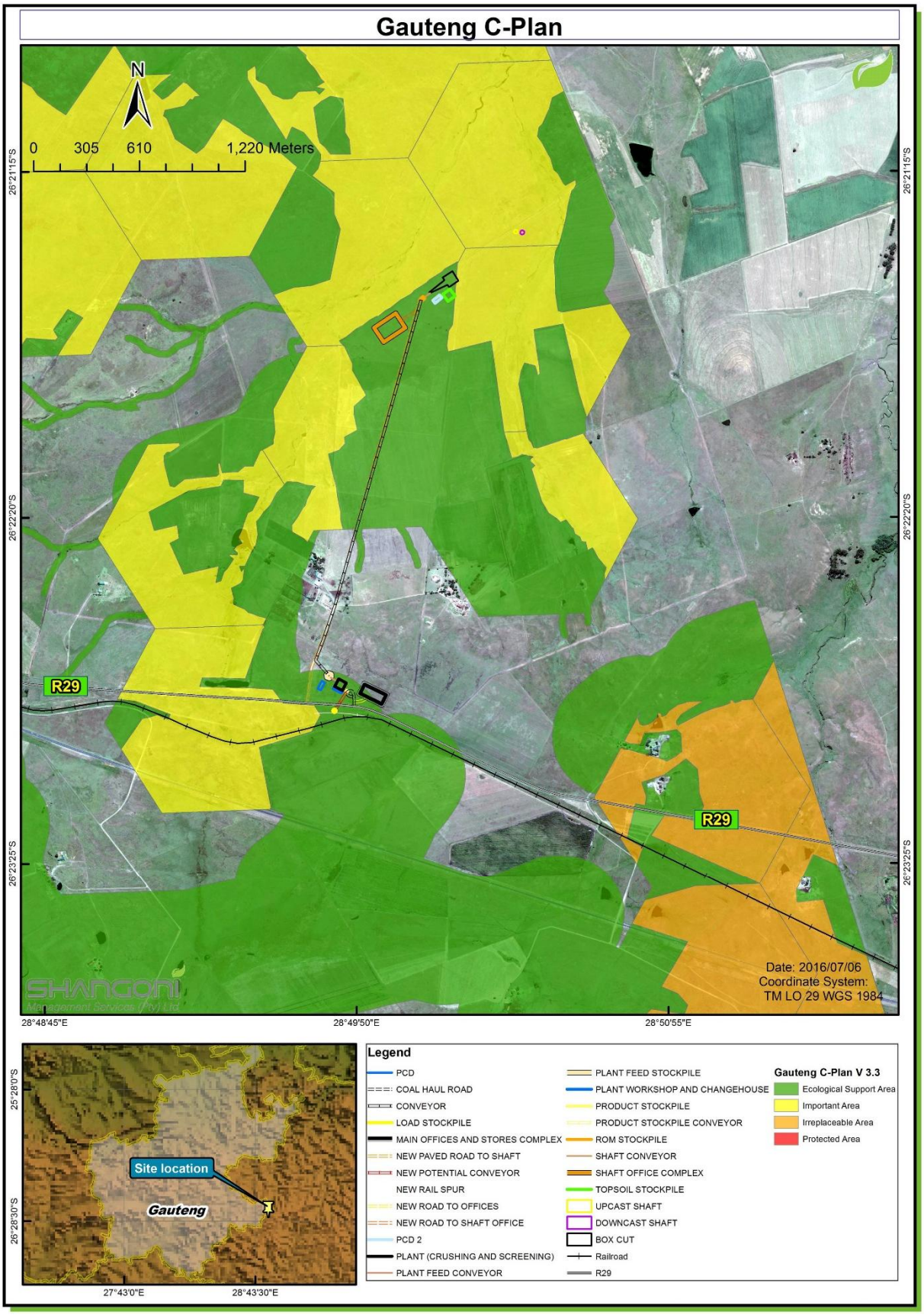

Figure 63: Gauteng Conservation Plan

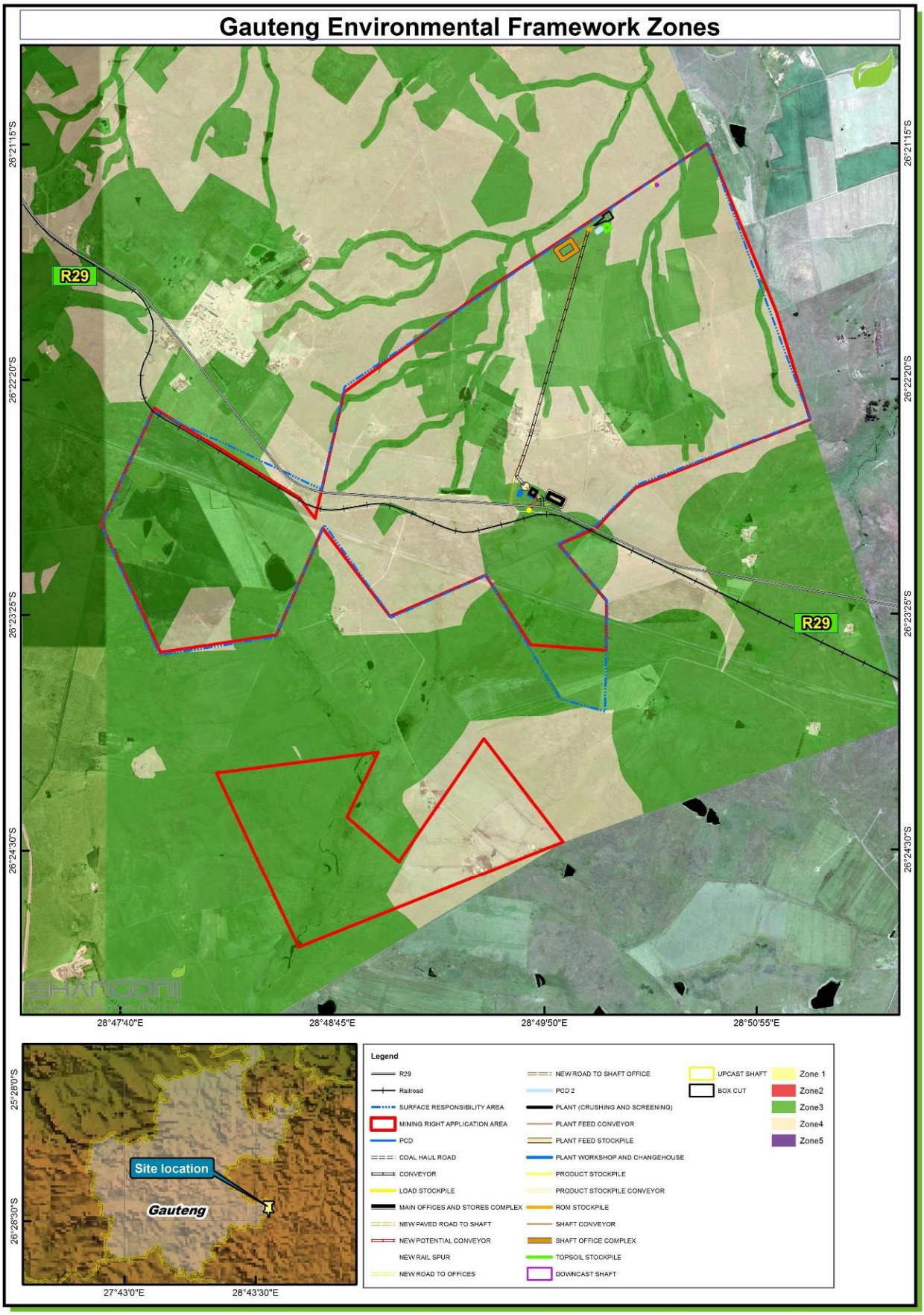

Figure 64: Gauteng Environmental Framework Zones

The Environmental Management Zones were derived from the desired state, the environmental sensitivity as well the unique control areas as identified in Section B of the GPEMF.
The five EMZs for the Gauteng Province are described below:

2.1.1 Zone 1: Urban development zone

The intention with Zone 1 is to streamline urban development activities in it and to promote development infill, densification and concentration of urban development within the urban development zones as defined in the Gauteng Spatial Development Framework (GSDF), in order to establish a more effective and efficient city region that will minimise urban sprawl into rural areas.

2.1.2 Zone 2: High control zone (within the urban development zone)

Sensitive areas within the urban development zone must be conserved and where linear development (roads etc.) cannot avoid these areas, a proper assessment and implementation of alternatives must be undertaken.

Sensitive areas within the Urban Development Zone include:

- Conservation priority areas (CBAs: Irreplaceable areas);
- Rivers (including 32m buffers);
- Ridges;
- Areas that are sensitive (as determined in the sensitivity assessment); and
- Protected areas.

2.1.3 Zone 3: High control zone (outside the urban development zone)

These zones are sensitive areas outside the urban development zone. These areas are sensitive to development activities and in several cases also have specific values that need to be protected.

The following areas have been identified in this zone:

- CBAs (Irreplaceable and Important areas) and ESAs outside the urban development zone as defined in the C-Plan 3.3;
- Rivers (including a 32m buffer on each side) and currently undeveloped ridges that must be conserved;
- Areas that are sensitive (as determined in the sensitivity assessment); and
- Protected areas.

Conditions

No listed activities may be excluded from environmental assessment requirements in this zone and further activities may be added where necessary to protect the environment in this zone. Additional requirements (guidelines, precinct plans, etc.) to ensure the proper development of identified areas in

this zone, in a manner that will enhance their potential for conservation, tourism and recreation may be introduced.

2.1.4 Zone 4: Normal control zone

This zone is dominated by agricultural uses outside the urban development zone as defined in the Gauteng Spatial Development Framework.

Conditions

No listed activities may be excluded from environmental assessment requirements in this zone.

Three categories of preliminary unique areas have been identified out of the desired state process, namely:

- Low Control Areas;
- High Control Areas; and
- Inter-sector Management areas.

The normal control zone is comprised of the following preliminary unique areas:

- Low control areas (4 types of areas) made up out of:
  - LC01: Urban existing developed land (± 9.22% of total provincial area);
  - LC02: Urban development priority (± 2.35% of total provincia area);
  - LC03: Rural development priority (± 4.72% of total provincia area); and
  - LC04: Rural and urban development priority (±0.47% of total provincia area).

The focus in the above-mentioned areas would be to exclude as many as possible compatible activities from EIA requirements provided that such activities conform to basic norms and standards that must be enforced through the relevant town planning and local development approval processes.

- Inter-sector management areas (8 area types), constitute areas where there are different and so - referred to as conflict management areas:
  - ISM01: Conservation and agricultural priorities (± 5.51% of total provincia area);
  - ISM02: Conservation and urban development priorities (± 2.25% of total provincia area);
  - ISM03: Conservation, urban development and rural development priorities (± 0.37% of totoal provincia area);
  - ISM04: Agriculture and urban development priorities (± 3.48% of total provincia area);
  - ISM05: Agriculture, conservation and rural development priorities (± 21.28% of total provincia area);
  - ISM06: Agriculture, conservation and urban development priorities (± 1.58% of the total provincia area);
  - ISM07: Agriculture, conservation, Urban development and rural development priorities (± 0.92% of total provincia area); and

- ISM08: agriculture, rural and urban development priorities (± 1.45% of total provincia area).

2.1.5 Zone 5: Industrial and large commercial focus zone

The intention with Zone 5 is to streamline non-polluting industrial and large scale commercial (warehouses etc.) activities in areas that are already used for such purposes and areas that are severely degraded but in close proximity to required infrastructure (such as old and even current mining areas). Certain currently listed activities (see section 5 of Section B of the GPEMF), in addition to those intended for Zone 1 may be excluded from environmental assessment requirements in this zone in future.

Conditions

- Development in this area must be sustainable in respect to the capacity of the environment and specifically the hydrological system to absorb additional sewage and storm water loads of increased densities; and
- Development in this area must identify any unmapped wetlands, especially seep areas that may occur on any site and when necessary apply for the required water use licence.

Non-polluting Industrial promotion areas where selected activities are to be excluded from EIA processes in addition to those excluded in Zone 1.

Chapter Q: Sites of archaeological, cultural and palaeontological importance

1 Archaeology

Information in this section of this report has been obtained from the following documents:

- The report titled: "*A phase I heritage impact assessment (HIA) study for Anglo Operations (Pty) Ltd's proposed Leslie 2 Project (near Leandra) in Gauteng Province,* compiled October 2016 by Dr Pistorius (Annexure H11).

The Phase I HIA for the proposed project area 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 and near the project area, namely:

- Historical remains consisting of farmsteads with outbuildings.
- Graveyards and graves (refer to Figure 65).

1.1 Historical remains

The project area at large is characterized by the presence of historical remains consisting of farmhouses with outbuildings which mostly relate to two periods from the past, namely sandstone residences with wagon sheds and cattle enclosures which date from the second half of the nineteenth century and farm houses with outbuildings which date from the more recent past, namely from the 1930/40's to the 1960/70's.

The younger remains are more common than the earlier historical remains. Infrastructure from both these periods is sometimes associated with graveyards belonging to the owners of these remains and graveyards of farm workers who lived and worked on the farms.

These remains sometimes constitute cultural landscapes composed of various independent but interrelated infrastructure such as houses, wagon sheds, outbuildings, cattle enclosures, etc.. Some of these buildings and structures may either have collapsed or have been demolished. Most of the earlier historical remains are severely dilapidated as they have been abandoned for some time. These remains are seldom maintained nor are they renovated to be utilized by farming communities. Most of the younger remains which date from the 1930/40's have been modernised (or restored). In both instances this has resulted in the total transformation of buildings and structures and subsequently to the diminishing of these structures' historical significance.

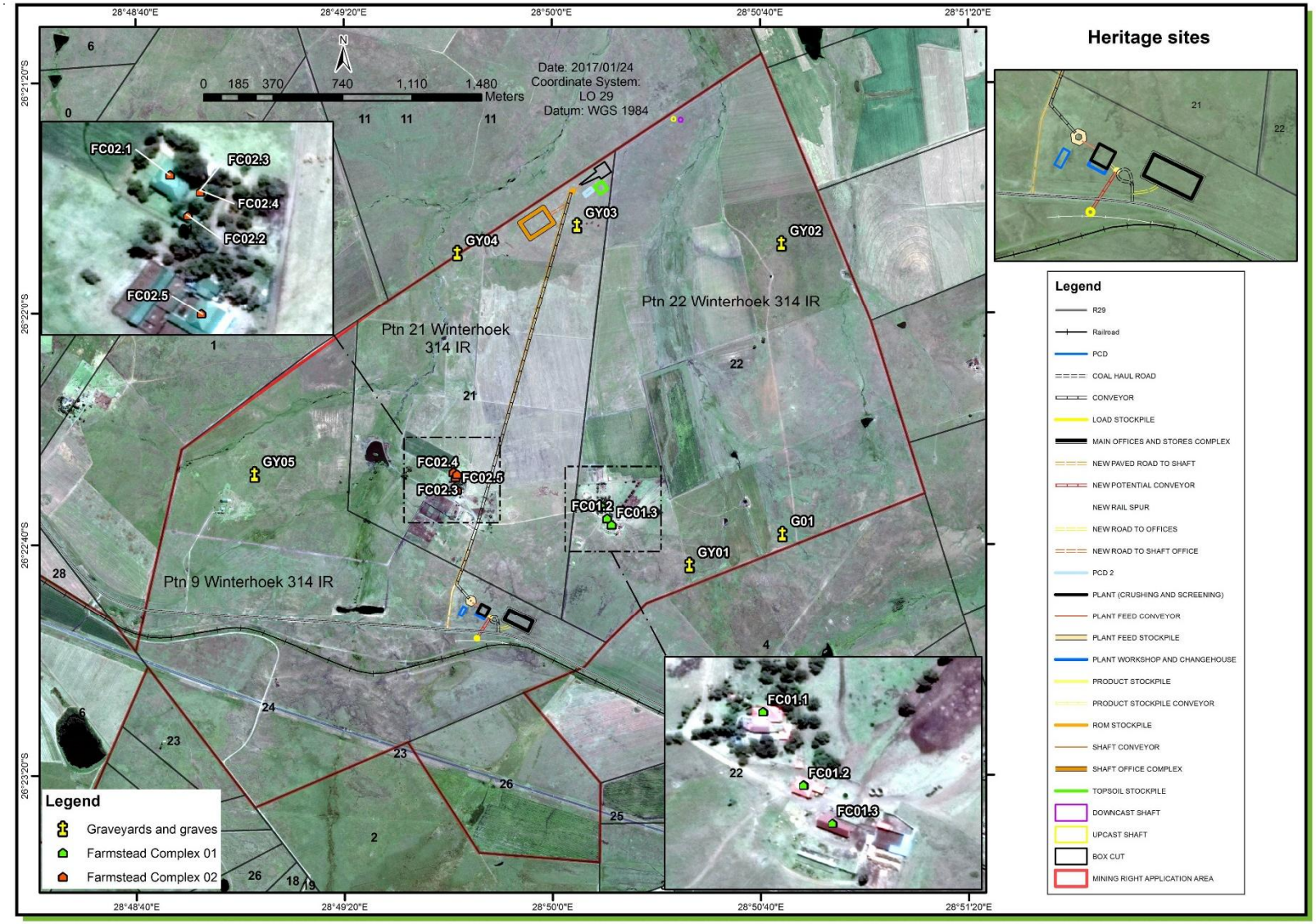

Figure 65: Heritage sites

1.1.1 Farmstead Complex 01

This farmstead complex (FC01) on Winterhoek 314IR (Portion 22) consists of a main residence and at least two sheds. All three structures were constructed with clay bricks and are fitted with pitched corrugated iron roofs. These buildings probably date from the 1930's or the 1940's and are in a good state of repair.

Figure 66: The main residence (FC01.1) in FCO1 comprises a multi-room dwelling which was built with clay bricks and fitted with a pitched corrugated iron roof and steel window frames (above).

Figure 67: The two sheds (FC01.2, FC01.3) in FCO1 were both constructed with clay bricks and fitted with pitched corrugated iron roofs and steel window frames (above).

1.1.2 Farmstead Complex 02

Farmstead complex (FC02) on Winterhoek 314IR (Portion 21) consists of a main residence (FC02.1) and three associated outbuildings (FC02.2, FC02.3 and FC02.4). A shed which serves as a core to which several structures were added complete the inventory for structures that are part of this complex (FC02.5).

The main residence (FC02.1) and two outbuildings (FC02.2, FC02.3) were constructed with dressed dolerite stone and cement and fitted with pitched corrugated iron roofs. The main residence is a multi-roomed structure with steel window frames, the first and second outbuildings are elongated structures constructed with the same building material whilst the fourth structure comprises a rondavel which was constructed with dolerite stone and covered with a pitched grass roof (FC02.4).

Although some of these structures may be older than sixty years it seems as if they all were altered, upgraded and modernised. A heap with dressed and undressed dolerite stone in close proximity of the structures suggests that some of the renovations were done in the more recent past.

Figure 68: The main residence (FC02.1) in FCO2 was constructed with dressed dolerite stone and is a multi-roomed structure with steel window frames which was covered with a pitched corrugated iron roof (above).

Figure 69: The main residence (FC02.1) (right) and an elongated outbuilding (FC02.1) which was constructed with the same material (left) (above). Note the dump with dresses and undressed dolerite stone suggesting that the complex of buildings was recently altered and upgraded (above).

Figure 70: The second outbuildings in FC02 (FC02.1) has a near square ground plan and was constructed with dressed dolerite stone, fitted with steel window frames and steel door and is covered with a with pitched corrugated iron roof (above).

Figure 71: The rondavel (FC02.4) near the main residence. It was constructed with dolerite and fitted with a pitched grass roof (above).

A shed with added on structures (FC02.5) comprises an irregular shaped complex of structures which was built with dolerite stone, clay and possibly cement bricks and fitted with a pitched corrugated iron roof. The structures that were consolidated and added to this shed were built with clay bricks and possibly with cement bricks as well. (The latter could not be ascertained due to the fact that some buildings are painted green).

Although the core of this compact group of structures contains a dolerite building fitted with a pitched corrugated iron roof the larger part of the add-on buildings were constructed with bricks and covered with flat corrugated iron roofs. Some of the construction work was probably also done in the more recent past.

Figure 72: The shed complex (FC02.5) that is part of FC02 comprises several structures that were added to a main shed which was constructed with dolerite stone. The extended, plastered structures were constructed with clay bricks and perhaps with cement bricks as well. The fitted window and door frames were manufactured from steel (above).

Figure 73: One of the extensions of FC02.5 was constructed with clay bricks and plastered with cement and is fitted with a low-pitched corrugated iron roof (above).

1.2 Graveyards and graves

The following graveyards and a possible grave were observed in and near the project area, namely:

1.2.1 Graveyard 01

GY01 is located on a rise overlooking the area to the north. It is neglected and overgrown with tall graves which prevent the identification of possible undecorated graves. Five graves were identified but

more may exist. The graves are merely covered with slabs of stone although one grave is covered with a cement slab.

No inscriptions are visible on the cement slab.
It is highly likely that the graveyard is older than sixty years.

Figure 74: GY01 holds the remains of at least five individuals and is located on a rise in open veld. It is covered with tall grass. Due to the tall grass and neglected state of the graves the graveyard is barely visible and more graves than those recorded may occur (above).

Figure 75: G02 holds the remains of at least forty individuals whose remains are covered with piles of stone (above).

1.2.2 Graveyard 02

This graveyard (GY02) is located on a ridge overlooking the area to the north. It holds as many as forty graves. Most are covered with piles of stone. A few graves are fitted with cement headstones. At least one grave is decorated with a granite headstone with the following inscription:

- 'Linah Masilela Mahlangu' * 1899-04-01 † 1965-12-08'

1.2.3 Graveyard 03

GY03 is located in open veld and holds as many as twenty two graves. Four of the graves are decorated with granite headstones and trimmings. The remainder are covered with piles of dolerite stone. This graveyard is probably older than sixty years.

Some headstones bear the following inscriptions, namely:

- 'In loving memory of Paulina Bongani Mnguni. Born 1935-07-21 Died 1980-12-27 Sadly missed by your family'
- In loving memory of Martha Zondi Mnguni. Sadly missed by your family'
- In loving memory of Solomon Ndyambani Mnguni. Sadly missed by your family'

Figure 76: G03 holds the remains of at least forty individuals most of which are covered with piles of stone. Four graves are fitted with granite headstones (above).

1.2.4 Graveyard 04

This graveyard (GY04) contains approximately twenty graves most of which are covered with piles of stone while a few are fitted with cement headstones and edged with clay bricks.

Two granite headstones with inscriptions occur, namely:

- 'Nomadlozi Johannes Skhosana *1924-02-10 †1987-02-04 God had mercy on her soul'.
- 'Abraham Sanyana Skhosana 1912-05-10 1979-10-27'

GY04 is probably older than sixty years.

Figure 77: G04 holds the remains of approximately twenty individuals. Two of the graves are decorated with granite headstones and trimmings (above).

1.2.5 Graveyard 05

GY05 holds approximately twenty one graves most of which are covered with piles of stone while a few are edged with clay bricks.

No headstones with inscriptions occur. GY05 most likely is older than sixty years.

Figure 78: G05 is located on a slight rise and contains at least twenty one graves which are older than sixty years (above).

1.2.6 Graveyard 06

GY06 holds approximately twenty two graves most of which are edged with bricks and covered with stones. A few graves are edged with clay bricks.

Two headstones with inscriptions occur, namely:

- 'In loving memory of our mother Johanna Marama'
- 'Hans Mahlangu 1984-23' (sic).

It is highly likely that GY06 is older than sixty years.

1.2.7 Grave 01

A possible grave occurs in context with evidence for rudimentary residential remains of no significance (G01). The location of the grave is indicated by the presence of an iron framework with the outline of a coffin.

If G01 does in fact represent a grave it is possibly older than sixty years.

Figure 79: G06 holds approximately twenty two graves which are severely neglected (above).

Figure 80: *A steel framework on lines of bricks indicates the position of a possible grave (G01) (above).*

1.3 Coordinates and significance

Table 59: Coordinates and significance rating for historical remains

Historical Remains		
	Coordinates	**Significance**
Farmstead Complex 01		
FC01.1. Main residence dating from the 1930/40's	26º 22 33.33's 28º 50 09.33'e	**Medium**
FC01.2. Outbuilding dating from the 1930/40's	26º 22 35.49's 28º 50 10.53'e	**Medium**
FC01.3. Outbuilding dating from the 1930/40's	26º 22 36.61's 28º 50 11.38'e	**Medium**
Farmstead Complex 02		
FC02.1. Main residence totally altered	26º 22 27.50s 28º 49 40.99e	**Medium**
FC02.2. Outbuilding totally altered or newly built	26º 22 28.39's 28º 49 41.38'e	**Medium**
FC01.3. Outbuilding totally altered	26º 22 27.87's 28º 49 41.65'e	**Medium**
FC01.4. Rondavel	26º 22 27.87's 28º 49 41.65'e	**Medium**
FC01.5. Shed complex with extension structures	26º 22 30.56's 28º 49 41.68e'	**Medium**

Table 60: Coordinates and significance rating for graveyards (below)

Graveyards and graves		
	Coordinates	**Significance**
GY01. Approximately 5 graves	26º 22.726's 28º 50.439'e	**High**
GY02. Forty graves	26º 21.798's 28º 50.735'e	**High**
GY03. Twenty two graves	26º 21.745's 28º 50.080'e	**High**
GY04. Twenty graves	26º 21.825's 28º 49.697'e	**High**
GY05. Approximately 21 graves	26º 22.464's 28º 49.046'e	**High**
GY06. Approximately 22 graves	26º 24.525's 28º 49.746'e	**High**
G01. Possible grave associated with steel framework.	26º 22.637's 28º 50.737'e	**High**

2 Palaeontology

Information in this section of this report has been obtained from the following documents:

- The report titled: "*Phase 1 Palaeontological Heritage Impact Assessment report on the site of a mining right application on an area known as the Leslie 2 project, Gauteng Province,* dated October 2016 and compiled by BM Geological Services (Annexure H12).

2.1 Vryheid formation: Palaeontological potential

The most conspicuous and common components of the palaeontological record of the Ecca Group in general are the plant macrofossils of the Glossopteris flora. Two large and conspicuous leaf form taxa dominate the *Glossopteris* flora; these being Glossopteris and Gangamopteris. Within the upper Ecca (containing the Vryheid Formation) Gangamopteris has ceased to occur with only Glossopteris present (Anderson and McLauchlan, 1976). The palaeobotanical record of the Ecca Group is diverse and the literature describing it is voluminous (numerous papers having been published by *E. Plumstead, H.* Anderson, J. Anderson, E. Kovaks-Endrıdy and M. Bamford amongst others). A comprehensive review of the flora in the Karoo Basin literature is, accordingly, beyond the scope of this study, but a thorough review of the palaeobotanical content of the Ecca Group in general and the Vryheid Formation in particular is presented in Bamford (2004). In that summary it is indicated that the Vryheid Formation can be expected to contain the plant macrofossils *Buthelezia, Sphenophyllum*, *Rangia, Phyllotheca*, *Schizoneura, Sphenopteris*, *Noeggerathiopsis, Taeniopteris, Pagiophyllum* and *Benlightfootia* and the wood taxa *Australoxylo*n and *Prototaxoxylon*. In addition to the above records can be added the observations of Tavener-Smith et al., (1988) where it was noted that both Glossopteris and Vertebraria occur within the palaeontological record of the formation.

In portions of the formation that are typified by low thermal alteration abundant assemblages of palynomorph plant microfossils (including acritarchs) can be expected (Anderson, 1977). Jubb and Gardiner (1975) report the presence of fragmentary fish fossils within the Ecca sequence of southern Africa; these being Coelacanthus dendrites from the Somkele coalfield of northern Natal and Namaicthys digitata from correlative strata in the Senge Coalfields of Zimbabwe. While fish faunas are

obviously rare and none have been reported from the Vryheid Formation the possibility remains that they may be present.

Figure 81: *Tabular cross-bedded sandstones of the Vryheid Formation*

Figure 82: *The coarse-grained nature of the Vryheid Formation sandstones*

Animal body fossils are rare within the Ecca Group in general (excepting the time equivalent faunas of the Whitehill Formation). However, no reptile fossils have been identified within the Vryheid Formation. Hobday and Tavener-Smith (1975) reviewed trace fossil assemblages identified within the Vryheid Formation. Within that fossil assemblage they identified two forms (*Helminthiopsis* and *Taphrelminthopsis*) within horizontally laminated siltstones and mudstones that represent part of the deep-water Nerites community.

No fossil materials were located during the conduct of the survey and the outcropping medium- to coarse-grained sandstone facies that outcrops in the study area is assumed to be unfossiliferous..

2.2 Karoo Dolerite Suite: Palaeontological potential

Dolerite is an intrusive igneous rock; as such, there is no potential for any fossil material to be located within this rock type.

2.3 Regolith: Palaeontological potential

The black turf soil is the result of in situ decomposition of the underlying dolerite. As the dolerite is unfossiliferous so must be the resulting soil. Similarly, no fossil materials were located within the sandy soils associated with the Vryheid Formation and this regolith type is assumed to be unfossiliferous.

Chapter R: Regional socio-economic structures

Information in this section of this report has been obtained from the following documents:

- The report titled: "*Anglo Operations (Pty) Ltd: Leslie 2 – Application for a mining right, environmental authorisation and waste management licence. Socio-economic Impact Assessment", dated November 2016 and compiled by Nemai Consulting (Annexure H13)*; and
- The report titled: "*Anglo Operations (Pty) Ltd: Proposed Leslie 2 Project. Land trade-off study and macro-economic impact analysis for the proposed Leslie 2 Project located near Devon and Leandra in the Sedibeng District Municipality",* dated January 2017 and compiled by Mosaka Economic Consultants trading as Conningarth Economists (Annexure H14).

1 Population, age and gender

The total population of the study area is 11 871 persons. Ward 1 has the highest population of 5 328 persons while the Lesedi Local Municipality wards 12 and 13 where the population is 3 060 and 3 483 respectively.

The age group 15 – 64 is defined as the working age population. In total, this group accounts for forty-seven percent of the population in the study area. The population is fairly young, with seventy-six percent below the age of 35.

2 Education

Education levels in the area are quite low with only twenty-one percent of the population over age 20 having received a matric or higher qualification.

Approximately a thirty-two percent of the population in almost all the Wards have no education or have not completed primary education and are considered to be functionally illiterate. Functional illiteracy is defined as a person who has received skills to read and write that are inadequate to manage daily living

and employment tasks that require reading skills beyond a basic level. Usually persons who have a low level of education, up to primary education, are classified as functionally illiterate.

3 Dwelling

The characteristics of the dwellings in which households live and their access to various services and facilities provide an important indication of the well-being of household members. It is widely recognised that shelter satisfies a basic human need for physical security and comfort.

According to the Statistics South Africa household classification, the following definitions apply to formal and informal housing (Table 61):

- **Formal dwelling** refers to a structure built according to approved plans, i.e. house on a separate stand, flat or apartment, townhouse, room in backyard, rooms or flatlet elsewhere. Contrasted with informal dwelling and traditional dwelling; and
- **Informal dwelling** is a makeshift structure not erected according to approved architectural plans, for example shacks or shanties in informal settlements or in backyards.

Table 61: Type of Dwelling, 2011

Type of dwelling	Ward 12	Ward 13	Ward 1	Total
Formal Dwellings	62%	85%	79%	76%
Traditional Dwellings	2%	0%	0%	1%
Informal Dwellings	35%	14%	20%	22%
Other	2%	0%	1%	1%

Majority of the households in the wards have formal dwellings with seventy-six percent of dwellings being houses on a separate stand or yard on a farm. Twenty-two percent of households in the study are hare informal dwellings.

The town of Devon has been earmarked by the Department of Rural Development and Land Reform (DRDLR) for Comprehensive Rural Development Programme (CRDP). One of the programs for the CRDP is to eliminate all informal housing structures. Ward 12 still has the highest proportion of informal dwellings at thirty-five percent with sixty-percent of households classified as formal.

Impumelelo is a historically disadvantaged township consisting of formalized/ serviced and informal settlements. About 1 259 houses are under construction to eradicate the informal settlements in this ward.

4 Access to piped water

Eighty-five percent of household in the study area have access to piped water with sixty-four percent of households having the infrastructure within the dwelling. Majority of the households, in each of the wards, have access to piped water above the basic level of service.

5 Annual household income

Annual household income is important to assess as it provides information on the poverty level of the community (Table 62). Unskilled communities tend to generate low incomes to the household, which contributes to poverty.

Table 62: Annual household income in the project study area, 2011

Type of dwelling	Ward 12	Ward 13	Ward 1	Total
No household income	14%	18%	15%	16%
Low income earning households	62%	73%	60%	65%
Middle income earning households	23%	8%	23%	18%
High income earning households	1%	0%	2%	1%

Sixty-five percent of households earn in the low-income bracket while sixteen percent of households have no income generation at all. Income generation over the three wards are very similar. In each of the wards, eighty percent of the population living in or close to poverty.

6 Labour force

The labour force comprises all persons who are employed plus all persons who are unemployed. In the study area, the total labour force is 12 846 and the unemployment rate is 36 percent.

In the study area, twenty-eight percent of the population have classified themselves as employed while twelve percent have stated that they are unemployed. The unemployment rate as calculated, is highest in Ward 13 at forty-seven percent, which is the community of Devon/Impumelelo. Ward 1 has an unemployment rate of twenty-nine-percent.

According the IDP Ward 12 It is a highly-impoverished area with a population of 8 569 of which only 1 865 have formal employment. (Stats SA: 2011)

7 Economic profile

The neighbouring Govan Mbeki LM has the most diversified economy within the Gert Sibande District, dominated by the petrochemical industry (Sasol II and III complexes) with mainly coal and some gold mining. Govan Mbeki LM has the largest underground coal complex in the world which makes it an important strategic area within the national context.

The following table provides an indication of the economic profile of the three bordering local municipalities.

Table 63: Socio-economic profile of Victor Kanye, Govan Mbeki and Lesedi Local Municipalities expressed in GVA (constant prices)

Industry	Victor Kanye	Govan Mbeki	Lesedi
Agriculture	45.7%	1.3%	1.4%
Mining	3.7%	38.7%	11.1%
Manufacturing	2.4%	24.1%	23.0%
Electricity and water	0.6%	1.3%	1.7%
Construction	7.0%	1.3%	5.6%
Trade	9.1%	15.2%	11.8%
Transport	13.7%	4.4%	3.9%
Business Services	8.0%	4.9%	20.6%
Government and Community Services	9.8%	8.8%	20.9%
Total:	**100%**	**100%**	**100%**

Refer also to information contained in the Social and Labour Plan (SLP) (Annexure I) with regards to socio-economic aspects specific to the project.

7.4.2 Description of the current land uses

7.4.2.1 Land use

Current land use activities within the proposed development area is largely dominated by natural grasslands, constituting approximately 48.3% (693.2 ha) of the MRA, as presented in Figure 83 below and depicted on the land use map in Figure 84 below. A fairly large portion of the study area comprises of agricultural activities; dominated by livestock farming and some cultivated crops and pastures. Cultivated lands collectively constitutes approximately 338.2 ha, amounting to 23.6% of the MRA (SAS, 2017). A number of farmsteads are located on the farms associated with the project site, as well as feedlots and a buffalo camp.

The N17 highway traverses the MRA in a west-east direction; and the R29 roadway, to the north of and roughly parallel to the N17, traverses the MRA in a west-east direction.

A 20 tonne/axle railway line runs from Springs in the west, to Secunda in the east, and on to Ermelo. This rail line crosses over the Leslie 2 project area.

Figure 83: *View of the dominant land uses including natural grasslands, cultivated lands, and wetlands within the MRA*

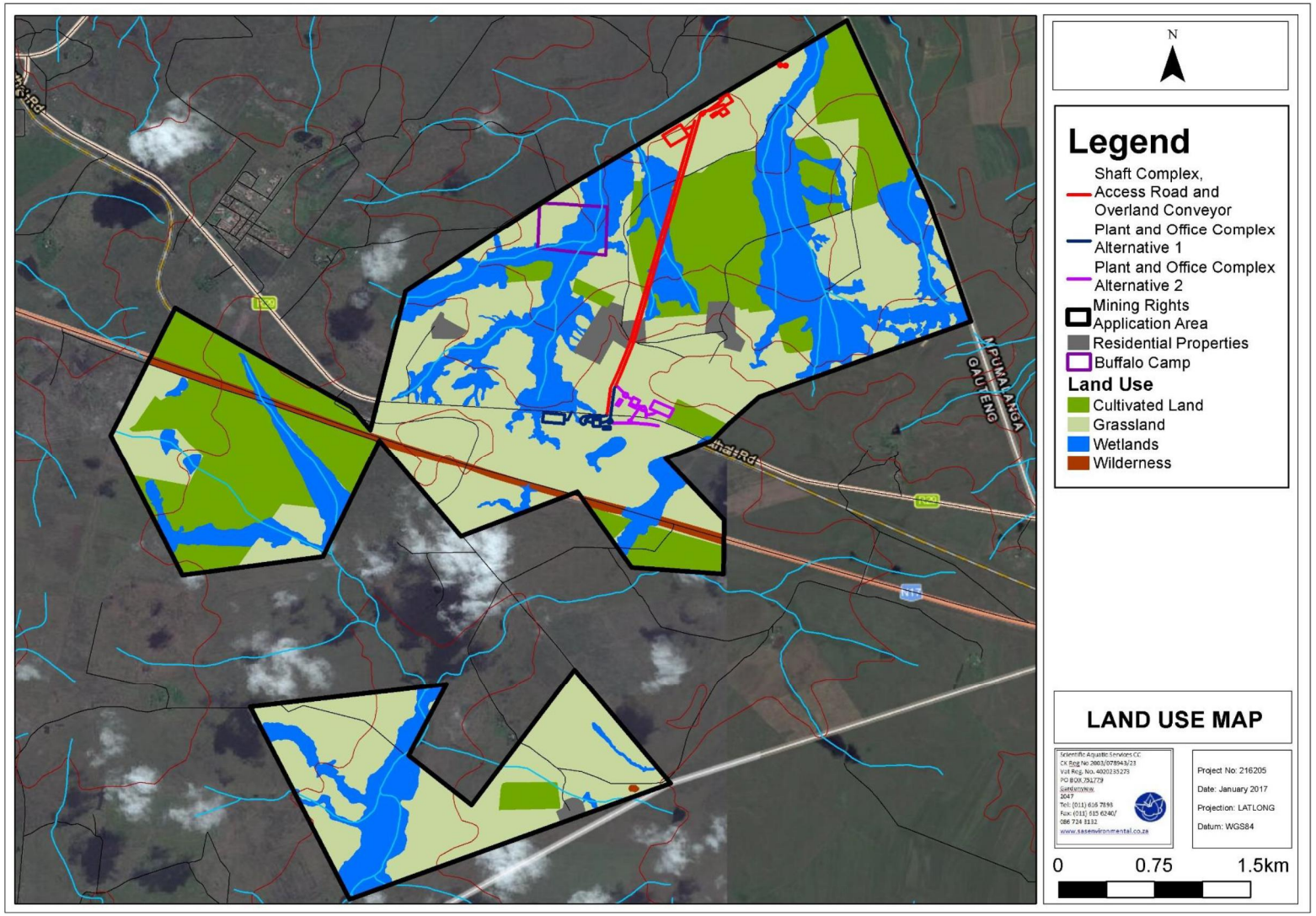

Figure 84: *Land use map depicting current land uses within the MRA (SAS, 2017)*

7.4.2.2 Land capability

High potential agricultural land is defined as having the soil and terrain quality, growing season and adequate available moisture supply needed to produce sustained economically high crop yields when treated and managed according to best possible farming practices (Scotney et al., 1987). For the purpose of this assessment, land capability was inferred from physical soil properties and prevailing climatic conditions. Climate capability (measured on a scale of 1 to 8) was therefore considered in the agricultural potential classification. The surveyed area is considered to fall within Climate Capability Class 4, with a good yield potential for a selected range of adapted crops under cautious planting date selection.

The identified soils were classified into five land capability classes as presented in Figure 85 below. The identified land capability limitations for the identified soils are discussed in comprehensive dashboard style summary tables presented in Tables 6 to 11 of Annexure H1.

Table 64 below provides a summary of the land capability classes.

Table 64: Summary of land capability classes (SAS, 2017)

Land Capability	Aerial extent	Description
Arable - Class IV	104.6 ha; which constitutes ≈ 7.3% of the MRA	The identified Valsrivier/Sepane soil forms have a moderate (class IV) land capability, which is considered to be marginally suitable to arable agricultural land use under prevailing Lowveld climatic conditions. These soils can be considerably productive under good agricultural management practices where rainfall is not scarce and/or irrigation water is available. These soils are typically best suited to grazing pastures and could potentially be used for forestry under dryland production systems.
Grazing - Class VI	988 ha; which constitutes 68.9% of the MRA	The identified Arcadia soil forms are considered to be of poor (class VI) land capability, which is generally not considered suitable to arable agricultural land use. The inherently high natural fertility of these soils is considered to be of significant value for grazing purposes. These soils are often ploughed for subsistence farming for shallow rooted arable crops like vegetables under resource-poor circumstances, particularly if rainfall and/or irrigation water is not scarce. These soils are therefore considered to make a substantial contribution to subsistence farming on a local scale.

Land Capability	Aerial extent	Description
Grazing - Class VII	224 ha; which constitutes 15.6% of the surveyed area	The identified Mispah/Glenrosa soil forms have inherently poor (class VII) land capability attributed to the occurrence of an indurated rock layer at shallow depth, which hinders root development for most arable crops. These soils are at best suitable for wilderness and typically provide a unique rocky outcrop habitat to certain fauna and floral species for ecology conservation purposes, under natural circumstances. These soils are therefore not considered to make a significant contribution to agricultural productivity even on a local scale. These soils are ideally suited for recreational land use purposes and/or natural grassland ecosystem, where livestock grazing may be permitted at low stocking rates.
Wetlands - Class VIII	71.8 ha; which constitutes 5.0% of the surveyed area	The Rensburg soil forms were classified as class VIII land capability due to land use limitations related to prolonged waterlogging attributed to inherently poor internal drainage of the G horizon. The prolonged waterlogging of these soils limits their land use largely to wetland habitats for various wetland plant species that are inherently tolerant and/or obligate to anoxic conditions. These soils are therefore not considered to contribute significantly to provincial and/or national agricultural productivity.
Wilderness - Class VIII	25.4 ha; which constitutes 1.8% of the MRA	These demarcated Witbank soils have very poor (class VIII) land capability due to the lack of soil as a growth medium for arable agriculture, attributed to anthropogenic activities. This land capability class also includes area where the original soil has been buried and/or extensively modified by anthropogenic activities, such as the main road (R29), traversing the site in a west-easterly direction. These soils are therefore not considered to make a significant contribution to agricultural productivity even on a local scale.

The following list of documents / plans were also consulted by the specialist and the following was said to be applicable to the project site:

- According to the Gauteng C-Plan (2011) the MRA has a low agricultural potential (Class IV). The soil in the area of the MRA has limited depth with a high clay content.
- According to the SOTER soil map, the MRA comprise heavy clay soils classified Eutric Vertisols (VRe), with a high proportion of swelling clays, soils forming deep wide cracks from the surface downward when dried out (IUSS, 2014);
- According to the AGIS Land Capability Atlas, the southern portion of the MRA comprise moderate (Class III) arable land, whereas the northern portion of the MRA comprises marginal (Class IV)

arable land, as presented in Figure 84. This implies that these soils were considered highly (Class III) and marginally (Class IV) suitable for Arable agriculture under pre-mining conditions;

- According to the AGIS database, the livestock grazing capacity potential of the entire MRA is estimated to be approximately 4 hectares per large stock unit (Morgenthal *et al.*, 2005); and
- The natural soil pH is estimated to range between 5.5-6.4 within the MRA, as interpolated from topsoil pH values obtained from the National Soil Profile Database (AGIS database). This indicates that the soils are anticipated to be naturally slightly acidic and could therefore require liming prior to cultivation.

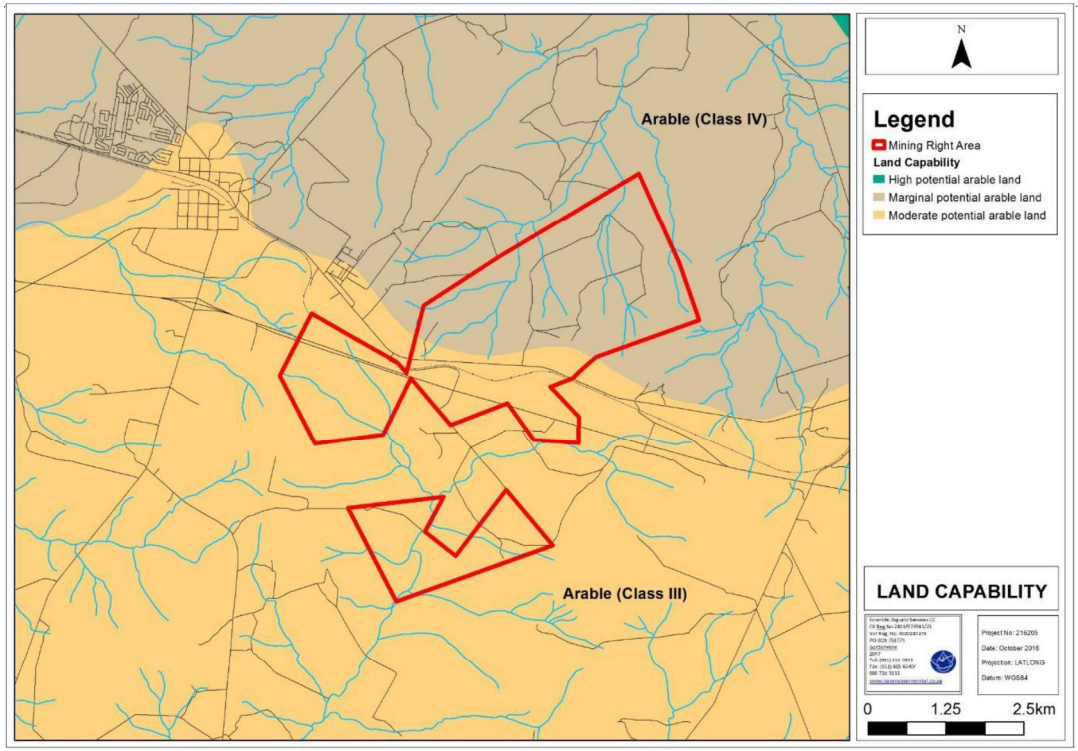

Figure 85: *Land capability of the prevailing soils in the vicinity of the proposed development areas according to the AGIS database.*

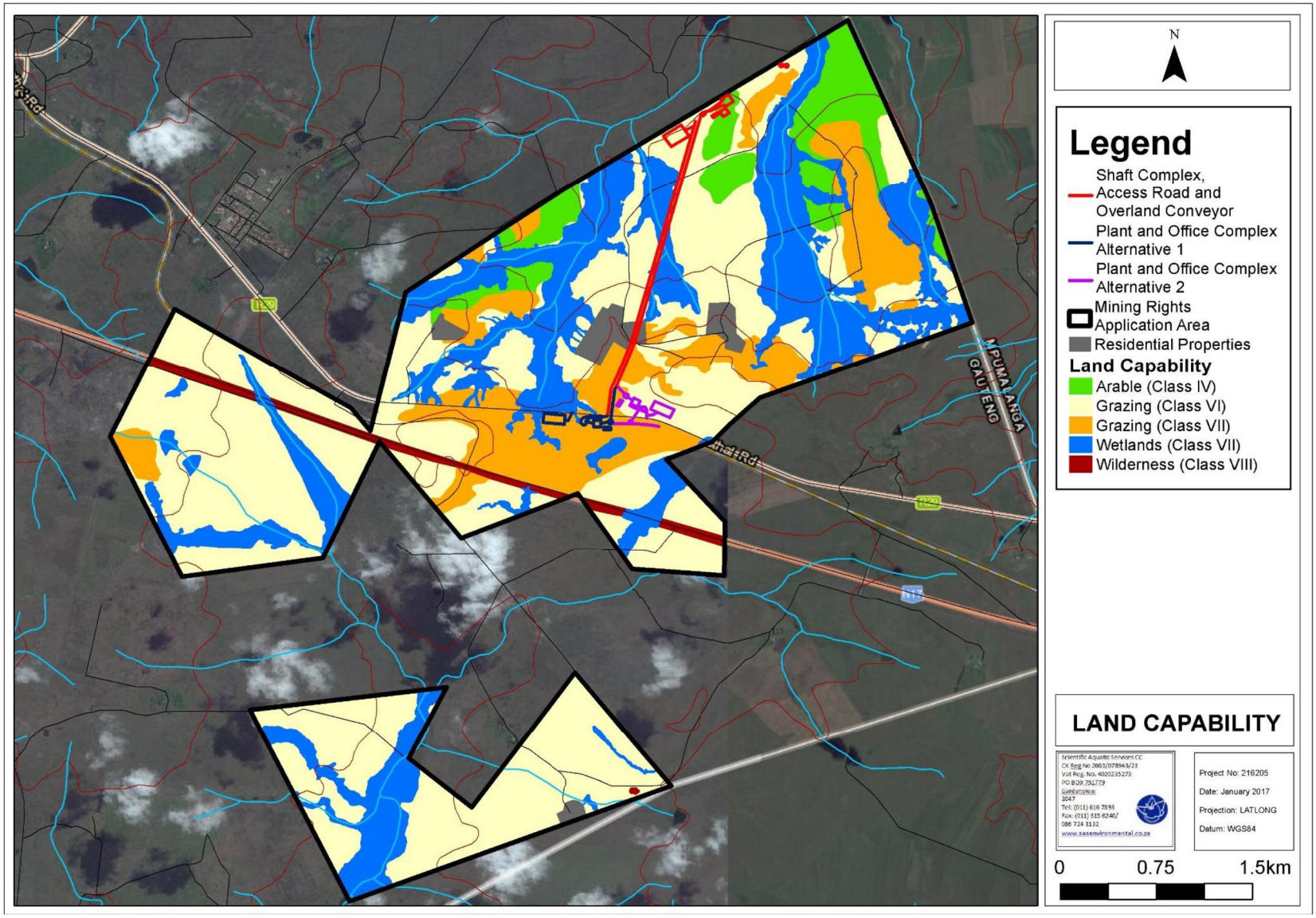

Figure 86: Land capability classification of the identified soils within the MRA.

7.4.3 Description of specific environmental features and infrastructure on the site

Refer to Sections 7.4.1 and 7.4.2 above and Section 7.4.4 and Figure 87 below.

7.4.4 Environmental and current land use map

Figure 87 below presents the specific environmental features in relation to the proposed Leslie 2 Project area.

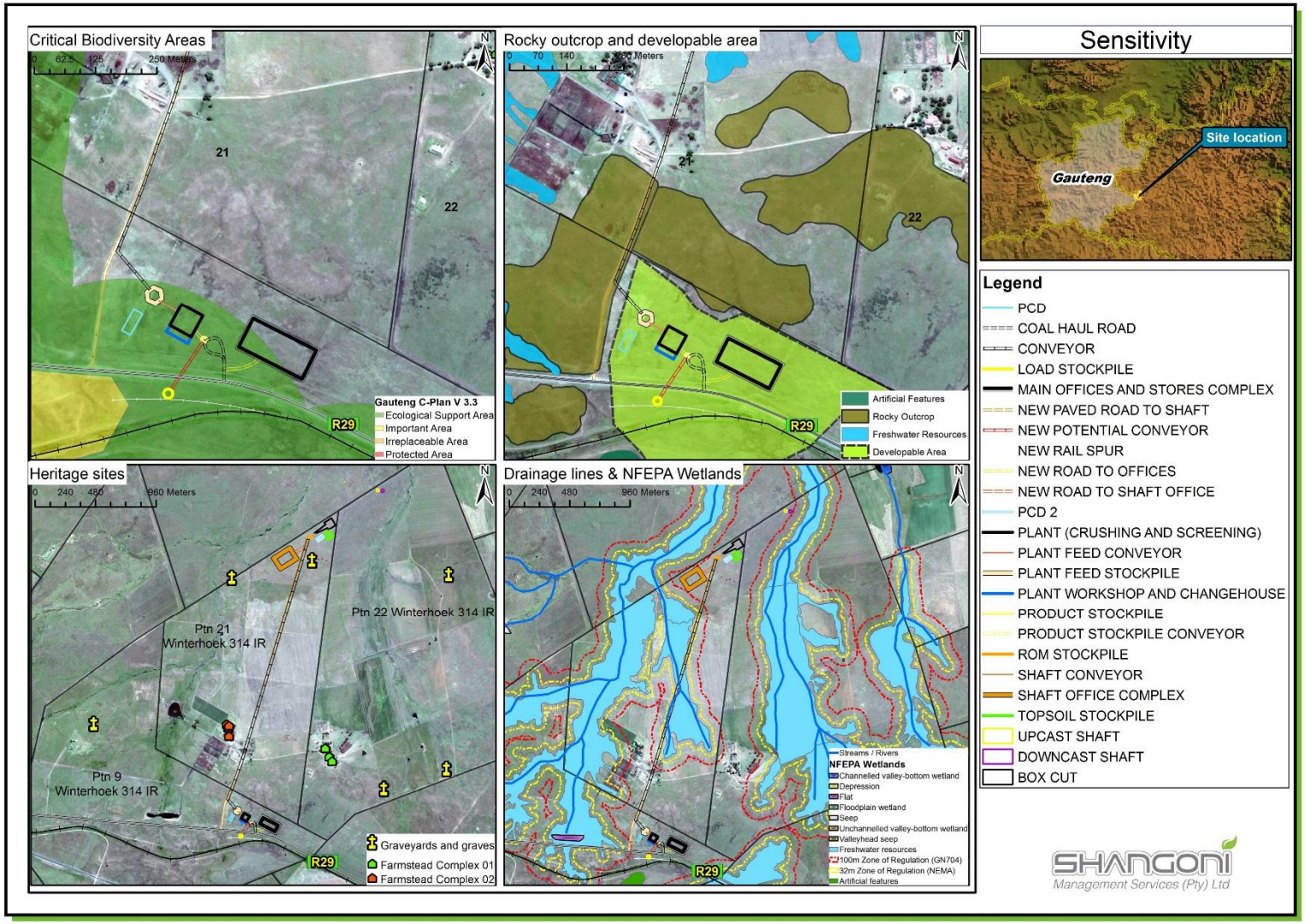

Figure 87: Environmental features (Sensitivity map) in relation to proposed site layout plan