8. GEOLOGY, SOILS AND AGRICULTURAL POTENTIAL

8.1. Geology

8.1.1. Preferred Site Geology

- *Naauwontkomen 509 LQ*
  The geology on Naauwontkomen is similar to that of the neighbouring farm, Eenzaamheid 512 LQ. Sandstone of the Mogalakwena Formation underlies the majority of this farm. Limited sandy soil cover occurs along the western boundary of the farm. The Eenzaamheid Fault strikes east - west across the site, some 250 m south of the northwest border to 1.25 km south of the northeast border (refer to Figure 6.1). Grootegeluk Formation (minor outcrop) and Swartrant Formation outcrops to the north of the fault. A north-south striking fault, joining the Daarby and Eenzaamheid faults, extends onto the farm. Fluorspar, associated with the Eenzaamheid fault and Waterberg Group, and stone aggregate occurs on the farm.
- *Eenzaamheid 512 LQ*
  Waterberg Group sediments underlie the majority of this site. The Mogalakwena Formation sandstone is covered with a ± 2 m thick sand veneer. The sand is derived from weathering of the Waterberg Group. The sand has angular grains and is poorly sorted. The Eenzaamheid fault strikes east - west across the farm, ± 250 m south of the farm's northern boundary. Grootegeluk Formation (shallow coal) and Swartrant Formation (sandstone) outcrops to the north of the fault. The Waterberg Group contains moderate percentages of apatite (fluoride bearing), which gives rise to the presence of fluorspar mineralisation along the Eenzaamheid fault.

8.1.2. The Grootegeluk Coal Deposits

The Grootegeluk coal mine produces coking coal and middlings from the Grootegeluk and Goedgedacht Formations (Upper and Middle Ecca Group).

The Grootegeluk Formation comprises intercalated shale and bright coal, with an average depth of 60 m. Coking and middlings grade coal are obtained from this formation.

The Goedgedacht Formation consists of 5 predominantly dull coal seams interbedded with carbonaceous shale, siltstone, and sandstone (± 60 m thickness). This coal is suitable for power generation, direct reduction, and formcoke.

Coal deposits occur on: -

- Eenzaamheid (north of the Eenzaamheid fault)
- Naauwontkomen (north of the Eenzaamheid fault)
- Appelvlakte (at depth)
- Nelsonskop (at depth)
- Droogeheuvel (at depth)
- Zongezien (at depth)

The construction of a power station and infrastructure on these coal deposits may have economic implications, as these coal deposits will become sterilised.

8.2. Geotechnical studies

Investigations with regards to geotechnical conditions were undertaken on the four alternative sites proposed for the establishment of a proposed new power station in order to determine geotechnical constraints and founding conditions. The geotechnical conditions on the farms Eenzaamheid and Naauwontkomen are described below:

- *Farm Naauwontkomen 509 LQ*
  On this farm the Eenzaamheid Fault is also present close to the northern boundary, but it swings further south towards the eastern limit of the farm. Ecca sediments (mostly soft mudstones and shales) are present to the north of the fault, whereas hard Waterberg sandstones and conglomerates occur to the south of it. Fairly widely spaced lineaments (probably dykes) are again present. Sand, overlying gravel, is widely present over the bedrock, but within an area near the centre of the farm 0 m – 2 m of gravel directly overlies soft to hard rock conglomerate and rock outcrops are exposed in places. This area has been identified as being particularly favourable from a geotechnical viewpoint. Elsewhere the soil/gravel cover is generally less that 3 m thick on the evidence of several road quarries and a railway cutting near the eastern end of the farm. However, boreholes drilled close to two of the lineaments showed that the cover thickness can increase locally to 7 m – 10 m in proximity to these features. The central area on this farm, in which shallow bedrock with a discontinuous thin gravel cover is present, seems to offer the most favourable founding conditions of any on the four farms that were inspected.

- *Farm Eenzaamheid 687 LQ*
  The Eezaamheid Fault lies a short distance to the south of the northern boundary of this farm. The remaining area to the south is underlain by sandstone and

conglomerate of the Waterberg Group. Fairly widely spaced lineaments (probably dykes) cross the farm. All of these rocks are, however, overlain by sand and gravel. A number of quarries used previously for road construction show that the sand cover is mostly less than 3 m thick; beneath it gravels, sometimes in a ferruginous or calcareous matrix and usually up to 1 m thick, overlie bedrock, which is usually of soft to hard rock consistency. Greater depths of cover are likely to be present in proximity to the lineaments. Founding depths over much of the farm are thus likely to be moderate. The Waterberg bedrock is likely to be able to support high foundation pressures.

8.3. Soils and Agricultural Potential

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was contracted by Bohlweki Environmental (Pty) Ltd to undertake a soil investigation of the farms Eenzaamheid 687 LQ and Naauwontkomen 509 LQ, near Lephalale in the west of Limpopo Province. The purpose of the investigation is to give an agricultural potential assessment for the above-mentioned properties. The objectives of the study are;

- To classify the soils and to produce a soil map of the specified area as well as
- To classify the agricultural soil potential and soil characteristics.

8.3.1. Site Characteristics

- *Location*

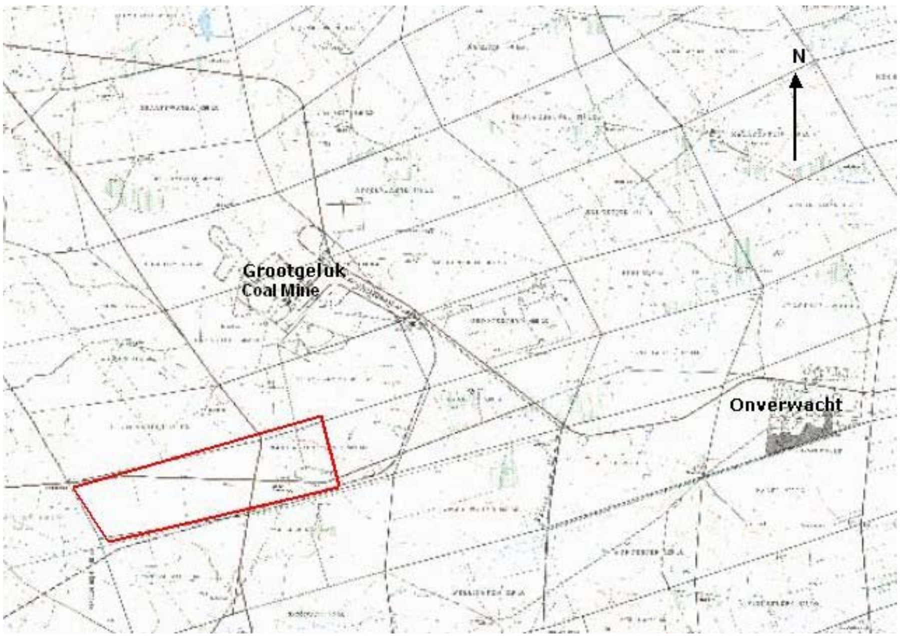

Figure 8.1: Locality map with the surveyed area in red.

The area that was investigated covers ± 1200 ha on the piece of land as mentioned above, lying west of Onverwacht and Lephalale. The location of the surveyed area can be seen in Figure 8.1, with the coordinates lying between 23°41′43″S to 23°43′42″S and 27°29′47″E to 27°33′36″E. The area covered includes the farm of Eenzaamheid 987LQ and Naauwontkomen 509LQ, where the planned infrastructure for the proposed power station is to be located.

- *Terrain*
  The terrain morphological class of the area can described as plains with low relief, lying at an altitude of around 910 meters above sea level (Kruger, 1983). The area is virtually flat, with very gentle slopes (<2%).

- *Parent Material*
  The geology of the area comprises sandstone and mudstone sediments of the Matlabas Subgroup, Waterberg Group, undifferentiated shale, sandstone and coal of the Karoo Sequence and also alluvium (Geological Survey, 1986).

- **Climate**
  The climatic regime of the study area is characterized by hot, moist summers and mild, dry winters. The main climatic indicators are given in Table 8.1.

Table 8.1. Climate Data

Month	Average Rainfall (mm)	Average Min. Temp (°C)	Average Max. Temp (°C)	Average frost dates
Jan	95.5	18.2	31.7	Start date: 21/6 End date: 12/7 Days with frost: ± 2 Years with frost: 43%
Feb	81.4	17.9	30.2	
Mar	56.9	17.3	30.2	
Apr	36.3	13.2	26.7	
May	10.3	9.2	25.4	
Jun	5.0	6.0	23.1	
Jul	2.2	6.0	23.2	Heat units (hrs > 10°C)
Aug	2.2	8.9	25.9	Summer (Oct-Mar): 2 600 Winter (Apr-Sept): 1 385
Sep	9.7	12.6	29.0	
Oct	32.5	15.7	30.5	
Nov	67.0	17.2	31.0	
Dec	86.4	18.3	31.5	
Year	**485.4 mm**	**20.8 °C (Average)**		

The long-term annual average rainfall is 485.4 mm, of which 420 mm, or 86.5%, falls between October and March. Temperatures vary from an average monthly maximum and minimum of 37.2ºC and 13.9ºC for January to 27.8ºC and 1.5^{o}C for July respectively. The extreme high temperature that has been recorded is 44.5^{o}C and the extreme low –4.3ºC. Frost is rare, but occurs occasionally in most years, though not severely.

8.3.2. Methodology

The survey was done freestyle but efforts were made to keep the observations to a grid of close to 200 x 200 m. A hand-held auger was used to conduct the survey to a depth of 1.2 m (or shallower, if a restricting layer such as rock was encountered). The position of the observation and sampling points was determined by GPS.

Three hundred soil observations were made and classified according to the Taxonomic System for South Africa (Soil Classification Working Group, 1991) and areas of different soil types were noted and mapped. Samples of topsoil and subsoil were taken at ten localities and the soils analyzed (Non-Affiliated Soil Analysis Work Committee, 1991) for sand, silt and clay percentage, exchangeable cations, cation exchange capacity (CEC), pH (H_2O) and P (Bray 1). The analysis results are given in Table 3.

The sampling sites are marked S1 to S10 on the soil map.

The agricultural potential of each soil mapping unit was then assessed. This information is given on the associated soil map (Appendix).

8.3.3. Soils

The surveyed area is very homogeneous in terms of texture, structure and soil depth. Two map units were identified within the surveyed area, with the only difference between the two being colour. The larger part of the area consists of deep soils, comprising dark reddish brown, apedal, sandy topsoil on reddish brown to yellowish red, apedal loamy sand subsoil. The soils in this unit cover approximately 58% of the area, belong to the Hutton soil form and the unit is marked **dHu** on the map.

The other portion of the area has soils with a dark brown, apedal, sandy topsoil on brown to dark brown, apedal loamy sand subsoil, belonging to the Clovelly form. This unit is marked **dCv** and comprises approximately 42% of the surveyed area.

The map units are shown on the soil map in figure 8.2 according to the following example:

dHu (m)
620.7 ha

where **dHu** represents the soil unit (in this case deep Hutton soils), **m** represents the agricultural potential (in this case moderate) and **620.7 ha** represents the area of the unit.

A summary of the main soil characteristics is given in Table 8.2 below.

The analysis results show the sandy nature of most of the soils, with generally only a slight increase in clay content from the topsoil to subsoil. The CEC values are low, as would be anticipated from the clay content, and the soils are generally slightly acidic. The P values are low, as would be expected from an area that has not been cultivated, and therefore not fertilized.

No abnormal or unexpected values or limitations could be observed from the analyses values.

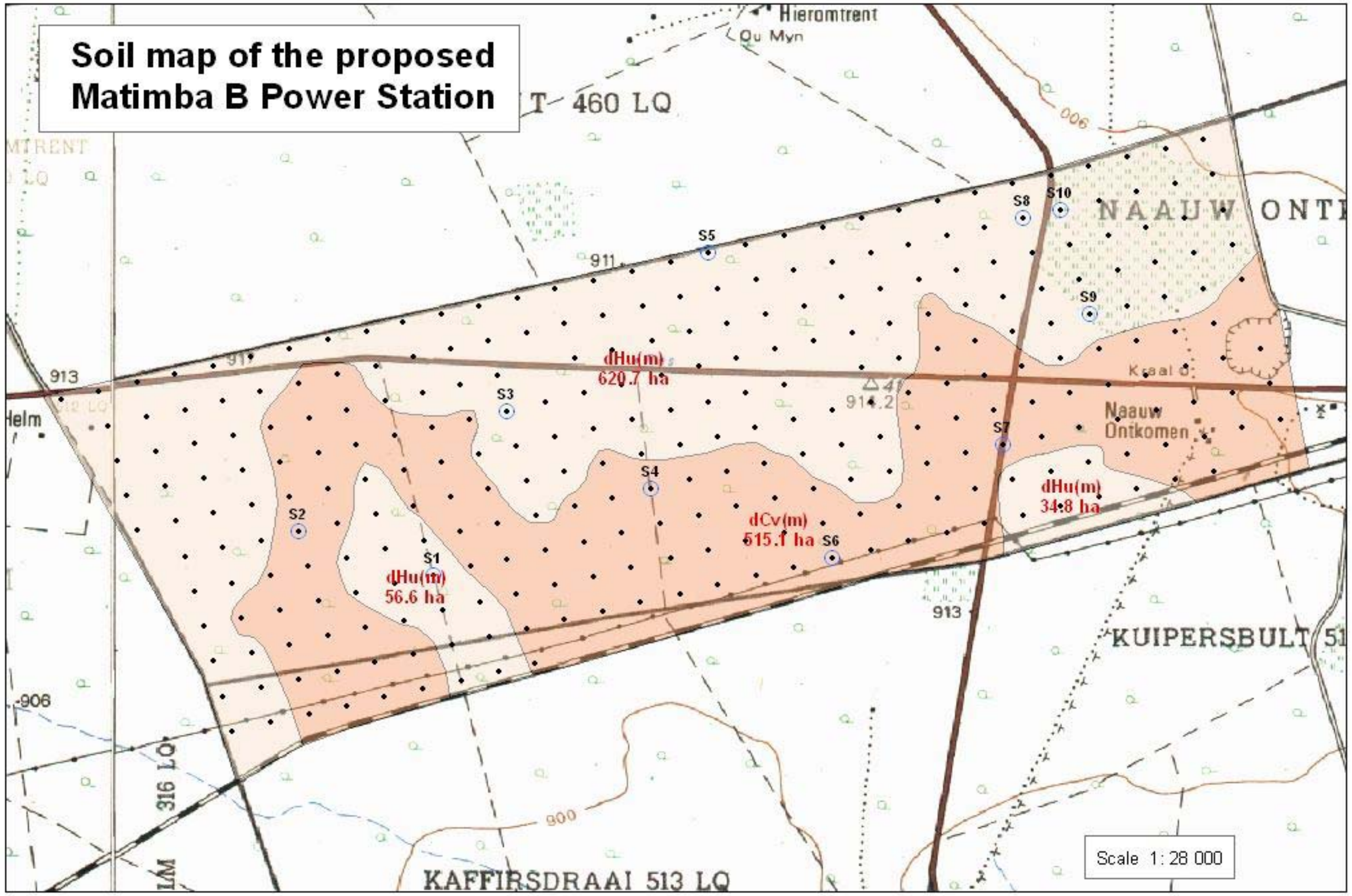

Figure 8.2: Soil Map

Table 8.2: Soil mapping units

MAP UNIT	DOMINANT SOIL FORM/ FAMILY	SUBDOMINANT SOIL FORM/FAMILY	EFFECTIVE DEPTH (mm)	DESCRIPTION OF MAPPING UNIT	AGRIC. POTENTIAL	AREA (ha)
Structureless (apedal) soils						
Hu	Hu3100	Hu3200 Cv2100	800 - 1 200+	Dark reddish brown, apedal, sandy topsoil on reddish brown to yellowish red, apedal loamy sand subsoil.	Moderate	712.1
Cv	Cv3100	Cv2100 Hu3100	600 – 1200+	Dark brown, apedal, sandy topsoil on brown to dark brown, apedal loamy sand subsoil.	Moderate	515.1
Total						**1 227.2**

Table 8.3a: Soil analysis results

Sample site		**S1**		**S2**		**S3**		**S4**		**S5**	
Co-ordinates (Lat/Long)		23° 43′ 06.1″ S 27° 30′ 56.7″ E		23° 42′ 58.2″ S 27° 30′ 32.6″ E		23° 42′ 36.5″ S 27° 31′ 10.0″ E		23° 42′ 50.5″ S 27° 31′ 35.9″ E		23° 42′ 08.1″ S 27° 31′ 46.1″ E	
Soil Form		Hu3100		Cv2100		Hu3200		Cv3100		Hu3100	
Horizon		A	B	A	B	A	B	A	B	A	B
Depth (mm)		250	1200+	250	500	250	900	250	1200+	250	1200+
Sa	**%**	84.5	80.9	85.8	80.3	79.8	69.4	89.0	85.8	84.7	78.0
Si		5.5	5.1	6.2	7.7	8.2	8.6	3.0	6.2	5.3	8.0
Cl		10.0	14.0	8.0	12.0	12.0	22.0	8.0	8.0	10.0	14.0
Na	**cmol kg^{-1}**	0.120	0.122	0.111	0.106	0.088	0.115	0.104	0.115	0.123	0.108
K		0.182	0.307	0.244	0.342	0.308	0.474	0.128	0.177	0.191	0.361
Ca		0.971	1.357	0.679	0.438	1.562	1.847	0.617	0.507	1.181	1.544
Mg		0.576	1.014	0.552	0.894	0.723	1.350	0.378	0.444	0.536	0.901
CEC		3.508	3.919	5.945	4.653	5.090	6.216	2.580	1.244	4.069	3.709
P (ppm)		1.13	0.84	2.15	1.41	1.90	0.50	10.35	3.35	4.71	1.66
pH (H_2O)		5.70	5.84	5.56	5.16	5.86	6.06	5.38	5.24	5.68	6.03

Table 8.3b: Soil analysis results

Sample site		**S6**		**S7**		**S8**		**S9**		**S10**	
Co-ordinates (Lat/Long)		23º 43' 03.0" S 27º 32' 08.5" E		23º 42' 42.6" S 27º 32' 39.3" E		23º 42' 01.9" S 27º 32' 42.7" E		23º 42' 19.2" S 27º 32' 54.7" E		23º 42' 00.3" S 27º 32' 49.6" E	
Soil Form		Cv3100		Cv3100		Hu2100		Hu3200		Hu3100	
Horizon		A	B	A	B	A	B	A	B	A	B
Depth (mm)		250	750	250	900	250	1200	250	1200+	250	1200+
Sa	**%**	84.9	76.5	82.2	74.3	86.2	79.7	81.9	62.4	84.7	78.7
Si		5.1	9.5	5.8	9.7	3.8	6.3	6.1	13.6	5.3	7.3
Cl		10.0	14.0	12.0	16.0	10.0	14.0	12.0	24.0	10.0	14.0
Na	**cmol kg^{-1}**	0.104	0.154	0.120	0.121	0.122	0.100	0.111	0.269	0.105	0.114
K		0.168	0.394	0.297	0.351	0.243	0.263	0.281	1.183	0.214	0.300
Ca		0.814	0.643	1.205	1.438	0.616	0.979	1.547	9.152	0.840	1.206
Mg		0.536	1.186	0.590	1.149	0.346	0.703	0.776	2.405	0.424	0.662
CEC		2.241	3.625	3.873	3.972	3.002	2.998	3.880	10.720	2.080	3.852
P (ppm)		6.20	1.86	5.13	1.67	2.85	1.04	3.61	2.11	2.71	1.24
pH (H_2O)		5.39	5.64	5.81	5.60	5.49	5.21	6.14	7.82	5.69	5.74

8.3.4. Agricultural Potential

- *Dryland*
  The soils of the area are sandy and generally deep (> 1 200 mm). They will therefore drain rapidly. Due to this tendency, along with the lack of fertility as shown by the low CEC values, they have a moderate agricultural potential.

  Coupled with the hot, dry nature of the climatic regime (Section 2.4), it can be seen that this area is not suited to dryland arable agriculture, and most of the farming enterprises in the vicinity are either game farms or cattle ranches. This is the optimum land use option given the environment.

- *Irrigation*
  The soils would have a moderate to high potential for irrigation, due to the lack of any restricting layer, but the sandy nature of the soils would necessitate very careful scheduling. The soils would require a substantial and reliable supply of water to ensure optimum soil moisture at all times.

8.3.5. Conclusions and Recommendations

After more detailed evaluation, the potential impact on the agricultural potential is considered to be of low significance, as a result of the moderate to low agricultural potential of the soils due to their sandy nature, increased susceptibility to wind erosion and excessively free drainage. The potential impact on areas with a high agricultural potential is also anticipated to be of a low significance due to the fact that while the soils may have a high potential, the climatic conditions in the area are not suited to rain-fed arable cultivation.

Due to the fact the establishment of an ash dump and power station will involve permanent loss of the soil resource, it is recommended that the topsoil (approximately 300-400 mm) be removed and stored prior to construction. In this way, the soil will be available elsewhere at a later date for rehabilitation purposes. There is not a significant difference between the topsoil and subsoil, so if some mixing occurs, it should not be significant.

Erodibility is not a problem in flat areas, such as the existing terrain, but if the stored topsoil were to be used for rehabilitation in sloping areas (for example on the sides of the ash dump), great care should be taken to ensure that erosion does not occur.

Such mitigation measures would include:

- Immediate re-vegetation of any exposed areas
- Seeding of indigenous grass species

- Water supply for irrigation to aid the re-vegetation process
- Placement of along-slope measures (berms, logs, geotextiles, etc) to aid the process
- Regular monitoring to ensure the continued success of the process