1 INTRODUCTION AND BACKGROUND INFORMATION

ESKOM intends to close the existing waste site, also known as the "Rock Dump" at Matimba Power Station.

Blue Rock Consulting (Pty) Ltd was appointed as an independent consultant to conduct an investigation for the geohydrological requirements for the application for authorisation.

The Waste Site is located on the farm Grootestryd 465 LQ situated to the west of Matimba Power Station (see attached locality map Appendix A). The entire site is surrounded by a berm wall of up to 10m in height. General waste and building rubble deposited there is covered by layers of sandy soil and in places by fly ash. All waste is located within the confines of the berm wall surrounding the site. No ponding of water was noted within the confines of the site. The berm and also substantial tracts of the waste within the berm are covered by shrubs and bushes and small trees that indicate that the site has not been used for a while.

There are several boreholes in the vicinity of the waste site and these have been monitored for groundwater table and water quality records since monitoring started in the Matimba area in 1987.

Groundwater monitoring covers the greater Matimba Power Station area which includes the power station and an associated petrol depot, the waste site and rock dump currently under discussion as well as a coal stockyard and emergency ash offloading site, evaporation dams and storm water dams on the farm Grootestryd 465 LQ and an ash dump and storm water dams on the farm Zwartwater 507 LQ.

The groundwater monitoring system at Matimba has been in place since 1987. Originally, 12 boreholes were drilled, of which 11 (P1 to P11) were selected for groundwater monitoring. Borehole P12 near the storm water dam at the ash dump on Zwartwater was drilled into a fault zone and collapsed before a piezometer tube could be installed. Two boreholes numbered P4 and P5 were drilled in the vicinity of the "Rock Dump" site to monitor the groundwater in this area.

In 1995 Frank Hodgson carried out a groundwater pollution risk assessment at Matimba and the compliance of the monitoring was discussed (ref.2). As indications of pollution were noted at several locations in the greater Matimba area, groundwater quality and pollution plume modelling was carried out at Matimba Power Station in October 2000 by Riaan Grobelaar, Lore-Mari Cruywagen, Elna de Necker and Frank Hodgson (ref. 3). In both of these studies traces of groundwater pollution were indentified in the area of the "Rock Dump" waste site. Due to a lack of adequate numbers of boreholes at the site, and because of the close proximity of other sources of pollution, (the coal stock yard and the emergency ash offloading site) it could however not be stated unequivocally that the waste site did in fact contribute to pollution of the groundwater in the area.

During the period 2001 and 2003 Eskom started negotiations with the then Department of Water Affairs and Forestry (DWAF) in lieu of closing the "Dump Rock" waste site. Additional investigations were carried out by several consultants during this period and these findings are presented in a report entitled "Site characteristics in the vicinity of an unregistered waste disposal facility, Matimba Power Station" by Geo Hydro Technologies in 2001 and a report entitled "Preliminary investigations and risk assessment to end-use the rock waste dump at Matimba Power Station" compiled by Enviro excellence Services in 2003 and final scoping reports on the closure of the waste site also compiled by Enviro excellence Services in 2003. In a letter to the manager of Matimba Power Station, referenced 16/2/7/A400/B21/1 and dated 17 August 2005, the Limpopo Regional Office of DWAF comments extensively on these reports and concludes that a closure permit could not be issued for the "Rock Dump" site as it cannot be classified as a waste disposal site under Section 20 of the Environment Conservation Act because fly ash has been used as compacting material. The site would therefore be administered under Section 19 of the National Water Act. DWAF also commented on inadequate numbers of monitoring boreholes in the vicinity of the waste site resulting in uncertainty regarding the flow of groundwater and hence the migration of any pollution plumes in the vicinity of the "Rock Dump" waste site.

In 2003 ESKOM commenced with the drilling 15 additional groundwater monitoring boreholes that are distributed across the greater Matimba Power Station area. Three additional monitoring boreholes numbered P26, P27 and P28 were drilled in the vicinity of the "Rock Dump" site. All the boreholes were located according to predictions of the 30-year pollution plume migration model compiled by Grobelaar et al. (ref 3) to ensure that they are located sufficiently far away from potentially polluting sites and downstream of them to pick up migration of polluted waters in future. Danie Vermeulen of the Institute for Groundwater Studies at UOFS (ref 5) interpreted the monitoring results of the old as well as the new boreholes and presented his findings in a report in 2006 (ref 5). His findings regarding the monitoring results in the vicinity of the "Rock Dump" waste site are also presented in this report and will be discussed in greater detail in this report below.

Detailed investigations for the Geohydrological Input for the Environmental Impact Report for three new 5 ha potential waste site areas for Eskom located to the south, east and north of the existing "Rock Dump" waste site were carried out by Blue Rock Consulting in 2009 (ref. 6). Four additional groundwater monitoring boreholes (numbered MBH1 to MBH4) were drilled in the area surrounding the existing "Rock Dump" waste site. As the three new proposed sites virtually surround the existing "Rock Dump" waste site, the data and findings of this investigation have been used in the current report.

2 SCOPE OF WORK

As part of the process for closure of the "Rock Dump" waste site located to the west of Matimba Power Station the following has to be included in the geohydrological study.

1. Clarification regarding the flow of groundwater and migration of a possible pollution plume at the site and in the surrounding areas has to be obtained.
2. More information, as detailed below, regarding the nature of the aquifers at the site has to be obtained.
3. In addition it has to be established to what extent the Rock Dump waste site is contributing to the pollution of the groundwater and what effect this will have on the surrounding areas.
4. The current status of the situation has to be determined and a geohydrological impact assessment has to be made.
5. Considering the future use intended for the waste site area, recommendations regarding remediation measures in mitigation of the impact have to be made and a

monitoring system has to be drawn up that records the effectives of the remedial measures in the future.

The work was carried out according to guidelines presented in the Minimum Requirements for Waste Disposal by Landfill (Second Edition 1998) and the Minimum Requirements for Water Monitoring at Waste Management Facilities (Second Edition 1998) both published by the Department of Water Affairs and Forestry and included the following:

- Investigate all geological and geohydrological information available for the area in detail.
- Consider and address queries and concerns raised by DWAF regarding the findings of the previous investigations and recorded on old correspondence.
- Carry out a geophysical survey (electrical resistivity and residual magnetic surveys) of the area surrounding the "Rock Dump" waste site to identify potential deep fracture zones and faults that will act as groundwater aquifers.
- Carry out a rotary percussion-drilling programme to verify the presence of any aquifers.
- Test the yield, storativity and transmissivity of these aquifers.
- Determine the groundwater quality of these aquifers by testing the water chemistry of samples collected from the boreholes in an accredited laboratory.
- Establish a groundwater monitoring system for the site that is based on this information.
- Determine the geohydrological properties of the soils (permeability etc.) in the area. This work was carried out in conjunction with the geotechnical field investigation. Soil profiles exposed in test pits were examined and insitu permeability tests will be carried out. Samples were collected for laboratory testing.
- Data analyses of information collected during the field investigations.
- Present data on maps and compile a report.

2.1 DESK STUDY

The desk study comprised a detailed study of the regional geology as described on the 1: 250 000 scale geological map 2326 Elliras (ref 1).

Reports on previous geohydrological investigations carried out in the Matimba and Medupi Power Station areas were also studied (ref. 2 to 5). These include groundwater pollution risk assessment studies of the coal stockyard and ash dumps and various dirty water contact dams around Matimba Power Station (ref 2) as well modelling studies of groundwater and pollution plume movements at the facilities mentioned above (ref 3). In addition a report describing the hydrochemistry of additional monitoring boreholes drilled in the Matimba Power Station Area during 2006 was also studied in detail (ref. 5).

The additional fieldwork and laboratory testing carried out for the EIA investigation for the proposed general and hazardous waste site was carried out in consideration of existing data and recommendations available from the previous investigations and on specific requirements to determine the impact of the "Rock Dump" waste site on its surrounding areas.

2.2 FIELDWORK

2.2.1 Geophysical Investigations

To ensure that groundwater monitoring boreholes will be drilled at optimum locations and intersect any significant aquifers that may occur at the "Rock Dump" waste site, a geophysical investigation was carried out at the "Rock Dump" waste site and its surrounding areas to detect any sub-surface geological structures such as fracture zones and faults that may exist in the bedrock and contact zones between different geological formations that are commonly associated with such aquifers. A resistivity survey consisting of four traverses was carried out around the site. The results of the geophysical survey are presented in Appendix B of this report.

2.2.2 Geological Investigations

The geological fieldwork carried out for this investigation comprised geological surface mapping, the logging of soil profiles exposed in test pits excavated at strategic locations across the area surrounding the "Rock Dump" waste site and the logging of drill cuttings derived from boreholes drilled for groundwater monitoring purposes to determine the rock profile at the site.

As part of the geotechnical investigation, a total of 20 test pits were excavated with the aid of a TLB to depths varying between 1m and 3,5m below surface level. The profiles exposed in the test pits were logged in detail and samples representative of the various soil types encountered in the geological profiles were collected and submitted to accredited laboratories for testing. In addition to the geotechnical testing carried out on these samples, tests to determine the permeability of these soils were also carried out in certain soil layers encountered in the test pits as well as on soil samples in the laboratory. The location of the test pits and detailed descriptions of the soil profiles encountered in them are presented in Appendix C of this report.

As part of the geohydrological investigation, four additional rotary percussion boreholes (MBH1 to MBH4) were drilled in the area surrounding the "Rock Dump" waste site at anomalous locations obtained from the geophysical survey and indicating possible minor faults and fracture zones and geological contacts. Each borehole has a diameter of 165mm and extends to 40m below the present surface level. The boreholes are cased with 110mm diameter HPVC casing that is perforated between 7m and 40m. Gravel packs and a sanitary seal extending to 3m depths have been installed in each borehole. Concrete blocks and lockable caps are provided for each of the four boreholes. At each of the four boreholes samples of the drill cuttings were collected at 1m intervals. Penetration rates of the hammer of the drilling machine were also recorded, as were the depths at which groundwater was intersected. Where no groundwater was intersected, this was stated on the log. The location of the four new boreholes as well as the location of four existing boreholes (P4, P5, P26 and P28) drilled during previous geohydrological investigations are indicated on a site plan included in Appendix D of this report. The detailed logs of the four new boreholes are also included. Detailed geological logs of the existing boreholes (P4, P5, P26 and P28) could not be located.

2.2.3 Geohydrological Investigations

Geohydrological field investigations were carried out in the test pits excavated for the geotechnical study of the site and comprised insitu permeability testing of representative soil layers encountered in the test pits as well as recording of seepage water infiltrating into the test pits. The insitu permeability tests consisted of constant head infiltrometer tests, which were used to calculate the permeability of the tested soil layer. Where possible these results were compared with the results obtained from laboratory tests carried out on similar materials.

Additional geohydrological field investigations consisted of recording of water strikes in the four new boreholes drilled for groundwater monitoring purposes. A week after completion of the drilling, static water tables were recorded in these four holes (MBH1 to MBH4) as well as the four existing monitoring boreholes (P4, P5, P26 and P28) drilled during previous investigations. The results of these measurements are presented on the borehole logs included in Appendix D. Water samples for laboratory testing were collected subsequent to the water table measuring exercise. The water sampling was carried out with the aid of a bailer that was lowered to depths varying between 15m and 20m below the static water table level.

3 GEOLOGY

3.1 REGIONAL GEOLOGY

According to the 1: 250 000 scale geological map 2326 Ellisras, sequences of sandstone, gritstone, mudstone and coal as well as mudstone carbonaceous shale and coal from the Swartrand and Grootegeluk Formations of the Karoo Supergroup underlie the farm Grootestryd. The coal situated in these rocks is currently mined at Grootgeluk mine located further west of Site 5 to fuel the Matimba Power Station and it will also fuel the Medupi Power Power Station in the future.

Regional faulting of the rocks has NE-SW and NW-SE trends. According to the geological map the prominent Daarby Fault is located to the north of site and strikes in a NE-SW direction almost parallel to the northern boundary of the Matimba Power Station terrain. Other subordinate smaller faults with a NW-SE trend occur in the southern portions of the farm Grootestryd. According to the geological map no faults cross the "Rock Dump" waste site.

At the "Rock Dump" waste site the sequence of sandstone and mudstone and shale rocks is overlain by dark brown sandy transported soils that extend to depths of 4m to 5m below the surface level (ref 1). There are no rock outcrops. Highly to completely weathered soft rock sandstone underlies the soils and extends to depths varying between 13m and 15m. Slightly- to unweathered sandstone and shale occur at depths exceeding 15m.

3.2 SOILS

As part of the geotechnical investigation carried out at the site, 20 test pits were excavated in the surrounds of the "Rock Dump" waste site with the aid of a TLB. The soils exposed in the test pits were logged and representative samples were taken and submitted to a soils laboratory to determine the geotechnical properties of the materials. In situ permeability tests were carried out to determine the permeability of the soils. Permeability tests were also carried out in the laboratory.

A map indicating the test pit locations and soil zones on the site has been included in Appendix C of this report. Detailed descriptions of the soil profiles encountered in the test pits are also presented in Appendix C.

3.2.1 Soil Profiles

Between surface and 3,5m depths the soils encountered at the "Rock Dump" waste site can be divided into fill, deposited during construction of the power station, transported soils, pedogenic soils, residual soils and bedrock.

Fill consisting of brown to reddish brown fine sand and large boulders of hard rock sandstone was commonly encountered to the south of the "Rock Dump" waste site. The thickness of the material varies from less than 1m to more than 2m. The boulder content is variable and in places the TLB could not dig through the layer of the boulders. Near the existing waste site the fill is often gravelly and may contain waste material such as ash.

Transported soils are brown fine sands, mainly of aeolian (windblown origin) and are most commonly encountered to the north of the "Rock Dump" waste site. These soils contain roots and are loose in general and can be in the order of 3m thick. The thickness of these soils decreases in a southerly direction.

Both ferricrete and calcrete soils of pedogenic origin occur on the site where they underlie the transported soil layers. To the north of the "Rock Dump" waste site they tend to consist of either nodular calcrete or ferricrete and occur at depths varying between 2m and 3m. Towards the south and east of the "Rock Dump" waste site the degree of cementation of the calcrete and the ferricrete increases and hardpan calcrete and/or ferricrete was often encountered at depth between 1m and 2m. These materials tend to have a high consistency and the TLB often could not dig through these deposits. The distribution of fill, transported soils and pedogenic soils across the area surrounding the "Rock Dump" waste site is indicated on the site plan included in Appendix C.

Residual soils comprising dark brown to dark grey silty clay with shale fragments and elsewhere light yellowish grey sandy silt with sandstone fragments were only encountered in a few test pits to the east of the "Rock Dump" waste site. They occur below the pedogenic layer at depths between 1.5m and 2m and seldom exceed 1m in thickness.

The residual soils tend to be underlain by very soft rock shale or sandstone upon which the TLB refuses.

3.3 BEDROCK

3.3.1 Bedrock Profiles

The bedrock encountered below the pedogenic- and/or residual soils consists of gently folded layers of grey mudrock and white to yellow sandstone. These rock types are moderately to slightly weathered up to about 15m depths and extend to between 20m and 31m below surface level. At greater depths medium hard rock slightly to unweathered dark grey to black carbonaceous shale was encountered in all of the four boreholes drilled around the "Rock Dump" waste site. Detailed logs of the four boreholes are included in Appendix D.

According to the geophysical survey carried out at "Rock Dump" waste site (Appendix B), vertical to sub-vertical faults occur in the bedrock in places. It was on these locations that the boreholes were drilled.

4 GEOHYDROLOGY

4.1 PERMEABILITY OF SOILS AND ROCKS AT THE "ROCK DUMP" WASTE SITE

Field and laboratory constant head infiltration tests were carried out on fine aeolian transported clayey sand and on pedogenic calcrete gravel soils encountered at shallow depths in Test pits TH1 and TH4. The results are summarised in Table 1 below. More details regarding the actual tests and methodologies used are presented in the Geotechnical Input report for the EIR for Site 5.

Hole no.	Test Type	Depth (m)	Material Description	Dry Density	Coefficient of Permeability (m/s)		
					Range		Average
					Minimum	Maximum	
TH1	Field Test	0.0 – 0.7	Aeolian fine sand (transported)		5.2E-06	1.3E-05	9.7E-06
TH4	Field Test	0.0 – 0.26	Clayey sand (transported)		1.1E-06	7.0E-06	3.8E-06
TH4	Lab Test	0.4 – 0.6	Calcrete gravel (pedogenic)	1812	1.2E-07	1.5E-07	1.3E-07

Table 1: Soils permeability test results

The test results indicate sandy materials with a moderate permeability depending on the clay content of the soils. The aeolian sands and the sandy fill materials have high coefficients of permeability.

The calcrete and ferricrete on the other hand tend to have moderate to low coefficients of permeability. It is likely that hardpan calcrete or ferricrete tends to be virtually impermeable. Where aeolian sands overlie well developed nodular to hardpan pedogenic horizons, considerable lateral movement of seepage and groundwater can be expected. Since the regional topography has a shallow gradient from the northwest to the southeast, it is likely that the flow of water in the shallow soil aquifer will follow the topography to the southeast. Since the gradient is very shallow however, localised ingress of seepage water (e.g. from a dam) can result in the formation of a groundwater mound in this localised area and groundwater flow away from this mound can be in any direction. This implies that groundwater in the shallow soil aquifer can flow in westerly and northerly directions in the vicinity of groundwater mounds.

In undisturbed and unweathered form the sandstone and shale rocks are hard and water tight and their potential as water bearing aquifers is low. Where affected by faulting, fracturing and weathering, they form secondary aquifers of limited storativity but potentially high transmissivity particularly in the sandstones. Monitoring boreholes drilled at "Rock Dump" waste site tended to have low yields and were often dry (boreholes MBH2 and MBH4). In those boreholes where it occurred, water was generally intersected at the base of the transported and pedogenic soil layers and also sporadically in weathered sandstone and mudrock zones encountered at depths between 7m and 10m (Borehole MBH1 and ref 2). Blow yields of 4 l/sec were recorded from the shallow aquifer intersected in borehole MBH1. Only rarely was water encountered in fracture zones within the carbonaceous shale layers. Borehole MBH3 intersected a fracture zone at 39m depth. The blow yields recorded from this aquifer were in the order of 0.5 l/sec.

4.2 GROUNDWATER FLOW

In order to evaluate the impact of groundwater flow the static groundwater levels were measured on 9 April 2009 and the values are shown in Tables 2 and 3 below.

BH No	Depth (mbgl)	Casing Collar (magl)	Water strike (elevat. masl)	Water table (mbgl)	Water table (elevat. masl)	X co-ordinate	Y co-ordinate	Z co-ordinate
MBH1	40	0.70	865.61	4.90	867.71	X2618438.583	27 Y-061123.249	872.606
MBH2	40	0.94	None	9.16	865.21	X2619059.120	27 Y-061021.789	874.370
MBH3	40	0.76	834.40	7.56	865.84	X2618942.448	27 Y-061203.638	873.400
MBH4	40	0.80	None	11.62	865.21	X2618675.729	27 Y-0605675.729	876.830

mbgl = metres below ground level

magl = metres above ground level

masl = metres above sea level

Table 2: New Monitoring Boreholes Data

BH No	Depth (mbgl)	Casing Collar (magl)	Water strike (elevat. masl)	Water table (mbgl)	Water table (elevat. masl)	X co-ordinate	Y co-ordinate	Z co-ordinate
P4	60	0.12	?	11.52	863.81	X2618787.510	27 Y-060693.398	875.329
P5	60	0.20	?	7.50	869.04	X2618401.131	27 Y-060767.051	876.539
P26	60	0.18	?	4.26	868.62	X2618635.240	27 Y-061209.244	872.877
P28	60	0.10	?	9.9	865.14	X2618860.128	27 Y-061038.089	875.039

mbgl = metres below ground level

magl = metres above ground level

masl = metres above sea level

Table 3: Existing Monitoring Boreholes Data

From Tables 2 and 3 above it is evident that high groundwater table elevations occur in boreholes P5, MBH1 and P26. These boreholes are located to the north- and north-eastern of the "Rock Dump" waste site. The water tables in boreholes P28 and MBH2 and MBH3, located to the south of the "Rock Dump" waste site, are within one metre of one another. An anomalous value has been obtained in borehole P4, located on the western boundary of the "Rock Dump" waste site and has an abnormally deep water table. The flow direction of groundwater at the "Rock Dump" waste site is therefore from north to south and from east to west.

It is speculated that the elevated shallow water tables in boreholes MBH1 and P26 can be attributed to water seepage originating from the spraying of the coal in the stockyard area. A mound of elevated groundwater, largely confined to the shallow aquifer located in the transported soils and the residual sandstone and shale layers located to depths of up to 5m below the surface may be situated below the coal stockyard and lateral flow of groundwater away from the coal stockyard area may occur.

According to the groundwater level contour map constructed for the modelling of groundwater flow around Matimba Power Station (Grobbelaar et al, 2000) the groundwater levels in the waste dump area lay between 860 and 865 masl. From that map it was concluded that the regional groundwater flow was in a south-easterly direction.

Although the relatively high water table in borehole P5 when compared with the water tables in boreholes P28 and MBH2 and MBH3 confirms a regional southerly flow of groundwater as per the findings of Grobbelaar et al, the irrigation activities in the coal stockyard may have resulted in a local change of the groundwater flow direction from east to west in the area to the east and north of the "Rock Dump" waste site. Polluted groundwater from the coal stockyard can therefore migrate from the east into the "Rock Dump" waste site area.

It was also noted that at the time of the Grobbelaar et al study in the year 2000, the groundwater table elevations in the "Rock Dump" waste site area were between 860m and 865m. On 9 April 2009, the groundwater elevations were between 865m and 869m (except for borehole P4). A rise of the regional groundwater table by about 4m has therefore occurred during this period. It is not certain whether this is attributable to the abnormally good rainy season experienced in the area or if this can be attributed to the irrigation activities in and around the power station.

4.3 HYDROCHEMISTRY

The boreholes were sampled on 9 April 2009. The samples were collected with the aid of a bailer lowered to depths between 15m and 20m below surface level. Due to the fact that most of the boreholes contain slowly percolating seepage water only, purging of the boreholes prior to the sample collection was not carried out at this stage. It is however recommended that the boreholes be pumped empty subsequent to water table measurement and water sample collection, or if this is not possible, that a volume equal to that of the water column in the borehole be pumped out of it to ensure fresh ingress of water into the hole.

The samples submitted to UIS Analytical Services (PTY) Ltd (an accredited laboratory in Centurion) for chemical analysis. The certificates of analyses are included in Appendix E and summarized in Table 4. The results were classified according to the drinking water quality guidelines of the South African National Standard (SANS).

From the table it is clear that all the water samples have some values that fall outside the parameters specified for domestic quality water and are therefore not suitable for use as drinking water. The test results also show that no water sample exactly duplicates another of the ones that were tested. This may imply separate aquifers or very slow movement of water within an aquifer.

A high salinity is displayed in some water samples, particularly those originating from boreholes drilled into the shale formations. This finding was also reported in previous studies (Vermeulen, 2006 and Grobbelaar et al, 2000).

The present results from boreholes P4, P5, P26 and P28 were compared with those reported by Vermeulen (2006) and are shown in Table 5. There is a fair similarity in the results such as high Fluoride in both P26 samples, high nitrate in both P5 samples and high iron in both of the results from boreholes P4 and P28 respectively.

If the high nitrate values that are present in both P5 samples are attributed to contamination from sanitation sources or fertilizers from outside the power station site, then P5 can be regarded as a background groundwater quality borehole not impacted on by the "Rock Dump" waste site or the coal stockyard area adjacent to it. This is also apparent from the low TDS and overall lower values of all the tested parameters (when compared with the other borehole water samples tested) and was also observed in previous reports by Grobbelaar (2000) and Vermeulen (2006).

Sample Nr.	MBH1	MBH2	MBH3	MBH4	P4	P5	P26	P28	Class I	Class II
Ca	62.80	24.30	4.51	170.00	32.60	24.70	74.90	23.30	150	300
Mg	237.00	45.10	4.95	140.00	35.70	16.40	167.00	32.90	70	100
Na	226.00	426.00	101.00	472.00	263.00	104.00	155.00	229.00	200	400
K	5.22	26.30	2.51	5.56	4.10	0.55	17.90	5.22	50	100
Mn	0.18	0.07	0.08	0.35	0.10	<0.05	<0.05	0.07	0.1	1
Fe	<0.05	<0.05	3.96	<0.05	3.66	<0.05	<0.05	2.48	0.2	2
F	1.94	0.99	0.25	0.19	0.34	0.37	2.26	1.17	1	1.5
NO_3	7.09	<0.3	0.31	<0.3	<0.3	46.40	16.90	<0.3	44	88
Suspended Solids mg/l	158	27.20	81.6	23.40	71.2	14.00	24.40	23.00		
Turbidity NTU	53.60	10.80	184.00	11.20	49.3	14.90	15.30	22.60		
COD ppm O2	132.00	16.00	40.00	68.00	12.00	48.00	12.00	20.00		
Si	30.3	10.5	42.3	15.9	18.7	48.2	42.4	22.9	-	-
Cl	96.70	221.00	93.50	1180.00	403.00	50.20	67.50	178.00	200	600
SO_4	468.00	127.00	16.70	79.60	81.10	6.93	311.00	32.70	400	600
TDS by sum	1930.00	1380.00	466.00	2820.00	994.00	386.00	1450.00	880.00	1000	2400
M-Alk($CaCO_3$)	1030.00	779.00	95.90	309.00	142.00	123.00	820.00	414.00	-	-
pH	7.80	7.98	6.56	7.11	6.63	7.54	7.82	7.15	5.0 - 9.5	4.0 - 10.0
EC mS/m	395.00	241.00	57.00	460.00	162.00	54.00	180.00	133.00	150	370
Cat/An Bal. %	0.87	3.26	-2.91	-0.61	-1.49	-4.55	-1.42	-0.80	-	-

Notes

Yellow = Class I

Tan = Class II

exceeds maximum allowable drinking water standard

na- not analysed

0 = below detection limit of analytical technique

Table 4: Results of the chemical analysis of the samples taken 9 April 2009.

Sample Nr.	P4	P4	P5	P5	P26	P26	P28	P28	Class I	Class II
	2009	2006	2009	2006	2009	2006	2009	2006		
Ca	32.60	23.00	24.70	12.00	74.90	33.00	23.30	21.00	150	300
Mg	35.70	32.00	16.40	11.00	167.00	84.00	32.90	36.00	70	100
Na	263.00	298.00	104.00	35.00	155.00	821.00	229.00	331.00	200	400
K	4.10	9.80	0.55	3.00	17.90	51.80	5.22	14.30	50	100
Mn	0.10	0.10	<0.05	0.05	<0.05	0.07	0.07	0.11	0.1	1
Fe	3.66	5.49	<0.05	1.62	<0.05	2.33	2.48	5.97	0.2	2
F	0.34	0.00	0.37	0.00	2.26	1.30	1.17	0.80	1	1.5
NO_3	<0.3	0.00	46.40	89.00	16.90	13.00	<0.3	0.00	44	88
Suspended Solids mg/l	71.2		14		24.4		23.00			
Turbidity NTU	49.3		14.90		15.30		22.60			
COD ppm O2										
Si	18.7	38.1	48.2	82.2	42.4	39.7	22.9	56.9	-	-
Cl	403.00	398.00	50.20	171.00	67.50	396.00	178.00	166.00	200	600
SO_4	81.10	72.00	6.93	2.00	311.00	179.00	32.70	18.00	400	600
TDS by sum	994.00		386.00		1450.00		880.00		1000	2400
M-Alk($CaCO_3$)	142.00		123.00		820.00		414.00		-	-
pH	6.63	6.13	7.54	6.70	7.82	7.29	7.15	6.67	5.0 - 9.5	4.0 - 10.0
EC mS/m	162.00	175.00	54.00	31.00	180.00	337.00	133.00	157.00	150	370
Cat/An Bal. %									-	-

Notes

Yellow = Class I

Tan = Class II

exceeds maximum allowable drinking water standard

na- not analysed

0 = below detection limit of analytical technique

Table 5: Comparing the present results in the existing boreholes with the 2006 results

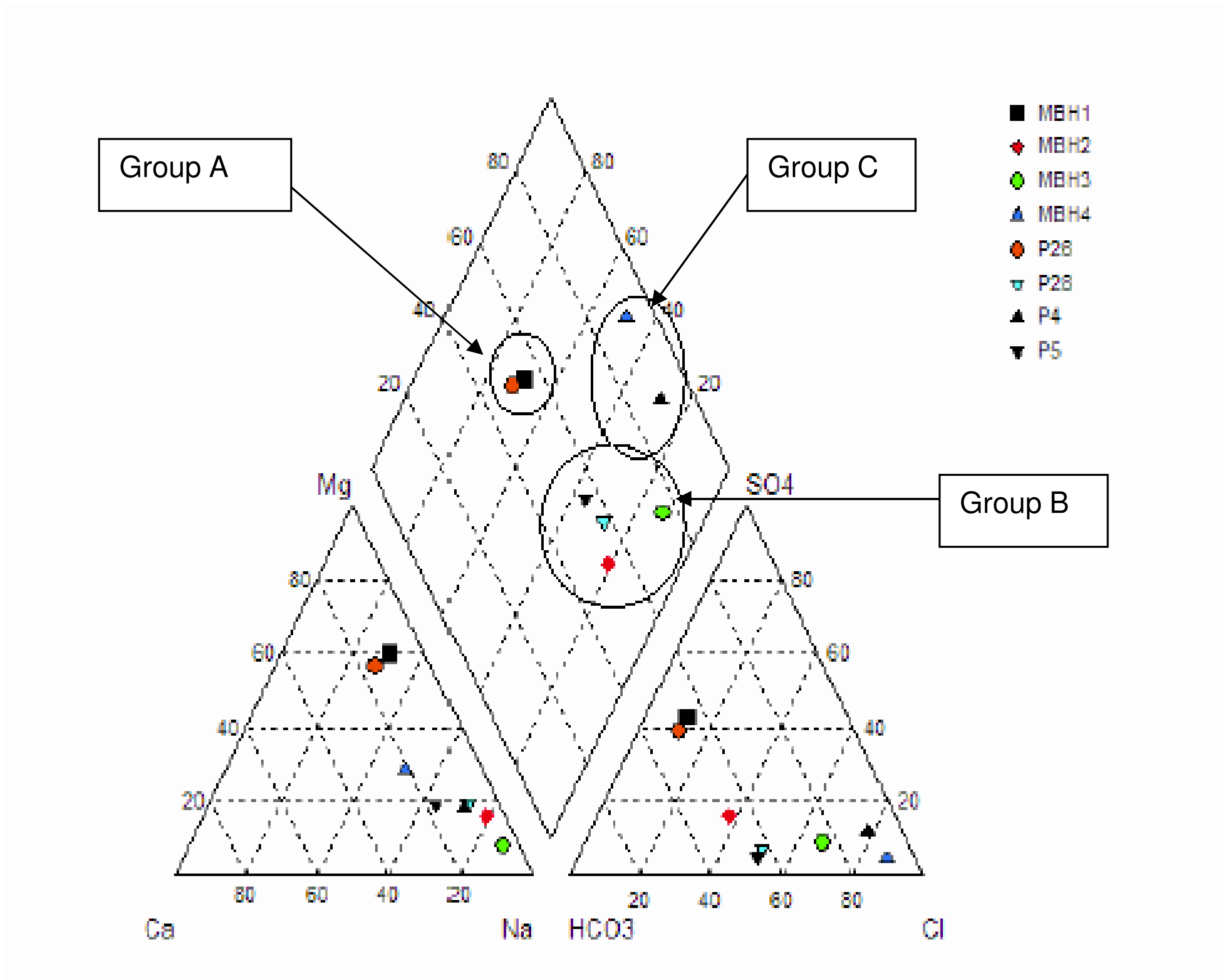

Figure 1: Piper diagram of the boreholes sampled on 9 April 2009.

The analytical results of the samples collected on 9 April 2009 were plotted on a Piper diagram to establish any similarities in chemical character between the boreholes. The Piper diagram is shown in Figure 1. Three groupings have been identified:

- **Group A**: MBH1 and P26: characterised by Na-Mg-HCO3-SO4
- **Group B**: MBH2, MBH3, P5 and P28: characterised by Na-Mg-Ca-HCO3-Cl
- **Group C**: MBH4 and P4: characterised by Na-Cl-Mg-Ca

4.3.1 Group A

The water samples from boreholes MBH1 and P26 both display high Magnesium and in the anion field SO4 and HCO3 are dominant, placing them away from the other boreholes. The two boreholes are located in close vicinity of the coal stockyard and are definitely impacted by water migrating from there. Both boreholes also have high TDS and fluoride values. The presence of high fluoride is natural in the area as fluorspar veins are present in the rocks and this is indicated on the geological map of the area. The fact that anomalous fluoride is restricted to these two boreholes shows that there is little or no connection between these and the other monitoring boreholes drilled at the site.

4.3.2 Group B

The groundwater from the boreholes in this group (MBH2, MBH3, P5 and P28) displays high Na content and low sulphate content. The boreholes are located between the coal stockyard in the east and the "Rock Dump" waste site in the west and it looks as if neither of these sites really has an impact on the water samples collected from these boreholes. However, MBH2 and P28 both have high TDS associated with high Na and Cl and this could indicate either some impact from the waste dump or salinity associated with aquifers located in shale rock. Previous studies concluded that P5 represents background groundwater unaffected by the "Rock Dump" waste site and the coal stockyard. P5 displays high nitrate that is not present in the other boreholes drilled around the site. However, Vermeulen reported high nitrate also in P6, a borehole located to the northeast of P5 and to the north of the coal stockyard. It was assumed that the source could be sanitation or fertilizer from outside the Power Station site area.

4.3.3 Group C

This group comprises water from boreholes MBH4 and P4 located west to northwest of the "Rock Dump" waste site. Previous studies concluded that the waste dump definitely impacts on borehole P4. Both boreholes P4 and MBH4 have prominent Cl values and high TDS values. The salinity in P4 is higher than that in MBH4. MBH4 had no water strike during drilling and the present water represents local seepage, the composition of which could change with time if the borehole is emptied periodically. Since the water table in borehole MBH4 is at a higher elevation than that in borehole P4, it is unlikely that the salinity and TDS values in borehole MBH4 are attributable to contamination from the existing waste dump.

4.3.4 Evaluation of Data

From the present sampling event it is clear that the geology and geological structures such as faults and fracture zones similar or associated with those shown on the geological map of the area are playing a role in the dynamics of the groundwater aquifers in the area. There is little or no interconnection between the groundwater from boreholes in Group C and groundwater from boreholes in Group A. It is also concluded that P5 displays background quality water. Boreholes MBH2, MBH3 and P28 may show some impact from the existing waste dump and the coal stockyard or they reflect the general salinity associated with shale aquifers commonly found in the certain Karoo formations rocks. It is recommended that stable isotopes oxygen -18 and deuterium as well as tritium values be sampled during the next monitoring event. The isotope data should give more information about groundwater interconnection and recharge dynamics.

The analytical data reported by Vermeulen (2006) were plotted on the Piper diagram shown in Figure 2. P4 and P28 show good similarity to the present 2009 results. The anion values for boreholes P5 and P26 show fair similarity to the 2009 results but the cation values do not correspond with the 2009 characterization. It is recommended that monitoring and analyses be carried out by the same accredited laboratory in future to determine if the variations in values analysed are seasonal or due to analytical or other errors.

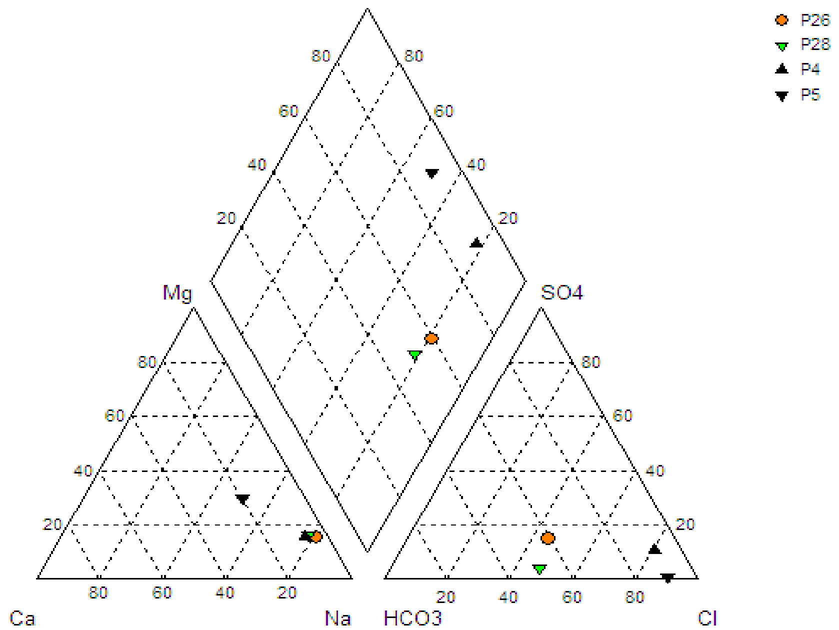

Figure 2: Piper diagram of 2006 analytical results (Vermeulen, 2006)

4.4 AQUIFER CLASSIFICATION

The shallow aquifers confined to the sandy and gravely surface soil deposits encountered in the area surrounding the "Rock Dump" waste site at Matimba Power Station have a moderate to high transmissivity and a low storativity and are vulnerable to external influences like pollution associated with water infiltrating the shallow aquifer at the coal stockyard. Leachates generated from any waste will influence the water quality in the aquifer. The shallow aquifers overlie the deep aquifers in the sandstone, mudrock and shale formations of the Karoo Supergroup and water from the shallow aquifer replenishes water in the deep aquifer in places such as fault lines, fracture zones and weathered rock layers. The water quality in the deep aquifer can therefore be affected by the water quality of the shallow aquifer.

Due to the nature of the surface and ground water flow directions as well as the nature of the shallow primary aquifer, which feeds the deep aquifers, pollution of this aquifer will affect groundwater from some localised deep aquifers. Seepage of polluted water in the shallow aquifer can also affect the quality of the water in the streams and may eventually end up in rivers.

Based on the available information the aquifers encountered at the "Rock Dump" waste site (Appendix A) are classed as part of a MINOR AQUIFER SYSTEM according to the definitions of Parson (1995) in his Aquifer System Management Classification.

The "Rock Dump" waste site aquifer system has generally low yielding boreholes and the water from the aquifers is contaminated at present. The contamination is attributable to pollution generated at the coal stockyard, the "Rock Dump" waste site and also to salts originating from the shale and mudrock formations of the Karoo Supergroup. The Aquifer is classed as HIGHLY VULNERABLE according to the definitions in Parson's Aquifer Vulnerability Classification. Due to the fact that piped water is available in the area, groundwater does not have to be relied upon as a sole water supply. Measures preventing the migration of polluted water in the shallow aquifer and into the deep aquifer and into streams down stream of the site will nevertheless have to be applied as this water is utilised by farmers further down stream and may affect the water quality of tributaries of the Mokolo River.

4.5 RATING OF THE AQUIFER

Using Parson's rating system as set out in the report and summarised in Table 6 and Table 7, the "Rock Dump" waste site aquifers form part of a MINOR AQUIFER SYSTEM with a HIGH VULNERABILITY and will qualify for HIGH PROTECTION, based on the GQM INDEX.

AQUIFER SYSTEM MANAGEMENT CLASSIFICATION		**AQUIFER VULNERABILITY CLASSIFICATION**	
CLASS	***POINTS***	**CLASS**	**POINTS**
Sole Source Aquifer system	6	High	3
Major Aquifer System	4	Medium	2
Minor Aquifer System	2	Low	1
Non-aquifer System	0		

"ROCK DUMP" WASTE SITE AQUIFER = 5

Table 6: Ratings for the Groundwater Quality Management (GQM) classification system for the "Rock Dump" waste site Aquifer

GQM INDEX	**LEVEL OF PROTECTION**
<1	Limited protection
1-3	Low level protection
3-6	Medium level protection
6-10	High level protection
>10	Strictly non-degradation

"ROCK DUMP" WASTE SITE AQUIFER = 7

Table 7: Appropriate Level of Groundwater Protection required for the "Rock Dump" waste site Aquifer based on the Groundwater Quality Management classification

5 CONCLUSIONS

The following conclusions are made:

- The soils covering the bedrock at the "Rock Dump" waste site are sandy and permeable and constitute a near surface primary aquifer. The aquifers contained in the underlying sandstone, mudstone and shale rock formations of the Karoo

Supergroup are of a secondary nature and low yielding. Although the reliance on these aquifers for water sources is small at present, particularly in the vicinity of the "Rock Dump" waste site and the area around Matimba Power Station, they are used for stock watering purposes on farms in the region.

- The static groundwater levels measured in the monitoring boreholes drilled at the "Rock Dump" waste site are variable between 4m and 12m below ground level indicating that the geology may affect the aquifers resulting in variable groundwater regimes. Irrigation of the coal in the coal stockyard adjacent to the "Rock Dump" waste site may result in shallow water tables recorded in boreholes MBH1 and P26. A comparison of groundwater level data from previous studies with that of the present study indicates a steady fairly continuous rise in the groundwater tables. Early studies indicated groundwater tables at depths exceeding 10m. At present the average groundwater tables at the "Rock Dump" waste site are between 4m and 8m below surface level.
- Previous groundwater studies indicated a regional groundwater flow to the south and east. The considerable variation in ground water levels in the eight boreholes investigated at the "Rock Dump" waste site for the present study is indicative that there may be local variations in the direction of groundwater flow. Besides localised groundwater flow from east to west in the area to the north-east of the "Rock Dump" waste site (adjacent to the coal stockyard), there is a flow from north to south across the "Rock Dump" waste site which corresponds to the regional flow direction of groundwater observed during previous studies carried out elsewhere in the Matimba Power Station area.
- Based on the available information the aquifers encountered in the "Rock Dump" waste site (Appendix A) are classed as part of a Minor Aquifer System according to the definitions of Parson (1995) in his Aquifer System Management Classification. The System has a High Vulnerability and requires a High Level of Protection and is applicable to the entire the "Rock Dump" waste site and surrounding area.
- The High Vulnerability class allocated to the aquifer system is confirmed by the results of chemical analyses of water samples collected from eight boreholes located around the "Rock Dump" waste site. All eight boreholes show signs of contamination. Although the contamination may originate naturally from the shales and mudrocks within which the aquifers are located (it is known that water from aquifers located in the Karoo shales and mudrocks tends to be saline), some of the contamination is attributable to pollution as a result of present or past activities on or adjacent to the "Rock Dump" waste site (P5, P4, MBH1 and MBH26).
- The geology and geological structures appear to have an impact on the interconnection of groundwater in the area. The fact that high fluoride values only occur in Boreholes P26 and MBH1 and not in any of the other boreholes drilled on the site, suggests poor connectivity of the groundwater intersected in the various boreholes drilled.
- The high fluoride values in the water samples from boreholes MBH1 and P26 are attributed to the natural occurrence of fluoride in the rock formations in the area.
- The high salinity and high nitrate values recorded in borehole P5 indicate that the water is polluted. These values are however different from values encountered in any of the other seven boreholes drilled near the "Rock Dump" waste site. For this reason borehole P5 is considered to contain water unaffected by pollution originating from the "Rock Dump" waste site or from the coal stockyard to the northeast of the "Rock Dump" waste site.
- Water samples from boreholes MBH1 and P26 are impacted by the coal stockyard.
- The domestic waste dumped at the existing waste dump impacts P4 and the effect of the ash dumped at this site also appears to affect the water in P26 (ref 5).

- MBH2, MBH3 and P28 show high salinity compared to background groundwater in P5. This could be due to impact of the coal stockyard and the "Rock Dump" waste site or as a result of the general salinity associated with the shale aquifers in the area.
- The "Rock Dump" waste site is not the only source of pollution of groundwater in the area to the west of Matimba Power Station. Pollution in this area could originate from the natural in situ rock formations in the area or from other sources like the coal stockyard.
- Water samples analysed by different laboratories may result in variations of the results. It is not certain if the variation of results dating from the 2006 investigation by Vermeulen and those from the April 2009 investigation can be attributed to seasonal changes or to changes that occurred as a result of the analytical procedures followed in the different laboratories.
- The 8 boreholes sampled should be adequate to monitor the impact on the groundwater of the "Rock Dump" waste site and the coal stockyard in future.

6 RECOMMENDATIONS

The following recommendations are made:

- To ascertain if variations in analytical results carried out in 2006 and in 2009 can be attributed to seasonal changes or to analytical errors it is recommended that future water table measurements and sampling be done as recommended below and that the be analysed by the same accredited laboratory to avoid variations in results attributable to analytical techniques which can mask variations over time.
- It is recommended that the static water tables and the water chemistry of all eight boreholes be monitored at three monthly intervals. Depending on the monitoring results and on possible future recommendations from the Departments of Water Affairs, the monitoring intervals can be adjusted after one year to correspond with those of the rest of the Matimba area. It is recommended that the same elements as those analysed for in this study be analysed for in future and that changes only be instituted once stable trends for certain elements can be established.
- Subsequent to measuring the water tables and collecting the water samples, the boreholes should be pumped empty or if this is not possible a volume equal to the column of water in the borehole should be pumped out of it to prevent re-analyses of stagnant water in the borehole.
- It is recommended that stable isotopes oxygen-18 and deuterium as well as tritium analysis be done during the next monitoring event to gather more information about groundwater interconnection and recharge dynamics.
- As is evident from the coal stockyard, which is unlined, leachates and run-off water from the "Rock Dump" waste site will pollute the water in the underlying aquifers. To minimise ingress of rain and stormwater in to the waste material at the "Rock Dump" waste site, it is recommended that the existing berm wall surrounding the site be kept intact and that an impervious cover be installed to cover the waste at the site and that any leachates and run-off water be collected in lined ponds located within the area surrounded by the berm. By keeping the waste deposited at this site in the past as dry as possible the chances of pollutants originating from this source can be minimised.
- It is recommended that the site be fenced and isolated and that no further development or dumping of additional waste of any kind be carried out.

6.1 GEOHYDROLOGICAL IMPACT ASSESSMENT TABLE FOR THE "ROCK DUMP" WASTE SITE

The anticipated impact of leachate originating from waste of the "Rock Dump" waste site on the groundwater is summarised in Table 8 below.

Development Phase	Impact: Leachate Seepage through porous soil cover into groundwater					
	Extent	Duration	Intensity	Probability	Significance	
					WM	WOM
"Rock Dump" waste site						
Operation	Regional	Medium Term	Medium	Highly Probable	N/A	High
Closure	Local	Long Term	Medium	Highly Probable	Low	High

WM = With mitigation
WOM = Without mitigation

Table 8: "Rock Dump" waste site Geohydrological Impact Assessment Table

Please Note:

Leachate and polluted water seepage originating from the coal stockyard to the northeast of the "Rock Dump" waste site will also affect the groundwater quality in the area to the west of Matimba Power Station. Laboratory tests carried out on water samples collected from monitoring boreholes drilled at "Rock Dump" waste site show that the groundwater has been affected by both the "Rock Dump" waste site and the coal stockyard. This effect is however masked to a certain extent by the high salt content in the groundwater that can be attributed to the leaching from the natural shales that form the aquifer in the area as is evident from the water quality encountered in borehole P5.

Considering the monitoring results presented above, there is little doubt that the groundwater quality in the area to the west of Matimba Power Station where the "Rock Dump" waste site is located is affected by the surface activities in and around the power station. It should however be remembered that the natural quality of the groundwater in this area, which is unaffected by human activities is also of poor quality, even if unaffected by any leachates originating from waste sites and coal stockyards.

6.2 MITIGATING MEASURES

To prevent or reduce the impact of the "Rock Dump" waste site on the geohydrology, mitigating measures as listed below are recommended.

- Due to shallow water tables (particularly in the neighbouring sites) it is recommended that excavations do not extend deeper than 4m below the present surface level. Deeper excavations may intersect the shallow perched water table that exists at least during the rainy seasons and will affect the design and the construction of the proposed facilities.
- It is recommended that the berm wall surrounding the "Rock Dump" waste site be kept intact and that no further dumping of waste be carried out at this site.
- Regional stormwater should be diverted away from the site.
- It is recommended that an impervious cover be placed on the waste material deposited at the "Rock Dump" waste site.
- Runoff stormwater and any possible near surface leachate that may be generated by the general waste at the site should be collected in lined drains and ponds located within the confines of the berm walls.

- It is recommended that the four boreholes drilled for this study be included into the monitoring programme for the Matimba Power Station and that this programme be adapted to include recommendations made in the geohydrological report and by the Department of Water Affairs.
- The results of the monitoring programme should be submitted to the Department of Water Affairs before they are included in the annual audit report.

A Schulze-Hulbe (Pr Sci Nat)
For BLUE ROCK CONSULTING (Pty) Ltd

7 REFERENCES

1. Regional Geological Map; 1: 250 000 Scale; Sheet No 2326 Elisras.
2. Groundwater Pollution Risk Assessment and Compliance Monitoring at Matimba Power Station by Frank Hodgson; February 1995.
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7. Minimum Requirements for Waste Disposal by Landfill: Department of Water Affairs and Forestry; second edition, 1998.
8. Minimum Requirements for Water Monitoring at Waste Management Facilities: Department of Water Affairs and Forestry; second edition, 1998.

APPENDIX A

<u>SITE LOCALITY MAP</u>

Locality of "Rock Dump" Waste Site

APPENDIX B

GEOPHYSICAL ,SURVEY

APPENDIX C

TEST PIT LOCATIONS & SOIL PROFILES

APPENDIX D

BOREHOLE LOCATIONS & BOREHOLE PROFILES

APPENDIX E

LABORATORY TEST RESULTS

APPENDIX F

EXPERTISE OF SPECIALIST: CURICULUM VITAE

APPENDIX G

DECLARATION

ENVIROLUTION CONSULTING (PTY) LTD

CLOSURE OF EXISTING WASTE SITE AT MATIMBA POWER STATION: GENERAL AS WELL AS SPECIFIC GEOHYDROLOGICAL REQUIREMENTS FOR APPLICATION FOR AUTHORISATION

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ABSTRACT

As part of the process for closure of the "Rock Dump" waste site located to the west of Matimba Power Station the following was included in the geohydrological study.

1. Clarification regarding the flow of groundwater and migration of a possible pollution plume at the site and in the surrounding areas has to be obtained.
2. More information regarding the nature of the aquifers at the site has to be obtained.
3. In addition it has to be established to what extent the site is contributing to the pollution of the groundwater and what effect this will have on the surrounding areas.
4. The current status of the situation has to be determined and a geohydrological impact assessment has to be made.
5. Considering the future use intended for the waste site area, recommendations regarding remediation measures in mitigation of the impact have to be made and a monitoring system has to be drawn up that records the effectives of the remedial measures in the future.

The work was carried out according to guidelines presented in the Minimum Requirements for Waste Disposal by Landfill (Second Edition 1998) and the Minimum Requirements for Water Monitoring at Waste Management Facilities (Second Edition 1998) both published by the Department of Water Affairs and Forestry and included the following:

- Investigate all geological and geohydrological information available for the area in detail.
- Consider and address queries and concerns raised by DWAF regarding the findings of the previous investigations and recorded on old correspondence.
- Carry out a geophysical survey (electrical resistivity and residual magnetic surveys) of the area surrounding the "Rock Dump" waste site to identify potential deep fracture zones and faults that will act as groundwater aquifers.
- Carry out a rotary percussion-drilling programme to verify the presence of any aquifers.
- Test the yield, storativity and transmissivity of these aquifers.
- Determine the groundwater quality of these aquifers by testing the water chemistry of samples collected from the boreholes in an accredited laboratory.
- Establish a groundwater monitoring system for the site that is based on this information.
- Determine the geohydrological properties of the soils (permeability etc.) in the area. This work was carried out in conjunction with the geotechnical field investigation. Soil profiles exposed in test pits were examined and insitu permeability tests will be carried out. Samples were collected for laboratory testing.
- Data analyses of information collected during the field investigations.
- Present data on maps and compile a report.

The following conclusions are made:

- The soils covering the bedrock at the "Rock Dump" waste site are sandy and permeable and constitute a primary near surface aquifer. The aquifers contained in the underlying sandstone, mudstone and shale rock formations of the Karoo Supergroup are of a secondary nature and low yielding. Although the reliance on these aquifers for water sources is small at present, particularly in the vicinity of the "Rock Dump" waste site and the area around Matimba Power Station, they are used for stock watering purposes on farms in the region.

- The static groundwater levels measured in the monitoring boreholes drilled at the "Rock Dump" waste site are variable between 4m and 12m below ground level indicating that the geology may affect the aquifers resulting in variable groundwater regimes. Irrigation of the coal in the coal stockyard adjacent to the "Rock Dump" waste site may result in shallow water tables recorded in boreholes MBH1 and P26. A comparison of groundwater level data from previous studies with that of the present study indicates a steady fairly continuous rise in the groundwater tables. Early studies indicated groundwater tables at depths exceeding 10m. At present the average groundwater tables at the "Rock Dump" waste site are between 4m and 8m below surface level.

- Previous groundwater studies indicated a regional groundwater flow to the south and east. The considerable variation in ground water levels in the eight boreholes investigated at the "Rock Dump" waste site for the present study is indicative that there may be local variations in the direction of groundwater flow. Besides localised groundwater flow from east to west in the area to the north-east of the "Rock Dump" waste site (adjacent to the coal stockyard), there is a flow from north to south across the "Rock Dump" waste site which corresponds to the regional flow direction of groundwater observed during previous studies carried out elsewhere in the Matimba Power Station area.

- Based on the available information the aquifers encountered in the "Rock Dump" waste site (Appendix A) are classed as part of a Minor Aquifer System according to the definitions of Parson (1995) in his Aquifer System Management Classification. The System has a High Vulnerability and requires a High Level of Protection and is applicable to the entire the "Rock Dump" waste site and surrounding area.

- The High Vulnerability class allocated to the aquifer system is confirmed by the results of chemical analyses of water samples collected from eight boreholes located around the "Rock Dump" waste site. All eight boreholes show signs of contamination. Although the contamination may originate naturally from the shales and mudrocks within which the aquifers are located (it is known that water from aquifers located in the Karoo shales and mudrocks tends to be saline), some of the contamination is attributable to pollution as a result of present or past activities on or adjacent to the "Rock Dump" waste site (P5, P4, MBH1 and MBH26).

- The geology and geological structures appear to have an impact on the interconnection of groundwater in the area. The fact that high fluoride values only occur in Boreholes P26 and MBH1 and not in any of the other boreholes drilled on the site, suggests poor connectivity of the groundwater intersected in the various boreholes drilled.

- The high fluoride values in the water samples from boreholes MBH1 and P26 are attributed to the natural occurrence of fluoride in the rock formations in the area.

- The high salinity and high nitrate values recorded in borehole P5 indicate that the water is polluted. These values are however different from values encountered in any of the other seven boreholes drilled near the "Rock Dump" waste site. For this reason borehole P5 is considered to contain water unaffected by pollution originating from the "Rock Dump" waste site or from the coal stockyard to the northeast of the "Rock Dump" waste site.

- Water samples from boreholes MBH1 and P26 are impacted by the coal stockyard.

- The domestic waste dumped at the existing waste dump impacts P4 and the effect of the ash dumped at this site also appears to affect the water in P26 (ref 5).

- MBH2, MBH3 and P28 show high salinity compared to background groundwater in P5. This could be due to impact of the coal stockyard and the

"Rock Dump" waste site or as a result of the general salinity associated with the shale aquifers in the area.

- The "Rock Dump" waste site is not the only source of pollution of groundwater in the area to the west of Matimba Power Station. Pollution in this area could originate from the natural in situ rock formations in the area or from other sources like the coal stockyard.
- Water samples analysed by different laboratories may result in variations of the results. It is not certain if the variation of results dating from the 2006 investigation by Vermeulen and those from the April 2009 investigation can be attributed to seasonal changes or to changes that occurred as a result of the analytical procedures followed in the different laboratories.
- The 8 boreholes sampled should be adequate to monitor the impact on the groundwater of the "Rock Dump" waste site and the coal stockyard in future.

The following recommendations are made:

- To ascertain if variations in analytical results carried out in 2006 and in 2009 can be attributed to seasonal changes or to analytical errors it is recommended that future water table measurements and sampling be done as recommended below and that the be analysed by the same accredited laboratory to avoid variations in results attributable to analytical techniques which can mask variations over time.
- It is recommended that the static water tables and the water chemistry of all eight boreholes be monitored at three monthly intervals. It is recommended that the same elements as those analysed for in this study be analysed for in future and that changes only be instituted once stable trends for certain elements can be established.
- Subsequent to measuring the water tables and collecting the water samples, the boreholes should be pumped empty or if this is not possible a volume equal to the column of water in the borehole should be pumped out of it to prevent re-analyses of stagnant water in the borehole.
- It is recommended that stable isotopes oxygen-18 and deuterium as well as tritium analysis be done during the next monitoring event to gather more information about groundwater interconnection and recharge dynamics.
- As is evident from the coal stockyard, which is unlined, leachates and run-off water from the "Rock Dump" waste site will pollute the water in the underlying aquifers. To minimise ingress of rain and stormwater in to the waste material at the "Rock Dump" waste site, it is recommended that the existing berm wall surrounding the site be kept intact and that an impervious cover be installed to cover the waste at the site and that any leachates and run-off water be collected in lined ponds. By keeping the waste deposited at this site in the past as dry as possible the chances of pollutants originating from this source can be minimised.
- It is recommended that the site be fenced and isolated and that no further development or dumping of additional waste of any kind be carried out.

ENVIROLUTION CONSULTING (PTY) LTD

CLOSURE OF EXISTING WASTE SITE AT MATIMBA POWER STATION: GENERAL AS WELL AS SPECIFIC GEOHYDROLOGICAL REQUIREMENTS FOR APPLICATION FOR AUTHORISATION

Report No.: 2008/ 0113/ 03 **OCTOBER 2009**

ENVIROLUTION CONSULTING (PTY) LTD

CLOSURE OF EXISTING WASTE SITE AT MATIMBA POWER STATION: GENERAL AS WELL AS SPECIFIC GEOHYDROLOGICAL REQUIREMENTS FOR APPLICATION FOR AUTHORISATION

REPORT NO: 2008 0113/ 03 OCTOBER 2009

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