ENVIROLUTION CONSULTING (PTY) LTD

PROPOSED ESKOM LANDFILL SITE DEVELOPMENT, LEPHALALE, LIMPOPO PROVINCE GEOHYDROLOGICAL INPUT FOR THE SCOPING REPORT OF THE ENVIRONMENTAL IMPACT ASSESSMENT

Report No.: 2008/ 0113/ 01 **JANUARY 2009**

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1 INTRODUCTION

Blue Rock Consulting (Pty) Ltd was appointed to conduct an investigation for geohydrological input for Scoping and Environmental Impact Assessment, for the Proposed Eskom Landfill Site Development in Lephalale, Limpopo Province. The proposed facility will be designed to accommodate general as well as hazardous waste generated during the construction phases of Mepupi Power Station and the anticipated two Waterberg Power Stations and waste generated by the construction village in Maropong. The site will also accommodate and general and hazardous waste generated during the operational phases of Medupi Power Station, the two anticipated Waterberg Power Stations and the existing Matimba Power Station. The total anticipated volume of waste generated by the four power stations and the construction village during construction and their anticipated life span of 50 years is 1 200 000 m^3. It is estimated that 50% of this total volume will be general waste and 50% will be hazardous waste. The hazardous waste is anticipated to be low-grade hazardous waste (e.g. oils, oily rags, lubricants and other waste generated by mechanical and maintenance workshops).

As part of the Scoping Investigation, a total of five potential waste sites were investigated. Four of these are located on the farm Grootvallei 515 LQ to the southwest of Medupi Power Station and one is located on the farm Grootestryd 465 LQ situated to the west of Matimba Power Station (see attached locality map Appendix A).

The aim of the study is to identify one of the five sites with the highest potential for use as landfill sites for hazardous and general waste disposal and which is to be taken into the EIR. The work included the following:

- Attend general briefing session to meet all project team members and compile and finalise the project programme and milestones. Collaborate with team members to ensure that milestones are feasible and to prevent possible duplication of work.
- Desk Study of existing geological maps and information, existing hydrological and geohydrological maps and water quality information and existing topographical maps and information and aerial photo's of the area.
- Site visits to the five potential sites to meet landowners, determine access and to carry out a walk-over survey for hydrological and geohydrological mapping purposes of the proposed sites to confirm the geology surface run-off and shallow water table conditions at the site and to determine potential fatal flaws.
- Data analyses of information collected during the desk study and the site visits.

This report for the Scoping Investigation presents the evaluations of information gathered during walkover surveys carried out during site visits to the five sites carried out on 17 and 18 November 2008 and 17 December 2008, on data obtained from published regional geological investigations and maps and on geological and geohydrological investigations carried out for Matimba Power Station and its surrounding water, coal, general waste and ash storage facilities (Ref 1 and 2). A site considered geohydrologically most suitable for further studies for the EIR is recommended.

2 POTENTIAL WASTE SITES 1 TO 4 ON THE FARM GROOTVALLEI

The sites numbered 1 to 4 are all located on the Farm Grootvallei 515 LQ (Appendix A). They are Greenfield sites. No previous development has taken place here.

2.1 REGIONAL GEOLOGY

According to the 1: 250 000 scale geological map 2326 Ellisras, the farm Grootvallei is underlain by a sequence of yellowish to purple coloured sandstones and conglomeratic layers of the Waterberg Group that dip in a southerly to easterly direction at angles varying between 3^0 and 10^0. In general these rocks are hard, unweathered and tight and their potential as primary water bearing aquifers is low. The transported and residual soils covering these rocks tend to be sandy and thin (rarely more than 3m in thickness) and outcrops of sandstone occur frequently. Clayey and silty soils are relatively rare. Outcrops of Waterberg sandstones are however not very common at the four potential waste sites investigated on the farm of Grootvallei. There are small vertical and sub-vertical faults and zones of open joints with NE-SW and NW-SE trends that occur sporadically in the Waterberg rocks.

2.2 GEOHYDROLOGY

The joints and faults in the Waterberg Group rocks are pervious and contain ground water in places. As these joints are often isolated from one another, the amount of water contained in them tends to be limited in general. Although some boreholes may have a high yield due to the high transmissivity of the fracture zones, the amount of water that can be extracted from them is limited due to a relatively low storativity.

The ash dump for Matimba Power Station is located on Waterberg sandstones and conglomerates identical to those described for the Grootvallei sites. Geohydrological investigations carried out at the ash dump for Matimba Powerstation (Ref 1 and 2) indicate fairly low yielding aquifers and a regional groundwater flow to the south and east. The investigations also show that the ash material deposited there does pollute the groundwater, all be it in a fairly minor and localised way. Modelling exercises show the plume of polluted groundwater slowly moving in a southerly and easterly direction.

The four potential waste sites considered on the farm Grootvallei are located in areas where faults and joints in the rock are least prominent and the likelihood of encountering groundwater in these areas is low in comparison to areas where faults and fracture zones are more prominent and frequent. Any waste site located on any of the four alternative locations will have to be designed in a way that prevents polluted liquids or leachates from entering the insitu soil and rock profiles and therefore reaching the regional groundwater table. From a geohydrological point of view the risk of groundwater pollution occurring at any of the four potential sites on the Grootvallei farm is virtually identical and fairly low provided that contaminated liquids and leachates are prevented from entering the sandy soil and fractured rock profile (see table below).

Farm Name	Site Name	Site Scoring	Remarks
Grootvallei	Site 1 Greenfields Site	Low Risk Low yielding aquifers	Thin sandy permeable soil cover over bedrock. Measures to prevent ingress of liquid pollutants and leachates into sporadically fractured rock profile are required.
Grootvallei	Site 2 Greenfields Site	Low Risk Low yielding aquifers	Thin sandy permeable soil cover over bedrock. Measures to prevent ingress of liquid pollutants and leachates into sporadically fractured rock profile are required.
Grootvallei	Site 3 Greenfields Site	Low Risk Low yielding aquifers	Thin sandy permeable soil cover over bedrock. Measures to prevent ingress of liquid pollutants and leachates into sporadically fractured rock profile are required.
Grootvallei	Site 4 Greenfields Site	Low Risk Low yielding aquifers	Thin sandy permeable soil cover over bedrock. Measures to prevent ingress of liquid pollutants and leachates into sporadically fractured rock profile are required.

3 POTENTIAL WASTE SITE 5 ON THE FARM GROOTESTRYD

Site 5 to the west of Matimba Power Station on the farm Grootestryd 465 LQ is located to the north and adjacent to an old borrow area (Appendix A). A coal storage facility is located close by and to the east of this site. In the past the old borrow area has been used for disposal of general household waste, building rubble and limited amounts of fly ash have also been dumped here at some stage. The deposition of waste appears to have been carried out in a controlled manner. The entire area where waste dumping has been carried out is surrounded by a berm composed of sandy transported and residual soils from the surrounding area. At present the existing site is not used for purposes of waste disposal. Four groundwater-monitoring boreholes numbered P4, P5 and P26 and P28 have been drilled to the north, west and south of the site (Appendix B). These holes are sampled on a regular basis to determine the groundwater quality.

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 form the Swartrand and Grootegeluk Formations of the Karoo Supergroup and 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 Powerstation and it will also fuel the Medupi Powerstation in the future.

At Site 5 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 GEOHYDROLOGY

In undisturbed and unweathered form the sandstone and shale rocks are hard and tight and their potential as water bearing aquifers is low. Where affected by faulting and fracturing, they form secondary aquifers of limited storativity but potentially high transmissivity particularly in the sandstones. Monitoring boreholes drilled in the vicinity of the site tended to have low yields and were often dry. In those boreholes where it occurred, water was generally intersected at the base of the weathered sandstone zone at depths between 13m and 20m (ref 2).

According to the geohydrological studies carried out at the site, the groundwater flow appears to be to the south. This is confirmed by the water quality encountered in the boreholes. Borehole P5 to the north of the site existing waste site shows uncontaminated water. Signs of pollution have been encountered in Borehole P4 to the south west of the site and in Boreholes P26 and P28 (Appendix B). The pollution in Borehole P4 is most likely attributable to the liquids and leachates originating from material dumped at the existing waste site at Site 5. The pollution in boreholes P26 and P28 can originate from the existing waste site at Site 5 or from the coal storage area (ref. 2). Additional work is required to determine the most likely origin. A borehole just east of the existing waste site should be considered. Geophysical surveys (electrical resistivity surveys) should be carried out to determine the most suitable drilling location for such a borehole.

An assessment of the geohydrological investigations carried out for Matimba Power Station (ref 1 and ref 2) indicates that the geohydrological conditions at Site 5 are similar to the conditions at Sites 1 to 4 on the farm Grootvallei. The soils covering the bedrock are sandy and permeable. At Site 5 these soils are considerably thicker though. The aquifers contained in the underlying sandstone rocks are of a secondary nature and low yielding. The reliance on these aquifers for water sources is small at present, particularly in the vicinity of Site 5. Unless adequate linings and collector drains prevent ingress of leachate and contaminated liquids into the underlying soil and rock profiles, the groundwater will be polluted.

4 RECOMMENDATIONS

The geohydrological conditions at all five sites investigated are similar. Unless adequate design and operating procedures are implemented, the groundwater will be polluted if general household and hazardous waste is dumped at any of the 5 sites. Due to the fact that the four sites on the farm Grootvallei are Greenfield sites, it is recommended that further work rather be carried out at Site 5 on the farm Grootestryd.

The existing waste material dumped at Site 5 does appear to affect the groundwater quality in the area (ref. 1 and 2). Due to the low yields the groundwater aquifers in the area are not used at present and no one in the immediate vicinity is reliant on groundwater. In order to prevent aggravation of the present situation, it is recommended that no additional household or hazardous waste be dumped on the existing dumping area and that the berm, presently constructed around the site be maintained. If any dumping is carried out on the existing location this should be restricted to building rubble. The surface runoff from this site should be contained and where possible seepage of water into the existing waste should be minimised by reducing the surface area of the exposed waste.

The area to the north of the existing dump at Site 5 should be investigated further for deposition of general household waste and for classified hazardous waste. If general and low-grade hazardous waste is to be dumped here, it is strongly recommended that general household waste be deposited in cells separate from those for classified hazardous waste. Ideally the cells containing classified hazardous waste should be

kept separate from the cells containing general waste and managed and monitored separately. Due to the permeable nature of the soils and the underlying rock where it is fractured, it is recommended that the cells are lined and provided with leachate collection systems.

Past geohydrological studies of the existing waste dump at Site 5 have shown that liquids and leachates deposited there have polluted the groundwater. These studies have also shown that groundwater underlying the area to the north of the existing waste dump is unpolluted. Although the existing groundwater monitoring system indicates a regional groundwater flow in a southerly direction, there is uncertainty of any flow to the west and east and the effect of the coal storage site on the groundwater in the area to the south and east of the existing waste dump is not known. If it is intended to locate the new waste disposal site directly to the north of the existing site it is recommended to extend the groundwater monitoring system in a way that any possible pollution originating from the new site can be detected. Additional studies should also be carried out to ascertain the potential of pollution originating from the existing waste site and possibly the coal storage site on the groundwater at the new proposed site.

The additional geohydrological work for the EIR entails further detailed studies of the existing geological and geohydrological information available for Matimba Power Station and the surrounding areas.

It is recommended that geophysical surveys be carried out in the areas surrounding the proposed site to the north of the existing waste site and also in the areas surrounding the existing waste site to identify faults and fracture zones and hence potential aquifers in the bedrock.

Based on the geohydrological data available from the existing reports and from the geophysical survey, rotary percussion boreholes should be drilled at strategic locations where fracture zones and zones of deep weathering that may represent potential aquifers have been identified. The boreholes should be located at positions that are indicative groundwater flow at the proposed new site to the north of the existing waste site. Yield test to determine the aquifer properties and water quality tests should be carried out at each borehole that has struck water. The boreholes should be used to establish the extended groundwater monitoring system for the new waste site. If possible monitoring boreholes should be drilled to monitor water flow in the area envisaged for general and for hazardous waste on the new site.

Soil profiles exposed in test pits excavated for the geotechnical investigation at the site should be investigated to determine the composition geohydrological properties of the materials overlying the bedrock and the materials used for cover material. Where necessary permeability tests should be carried out on insitu materials and also materials collected for laboratory testing.

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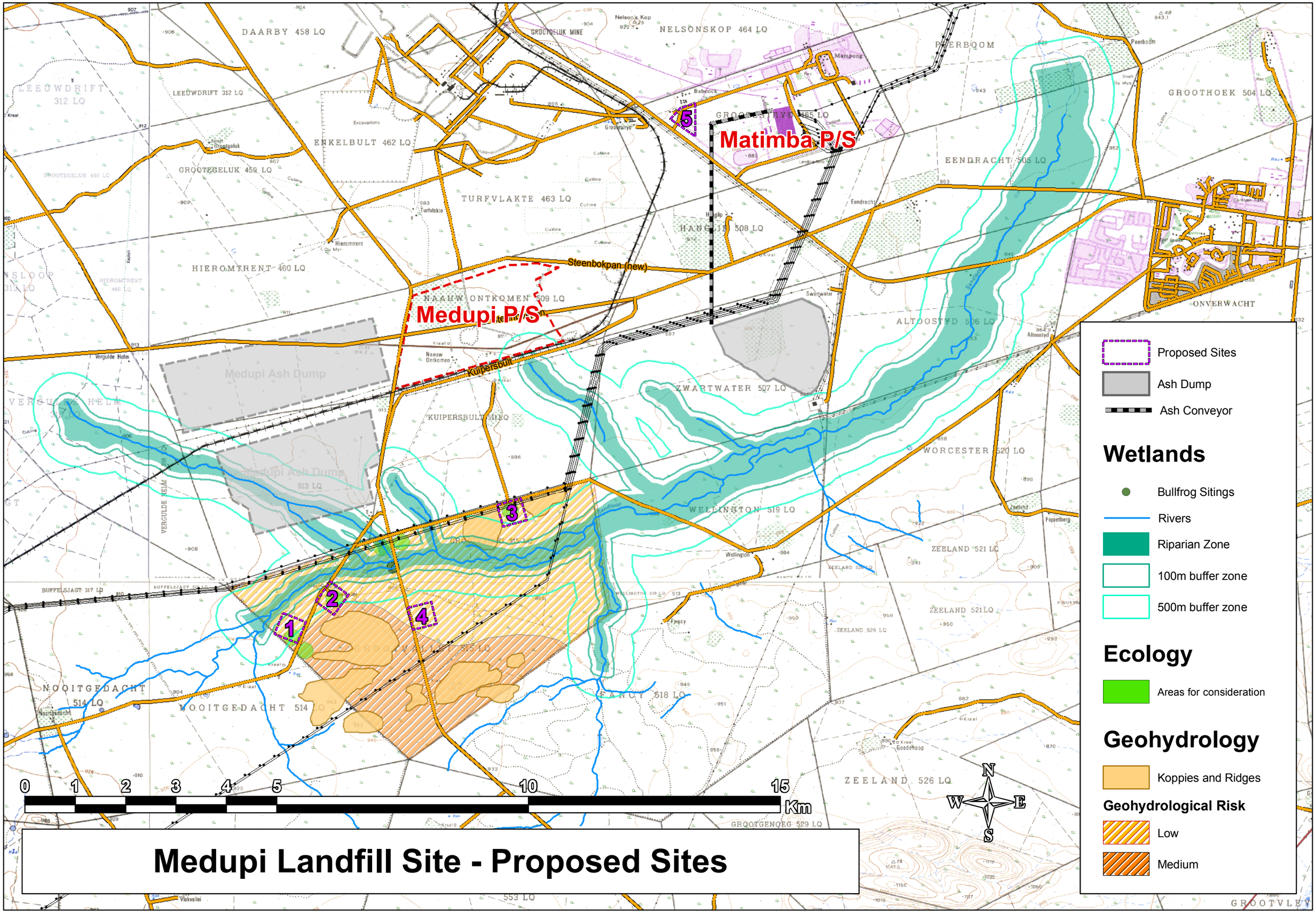
For BLUE ROCK CONSULTING (Pty) Ltd

5 REFERENCES

1. Groundwater Quality and Pollution Plume Modelling at Matimba Power Station: Riaan Grobbelaar, Lore-Mari Cruywagen, Elna de Necker and Frank Hodgson; October 2000.
2. Interpretation of the Groundwater Results, Matimba Power Station; Report No 2006/14/PDV by Danie Vermeulen; July 2006; Institute for Groundwater Studies, University of the Free State.

APPENDIX A

SITE LOCALITY MAP

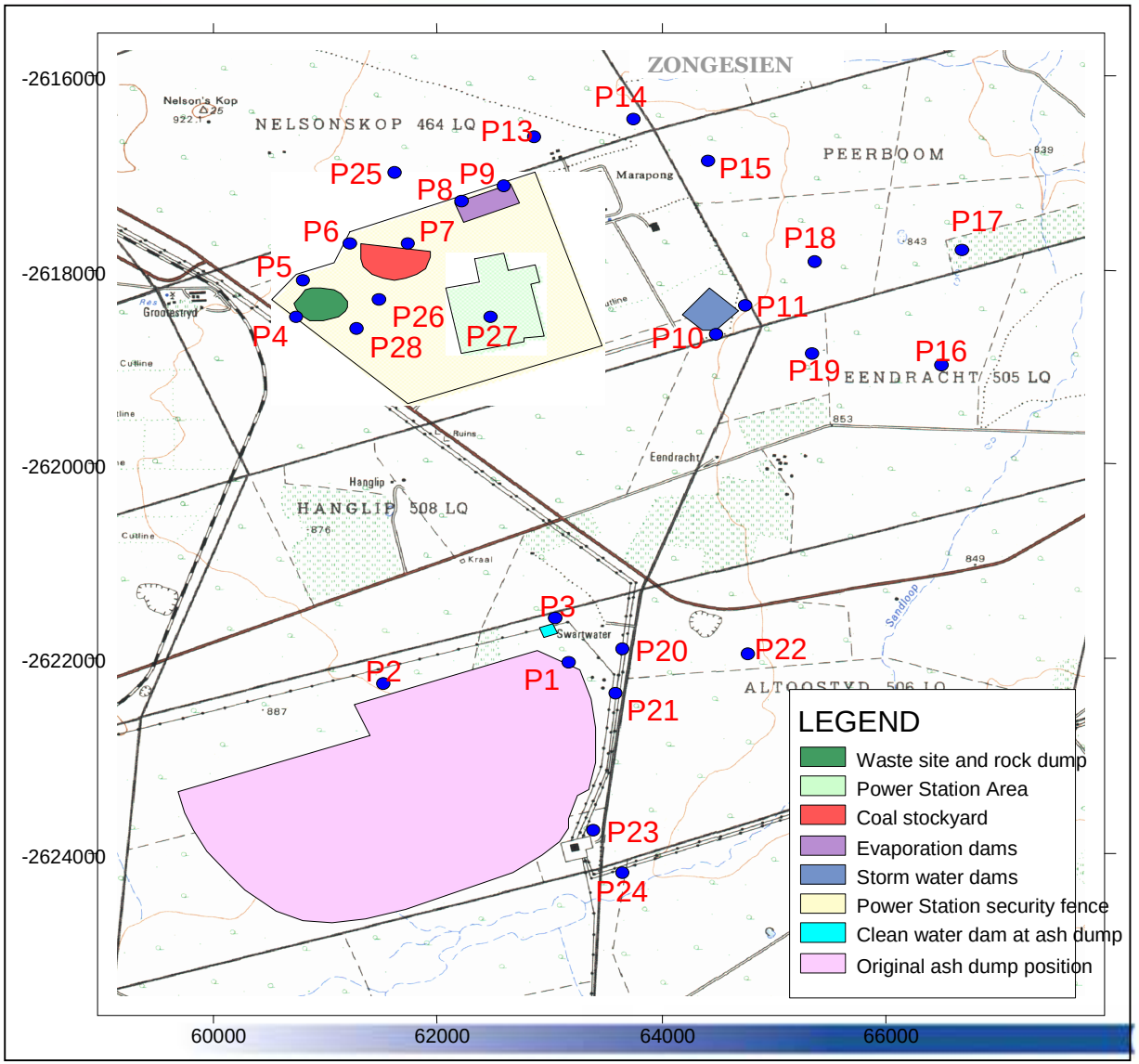


Medupi Landfill Site - Proposed Sites

APPENDIX B

MATIMBA MONITORING BOREHOLE LOCATION MAP

Map of Boreholes



ADDENDUM SCOPING REPORT

GEOHYDROLOGICAL INPUT FOR THE INVESTIGATION OF THE POTENTIAL LANDFILL SITES FOR GENERAL WASTE AND HAZARDOUS WASTE FOR SCOPING PURPOSES

The geohydrological conditions at all five sites investigated are similar. Unless adequate design and operating procedures are implemented, the groundwater will be polluted if general household and hazardous waste is dumped at any of the 5 sites. Due to the fact that the four sites on the farm Grootvallei are Greenfield sites, it is recommended that further work rather be carried out at Site 5 on the farm Grootestryd.

Previous investigations carried out at Site 5 indicate the aquifers have a low yield and no one is relying on water from them at present.

ANTICIPATED IMPACTS OF A GENERAL WASTE SITE AND A HAZARDOUS WASTE SITE AT SITE 5

The existing material dumped at Site 5 does appear to affect the groundwater quality in the area.

Based on the existing information studied to date, it is not certain if the pollution to the south of the dump originates from the existing waste dump only or if the coal stockyard located to the east is also contributing to the contamination of the groundwater.

The direction of groundwater flow is likely to be in a southerly direction. The information from the exiting four groundwater monitoring boreholes located near the Site 5 does not present an unambiguous picture regarding the groundwater flow direction however.

Pollution of the aquifers occurs to the south of the existing waste dump only.

The aquifers to the north of the existing site do not appear to be polluted.

Provided that precautionary measures are taken, the area to the north of the existing dump is potentially suitable for the proposed general and hazardous waste site.

Unless special precautionary design measures are taken liquids and leachates from the proposed facility will pollute the groundwater in the area to the north of the existing dump at Site 5. The quality of the runoff from the site will also have to be determined. If it is likely to be contaminated it will have to be contained to prevent ingress of this water into the aquifers.

The soils in the area of the proposed site are very sandy and therefore likely to be permeable. Detailed investigations are necessary to determine the properties of these soils and their suitability w.r.t. cover material.

ADDITIONAL GEOHYDROLOGICAL STUDIES TO BE CARRIED OUT IN THE EIA PHASE

The aim of the additional geohydrological work for this phase of the investigation will be

three fold:

1. Clarify the groundwater flow and the likely migration of a pollution plume around Site 5 and determine the groundwater conditions to the north of the existing dump site.
2. Establish a more comprehensive groundwater monitoring system around the entire Site 5.
3. Determine the hydrological properties of the soils that cover the bedrock in the northern sector of Site 5.

The work will involve the following:

- Investigate all geological and geohydrological information available for the area in detail.
- Carry out a geophysical survey (electrical resistivity and residual magnetic surveys) of the entire Site 5 to identify potential deep fracture zones and faults that will act as groundwater aquifers. Subcontractors will carry out the work.
- Carry out a rotary percussion-drilling programme to verify the presence of any aquifers. Subcontractors will carry out the fieldwork.
- To test the yield, storativity and transmissivity of these aquifers. Subcontractors will carry out the fieldwork.
- To determine the groundwater quality of these aquifers.
- To 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 will be carried out in conjunction with the geotechnical field investigation. Soil profiles exposed in test pits will be examined and insitu permeability tests will be carried out. Samples will be collected for laboratory testing.
- Data analyses of information collected during the field investigations.
- Discuss preliminary findings with other relevant team members during progress meetings.
- Present data on maps and compile a report on each of the three sites.
- Present data at meeting and finalise report.