PRELIMINARY CLOSURE REPORT AND END USE PLAN MATIMBA POWER STATION "ROCK DUMP" WASTE SITE

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Disclaimer

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GLOSSARY OF TERMS AND DEFINITIONS

Aftercare

- The steps necessary to bring the land to the required standard for the planned end-use.
- The period after closure before the acceptance of surrender during which maintenance and monitoring work is needed to ensure that the restored that the restored landfill does not cause pollution of the environment, harm to human health or adverse effects on local amenities.

Capping The covering of a landfill, usually with low permeability material. Permanent capping is part of the final restoration following completion of landfilling/tipping. Temporary capping is an intermediate cap, which may be removed on resumption of tipping.

Completion The point at which a landfill has stabilised physically, chemically and biologically to such a degree that the undisturbed contents of the site are not likely to pose a pollution risk in the landfill's environmental setting.

End Use The ultimate use for the land after the landfill permit has been surrendered.

Emission The direct or indirect release of substances, vibrations, heat or noise from the individual or diffuse sources in an instillation into the air, water or land.

Groundwater All water that is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.

Harm The damage to a receptor that results when a hazard is realised. Harm to the health of living organisms or other interference with the ecological systems of which they form a part and in the case of man, includes offence to any of his senses or harm to his property.

Hazard A property or situation that in particular circumstances could lead to harm.

Landfill gas All the gases generated from the landfilled waste.

Landfill site A waste disposal site for the deposit of the waste onto or into land.

Leachate Any liquid percolating through the deposited waste and emitted from or contained within a landfill.

Monitoring A continuous or regular periodic check to determine the ongoing nature of a potential hazard, conditions along environmental pathways and the environmental impacts of landfill operations to ensure the landfill is performing according to design. The general definition of monitoring includes measurements undertaken for compliance purposes and those undertaken to assess landfill performance.

Permeability A measure of the rate at which a fluid or gas will pass through a medium

1 INTRODUCTION AND BACKGROUND INFORMATION

1.1 Project Background

ESKOM intends to submit an application for a closure license for an old waste dumpsite, also known as the "Rock Dump" at Matimba Power Station. USK Consulting was appointed by Envirolution Consulting (Pty) Ltd to compile a closure report and end use plan for the Matimba Power Station “Rock Dump” waste disposal site. The Waste Site is located on the farm Grootestryd 465 LQ situated to the west of Matimba Power Station in Limpopo Province.

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. In a letter to the manager of Matimba Power Station, referenced 16/2/7/A400/B21/1 and dated 17/08/2005 (attached as Appendix 2), the Limpopo Regional Office of DWAF declined the issuing of a closure permit stating that the "Rock Dump" site 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. The requirements in terms of the act are attached as Appendix 3. 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.

As part of the process for closure of the "Rock Dump" Landfill site a geohydrological study was conducted by Blue Rock Consulting (Pty) Ltd. This study was published in a report dated October 2009. This study clarified the questions raise regarding the flow of groundwater and migration of a possible pollution plume at the site and in the surrounding areas. It presented more information regarding the nature of the aquifers at the site. It detailed to what extent the site is contributing to the pollution of the groundwater and what effect this will have on the surrounding areas. It determined the current status of the situation and made an assessment as to the geohydrological impact of the site and the closing of the site. Finally it made recommendations for remediation measures and mitigation of the impacts, taking into consideration the future use of the site, as well as specifying a monitoring system that records the effectiveness of the remedial measure (Schulze-Hulbe, A. 2009).

1.2 Context of Closure Plans

Closure plans are best developed before a landfill is put into service. The final use of the site should be kept in mind during the daily operation of the facility to minimize the final cost of site closure. Sites that have been adequately planned generally cost less for reclamation at closure of the site than facilities that have not been carefully thought

through and planned. The objective of the closure plans is to steer the use of the site during its life time toward and a desirable end use state that minimizes environmental risk, social risk, and financial or economic risk. The closure report aims to specify the implementation of requirements for closure of the landfill and would typically include details of rehabilitation measures. The report also seeks to specify details of management, inspection, monitoring and maintenance of the site after it is closed. The closure plan therefore must include:

- The final site topographic plan,
- Include a site drainage plan
- Prepare appropriate cross-sections of the closed site.
- Specify source of cover material, especially for any required clay cover that may be necessary.
- Laboratory testing of the cover material should be completed to determine the soil's permeability when properly compacted.
- Specify procedures for compaction testing of the "barrier layer" during its installation.
- Specify measures to minimize soil erosion and of the materials.
- The closure plan should also identify the vegetative cover and landscaping plan.

It is however important to bear in mind that this plan is a retrospective Closure Plan as Rock Dump site was never opened formally and not designed as a dumpsite or landfill.

1.3 Scope of Work and Methodology

This report, the Closure and End use Plan was prepared in accordance according to guidelines and requirements:

1. Minimum Requirements for Waste Disposal by Landfill (Second Edition, 1998); Table 12 in the Minimum Requirements for Waste Disposal by Landfill summarizes the requirements for the closure of a landfill site and is attached as Appendix 5. In terms of the Minimum requirements, at the minimum the closure report and end use plan must include the following:

    - Evaluation of the current status of the landfill.
    - Comparison of the current status with the closure design and end use requirements.
    - Make recommendations for measures to upgrade the existing condition of the landfill to that desired. This includes the recommendations for implementation of the Closure Design and includes details of rehabilitation measures.
    - Detail plans for management, monitoring, inspection and maintenance plans for the site once it has been closed.

2. Standard guidance and requirements for closure and rehabilitation of potentially contaminated lands; the process to be followed in order to manage the remediation of contaminated land is a five step process.

    - Indication of intention to embark on the process of remediation.
    - Determination of current status and setting of remediation objectives
    - Determination of remediation alternatives.
    - Impact assessment.
    - A summary report for the purpose of application for authorization

3. Specific requirements and steps heighted in the correspondence letters from the DWAF to ESKOM including letter referenced 16/2/7/A400/Z24/1 and dated 15/10/2003 (attached as Appendix 4) in which the intention to close the landfill site is noted and reference is made to the Minimum Requirements for Waste Disposal by Landfill (Second Edition 1998). It was also noted that that delisting of the fly ash should be considered. This will be considered as part of Section 3 below. The other requirements of this letter are addressed in terms of the Minimum Requirements for Waste Disposal by Landfill (Second Edition, 1998).

2 CURRENT STATUS OF THE ROCK DUMP SITE

2.1 Description of the Rock Dump

The following summarizes the current description and status of the site:

- The Rock Dump is located on the farm Grootestryd 465 LQ situated to the west of Matimba Power Station (see attached locality map Appendix 1). The entire site is surrounded by an up to 10m high earth berm wall.
- According to ESKOM only general waste, rubble, and fly ash from the power station was dumped at the site.
- All waste is located within the confines of the berm wall surrounding the site.
- The site is covered by layer of sandy soil and in places fly ash.
- 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 (Schulze-Hulbe, A. 2009).

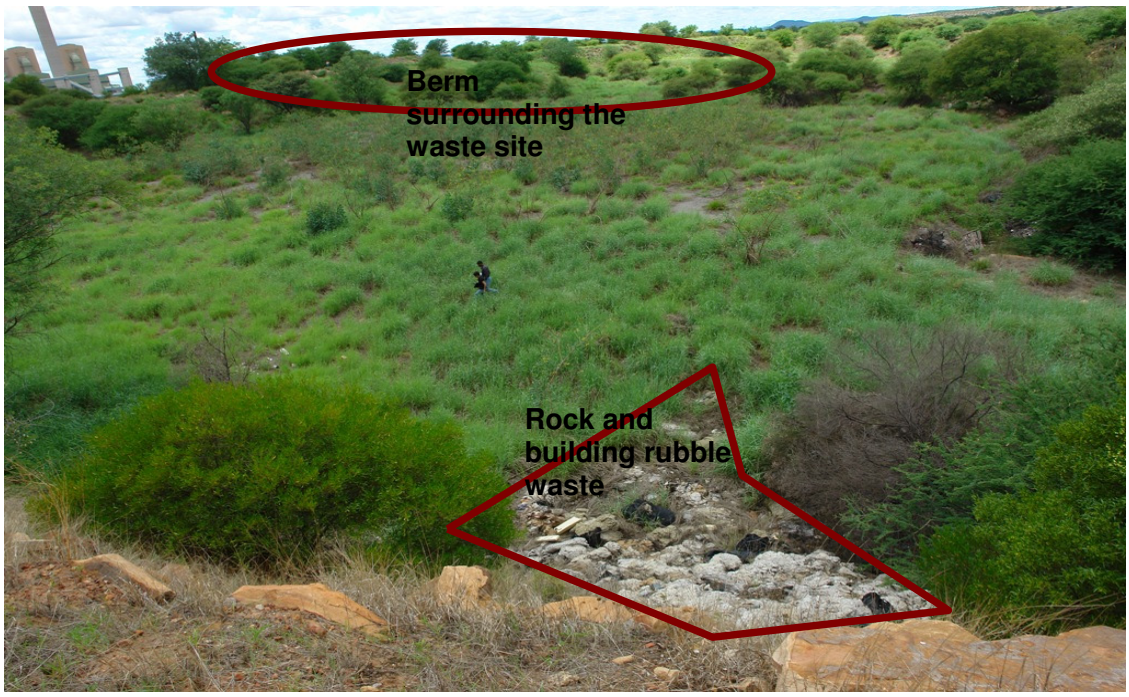

Figure 1 view of the Rock dump showing the main waste body and berm

1.4 Climate

Summer in the region extends from mid-October to mid-February and is characterized by hot, sunny weather often with afternoon thunderstorms. Winter occurs from May to July and is typified by dry, sunny, days and cold nights. The monthly distribution of

average daily maximum temperatures range from 22,3°C in June to 31,9°C in January. The region is the coldest during July when temperatures drop to a minimum of 3,7°C at night. Lephalale receives some 400 mm of rain per year, with most of it occurring in mid summer. It receives the lowest rainfall of 0 mm in June and the highest averaging 81 mm in January (Inroads Consulting, 2009).

1.5 Vegetation

The area in which the site is located has been extensively disturbed and as a result in many places covered by alien vegetation and weeds. Dense groves of mature acacia and other trees are, however, present over parts of the site (Inroads Consulting, 2009).

Figure 2: Vegetation cover on the Rock Dump

2.2 Classification of the Landfill

Although the site was never formally permitted or licensed and classified in terms of the current regime for classification of landfill in South African (Minimum Requirements, DWAF, 1998), in a letter referenced 16/2/7/A400/Z24/1 and dated 15/10/2003 (attached as Appendix 4) it is noted that the landfill site is classified as a Class II disposal site with the classification G:C:B-. However, in a letter to the manager of Matimba Power Station, referenced 16/2/7/A400/B21/1 and dated 1708/2005 (attached as Appendix 2), the Limpopo Regional Office of DWAF declined the issuing of a closure permit stating that

the "Rock Dump" site 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.

Further to the above due to the evidence of leaching and contamination in the ground water and the recommendations as per the geohydrological report, it is considered necessary to treat the landfill as a higher grade of landfill for the purposes of the Closure Design. The requirements for a G:S:B+ landfill (See Table 12 attached as Appendix 5) will be considered for the Closure Design in order to satisfy the recommendations made in the geohydrological report.

2.3 Requirements for End Use Plan the Rock Dump

According to the Minimum Requirements for Waste Disposal by Landfill (Second Edition 1998), the end use of a landfill is determined by the following:

- The permit application report
- The permit conditions
- The department (DWAF)
- Interested and affected parties

The Rock Dump was never opened properly designed or permitted as a landfill site in terms of the old permitting regime under the ECA, and hence there are no proposals for end use.

2.2 Closure Design

In terms of the current status of the Rock Dump, there is no existing landfill design or closure design.

2.3 Findings of the Geohydrological Report

As part of the process for closure of the "Rock Dump" waste site a geohydrological study was conducted by Blue Rock Consulting (Pty) Ltd. This study was published in a report dated October 2009. This study serves as the closure investigation, as per the Minimum Requirements for Waste Disposal by Landfill (Second Edition, 1998). The geohydrological report also addresses Stage 1 of the Generic Process for Remediation of Contaminated land Areas and Deteriorated Water Resources (Appendix 3).This study clarified the questions raise regarding the flow of groundwater and migration of a possible pollution plume at the site and in the surrounding areas. It presented more information regarding the nature of the aquifers at the site. It details to what extent the site is contributing to the pollution of the groundwater and what effect this will have on

the surrounding areas. It determined the current status of the situation and made an assessment as to the geohydrological impact of the site and the closing of the site. Finally it made recommendations for remediation measures and mitigation of the impacts, taking into consideration the future use of the site, as well as specifying a monitoring system that records the effectiveness of the remedial measure (Schulze-Hulbe, A. 2009).

Some of the conclusions from the report, that pertain to questions of the current status of the site and that are important to the Closure Design, are summarized as follows:

- Aquifers encountered in the "Rock Dump" waste site are classed as part of a Minor Aquifer System. 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.
- Chemical analyses of water samples collected from eight boreholes located around the "Rock Dump" waste site show signs of contamination. The contamination can originate naturally from the shales and mudrocks within which the aquifers are located. 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.
- The "Rock Dump" waste site is not the only source of pollution of groundwater Pollution in this area could originate from the natural in situ rock formations in the area or from other sources like the coal stockyard.
- Mitigation measures, preventing the leaching of pollutants from the landfill site are deemed necessary. The migration of polluted water in the shallow aquifer to the deep aquifer and into streams downstream of the site are believed to have an impact on water utilized by farmers further downstream and may affect the water quality of tributaries of the Mokolo River.
- The environmental impact of the Rock Dump can be reduced through proper closure of the Rock Dump site and the implementation of mitigation measures to reduce contamination leaching from the site.
- Recommendations are made in terms of future sampling and monitoring as well as mitigation measure to be employed to reduce the impact of the landfill.

(Schulze-Hulbe, A. 2009)

The above conclusions and recommendations are valid and must be adopted as part the Closure Design and ongoing inspections and maintenance of the Rock Dump Site

3 SPECIFICATIONS FOR END USE AND CLOSURE

3.1 Determination of End Use

There are many different options and alternatives for end use of landfills including agricultural use, ecological uses, recreational and amenity uses etc, and the choice of the desired end use is typically influenced by a number of factors including:

- Type of waste and associated operational constraints;
- Size, location and access;
- The development plan or framework;
- The aspirations of local residents, interest groups, etc.;
- Scheme economics;
- Long-term management requirements.

Given that;

- The Rock Dumpsite was never formally authorised in the first place and that there is no landfill design, closure design and no planned end use, and that the site is no longer operational, the following is recommended that the site is surveyed and a DTM Model is developed to determine the topographical aspects of the site;
- That the site is located within an industrial area i.e. within the property of Matimba Power Station, that site cannot be used for public amenities;
- Due to the fact that initial studies near the site, have indicated potential pollution risk that may arise from the site, it recommended that the site remains non operational and not accessible to public;

The recommended end use for at least in the medium term (5 years) year should be '**No Use**' Option and must be properly rehabilitated is to leave the site to stabilise and allow the vegetation cover to properly go through the ecological succession phases.

A site closure design must be developed and this must take into consideration information from the survey turkey survey, DTM Model, environmental risk assessment, geohydrological investigation and the end use recommendation.

3.2 Determination of Closure Requirements and Pollution Risk Assessment

As part of the process for closure of the "Rock Dump" waste site a geohydrological study was conducted by Blue Rock Consulting (Pty) Ltd. This study was published in a report dated October 2009. This study serves as the closure investigation, as per the Minimum Requirements for Waste Disposal by Landfill (Second Edition, 1998). See section 2.3 above. The geohydrological report also addresses Stage 1 and Stage 3 of the Generic Process for Remediation of Contaminated land Areas and Deteriorated Water

Resources (Appendix 3). As well as the letter referenced 16/2/7/A400/Z24/1 and dated 15/10/2003 (attached as Appendix 4).

The report established the reason, extent and type of contamination. It was concluded in this report that the landfill currently is having an impact on the environment, and that remediation measures are necessary. A measure for remediation was proposed and it was concluded that should the site be properly closed and the measures effectively employed, that the impact on the environment will be significantly reduced. The mitigation measures will be incorporated in the Closure Design under section 3.3.3 below. Table 1 below has been taken from the geohydrological report and summarises the environmental impact associated with the site.

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 1 Rock Dump Impact Assessment (Shulze-Hulbe, A 2009)

The geohydrological report also considered requirements for ongoing monitoring and management of the site. These requirements are addressed in the section 3.4.1 and 3.4.2 below.

3.3 Closure Design and Proposals for Rehabilitation

The Closure design and proposals for rehabilitation made under this section of the Closure Report address the requirements as per the Minimum Requirements for Waste Disposal by Landfill (Second Edition, 1998). It also addresses Stages 2, 3 and 4 of the Generic Process for Remediation of Contaminated land Areas and Deteriorated Water Resources (Appendix 3). As well as the letter referenced 16/2/7/A400/Z24/1 and dated 15/10/2003 (attached as Appendix 4).

The following recommendations are taken from the geohydrological report. They have been recommended in order to prevent or reduce the impact of the "Rock Dump" waste site on the geohydrology:

- 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.
- 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.
- The results of the monitoring programme should be submitted to the Department of Water Affairs before they are included in the annual audit report.

3.3.1 Dealing with the Fly Ash Waste and other potentially hazardous wastes

- Although one of the conditions specified by DWAF in their correspondence called for the delisting of the fly ash, it is important to understand that principles are important for purposes of determining the pollution and ecological risk, but it is not necessary to go through the delisting procedure and application for delisting of the fly ash.

- As part of the proper closure of the site, it is recommended that the ecological risk of the fly ash is determined, and the following steps are taken:

    - Sampling of the soils and fly ash from the site;

    - Samples must analyzed an accredited laboratory for Full suit of metals, Volatile Organic Compounds (VOCs), and Semi Volatile Organic Compounds (SVOCs);

    - The samples will be subject to a Toxicity Characteristic Leaching Procedure (TCLP), and the resultant leachate must be again analyzed.

    - A specialist environmental toxicologist must prepare a report which indicates the Estimated Environmental Concentration (EEC) and the Acceptable Risk Level (ARL) as per the delisting process specified in the Minimum Requirements for Handling, Classification and Disposal of Hazardous Waste (Second Edition, 1998).

    - The Ecological Risk of the site must be determined and recommendations out of this report shall then form part of this closure plan and implemented accordingly.

3.3.2 Alternatives for Remediation

- Because at this stage the Ecological Risk of the site is not fully known it is not possible to provide alternative measures for remediation of the site.
- Further to this although the geohydrological report provides enough insight into the potential pathways to the ecological risk, it does not address the issue of alternatives alternative remediation measures were not considered. As an example of an alternative is excavation of the site and removal of the waste to a permitted landfill, but this is not always the most practical and feasible alternative, however this could be considered if the ecological risk assessment indicates that the risk level is significantly high.
- Other measures and alternatives may include excavating part of the fly ash and disposing it at properly lined site.
- Other contaminated site remediation technologies may be investigated and employed one the Risk as been properly assessed and determined.

3.3.3 Requirements for Closure Design

1. The landfill design process should start by identifying the potential hazards that the landfill poses to the environment. Once this screening has been carried out, an appropriate risk assessment should be completed to allow identification of the mitigation measures (essential and technical precautions) that need to be adopted to ensure satisfactory environmental protection.
2. The final closure design shall be primary informed by the risk assessment process of the dumpsite must:
   - Ensure that the identified pollution Risk is mitigated and managed. Pollution control is the primary function of the closure design;
   - Reduce the infiltration of precipitation into the landfill to control leachate generation;
   - Minimise fugitive emissions of landfill gas through the surface of the cap;
   - Separate the waste in the landfill from its surrounding environment.

The following steps and measures need to be implemented in terms of the Closure Design and rehabilitation of the Rock Dump:

1. <u>Surveying</u>
   - The site must be surveyed by a professional land surveyor,
   - An attempt to quantify the amount of waste within the dumpsite should be made via survey methods and DTM modelling.
2. <u>Design</u>

- Once site survey diagrams, cross-sections and layouts have been generated and other site risk assessment have been completed, the design engineer shall develop a final closure design which must be submitted to the department;

3. Final Elevation
   - The final elevation of the site shall be determined following the survey, but it must not exceed the background topographical features.
4. Slope and Grading
   - The plateau of the site must be graded to 2 - 3% slope and the sides to a minimum of 3:1 slopes; however the final shape must be approved by the regulating authority.
5. Final Cover and Capping
   - The final covering and capping of the site must undertaken based on recommendations from the risk assessment and design.
   - Before final capping, the waste must be compacted and shaped in such a way as to promote run-off and to prevent any ponding of water on the landfill site.
   - Filling and landscaping may be necessary to achieve this. This is very important in order to prevent any pooled water from seeping through the capping layer and in to waste below.
   - The final shaping of the landfill should comprise a gentle slope and must incorporate the existing berm. The final sloping of the landfill should not exceed 1 in 2.5. This does not include the outside slope of the existing berm, or any part of the inside slope that remains vegetated. Care must be taken not to disturb the vegetation on the berm so that erosion is minimized.
   - The berm should not be continuous around landfill such that damming of water can occur. Storm water should be allowed to drain away from the landfill, without coming into contact with the waste.
   - The capping needs to be impervious to water in order to keep the waste in the landfill as dry as possible and to prevent any further contamination leaching into the ground water. It should also be continuous with the existing berm.
6. Vegetation cover
   - Once the final layer of top soil has been placed on the cap, the site must be seeded with a mixture of indigenous grasses, and allowed to propagate to form a health grass community on the site.
   - The grassing and vegetation must commence immediately after final capping in order to prevent soil erosion.
7. Leachate Management
   - Due to the location of the site and the nature of waste that was deposited into the site it is not anticipated that the site will generate significant amounts of leachate post closure.
   - If the landfill site can be shaped and capped in such a way as to prevent any pooling or damming of storm water over the landfill, it will not be necessary to construct a lined pond for collection of the run-off or leachate. If properly

constructed the shaping and capping of the landfill should prevent water from coming into contact with the waste.

8. Site Access
    - It is recommended that the site be fenced off and isolated and that no further development or dumping of additional waste of any kind be carried out.
    - Signage in at least 3 applicable languages in the region, must be placed at the fences and entrance of the site indicating that the site is out of bounds for public, closed and that no disposal or dumping is allowed on this site.

3.4 Environmental Management Plan

It recommended that standard ESKOM Environmental Management Plan specification for construction projects be included as part of this plan to provide a framework for general environmental management and good housie keeping during the construction works for closure of the rock dumpsite.

3.4 Post Closure Monitoring, Inspections and Maintenance

Recommendations made in the geohydrological report in terms of ongoing monitoring, inspection and maintenance are here incorporated. The specifications made under this section address the requirements as per the Minimum Requirements for Waste Disposal by Landfill (Second Edition, 1998); as well as the requirements of the Generic Process for Remediation of Contaminated land Areas and Deteriorated Water Resources (Appendix 3). As well as the letter referenced 16/2/7/A400/Z24/1 and dated 15/10/2003 (attached as Appendix 4).

3.4.1 Ongoing Monitoring

The following specifications are made in terms of the ongoing water monitoring:

- The 8 boreholes sampled may be adequate to monitor the impact on the groundwater of the "Rock Dump" waste site and the coal stockyard in future, however it may be advisable to sink an additional borehole with 1 or 2 peizometers may be within the waste body itself. This can then be used to complement the existing monitoring network.
- Future water table measurements and sampling should be analyses by the same accredited laboratory to avoid variations in results attributable to analytical techniques which can mask variations over time.
- Static water tables and the water chemistry of all boreholes must be monitored at three monthly intervals. Once stable trends have been established, the interval can be extended to a longer period in consultation with the Department.
- The same elements as those analyzed for in the Geohydrological study should be analyzed for in future. These include all the determinants analyzed for in the

Certificate of analysis attached as Appendix 7. Table 4 from the geohydrological report showing the results of the chemical analysis is attached as Appendix 6.

- Additional parameters may be added once a full suite of Metals, VOCs, and SVOCs, has been analysed during the TCLP and risk assessment study has been done.
- Changes can 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.
- The results of the monitoring program should be submitted to the Department of Water Affairs before they are included in the annual audit report.

3.4.2 Site Inspections, maintenance and management

The following specifications are important in order to meet the requirements ongoing site inspections, maintenance and management.

- The site should be fenced and isolated so that no further development or dumping of additional waste of any kind can be carried out.
- The security of the site should be maintained at all times to prevent illegal access and dumping.
- The site must be inspected at 3 monthly intervals. Once the stability of the site has been established, the inspection interval can be extended in consultation with the Department.
- Inspection of the cover integrity must include the following: the presence of any depressions, evidence of ponding, evidence of erosion.
- Any breach in cover integrity needs to be reported, the cause identified and the situation restored by infilling.
- Any issues of subsidence must be filled.
- Evidence of ponding or poor drainage must be corrected.
- Fires need to be identified, exposed and covered with soil.
- The vegetation that has been established on the landfill needs to be maintained in order to prevent erosion.

4 CONCLUSION

The closure of the Matimba Power Station "Rock Dump" waste site is subject to the following requirements:

- The recommended end use is the 'NO USE' option once the site has been fully remediated or rehabilitated.
- Further site investigations must be undertaken and these must then become part and parcel of the closure plan and end use plan. Such investigations include:
- Ecological Risk Assessment of the site particularly in light of the fly ash and any other potentially hazardous waste that may have been dumped off at the site. This must be done by an Environmental Toxicologist and Pollution expert and analysis and TCLP must be done by a competent and accredited laboratory. This process must be similar to the procedure for delisting of hazardous waste as per Minimum Requirements for Handling, Classification and Disposal of Hazardous Waste (Second Edition, 1998).
- The site must be surveyed and cross-sections and layouts must be developed and submitted to aid the design of the site.
- The final shaping and capping of the landfill should be carried out as per the Closure Design.
- Ongoing monitoring of the groundwater should continue according to the requirements and recommendations stipulated in this report.
- The site should be fenced off to prevent unauthorized access and further dumping.
- The site should be subject to ongoing inspection and maintenance as stipulated in this report.

5 REFERENCES

- Bolton, Neal; Handbook of landfill operations a practical guide for landfill engineers, owners and operators.

- DWAF, Minimum Requirements for Waste Disposal by landfill (Second Edition, 1998).

- DWAF, Minimum Requirements for Handling, Classification and Disposal of Hazardous Waste (Second Edition, 1998).

- Schulze-Hulbe, A., Closure of Existing Waste Site at Matimba Power Station: General as well as Specific Geohydrological Requirements for Application for Authorisation, 2009.

- U.S. EPA, November 1993, Technical Manual for Solid Waste Disposal Criteria - 40 CFR Part 258, Subpart F (Chapter 6).

APPENDIX 1:
Locality of "Rock Dump" Landfill site, west of Matimba Power Station

APPENDIX 2:
Letter from DWAF Ref 16/2/7/A400/B21/1 Date 17/08/2005

17.AUG.2005 15:28 NO.865 P.2

DW 6/1

att: Mandla
(012) 802 1004

DEPARTMENT: WATER AFFAIRS AND FORESTRY

REGIONAL OFFICE: LIMPOPO
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Azmo Place, 49 Joubert st, Polokwane

Ledwaba RM
16/2/7/A400/B21/1

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0829034588

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The Manager
Matimba Power Station
Private Bag X 215
Lephalale
0555

ATTENTION: Pholoto P

The meeting between Department of Water Affairs and Forestry (DWAF) officials and the Matimba Power station on the 28 July 2005 is hereby referred to:

The Department of Water Affairs And Forestry will not issue a closure permit to Matimba Power station based on the fact that fly ash was used as a compacting material and therefore the site cannot be classified as waste disposal site under section 20 of Environment Conservation Act. The site will be administered under section 19 of the National Water Act and guidelines on how the site should be rehabilitated are attached.

The Department has reviewed the documents supplied and still commenting on the reports by F Hodgson (1995) *Groundwater risk assessment and compliance monitoring at Matimba Power Station* and the report by Grobbelaar R., Cruywagen L.M, de Necker E. and Hodgson F (2000) *Groundwater quality and pollution plume modeling at Matimba Power Station*. This would assist to understand the situation at the waste site better especially in terms of the groundwater flow direction and location and migration of the alleged pollution plume.

The Department, however, did go through the reports (*Site characteristics in the vicinity of an unregistered waste disposal facility, Matimba Power Station* by Geo Hydro Technologies (2001) and preliminary investigations and risk assessment report to end-use the rock waste dump at Matimba Power Station as well as final scoping reports on the closure of the waste site by Enviroxcellence Services (2003). The following issues require clarification:

- EXS states there are two monitoring boreholes down gradient of the waste site i.e. P4 and P5. What does down gradient means in this case? - Is it in terms of the topography or groundwater flow direction? The Department questions this statement for the simple reason that P5 is about 1.5 meters higher above sea level than P4 but more important the groundwater level in P5 is 7.3m and in P4 11.7m, which means there is a 4.4m head difference between P5 and P4. Groundwater should therefore be flowing from P5 to P4 and not the other way round.
- If the above assumption regarding the flow direction is correct, the significance thereof is that the two boreholes are totally insufficient to derive conclusive evidence of impacts or the contrary from the waste site. At least two boreholes south and east of the dump would be required to obtain clarity and more conclusive evidence of possible impacts or not. If the natural groundwater flow direction is not disturbed P5 should in fact represent background values. There is thus no monitoring taking place down gradient of the dump, which is obviously a great concern.
- A comment on the drilling log of P5 states, "Borehole P5 was drilled to the west of the rock dump to enable monitoring of groundwater quality between the power station site and the Grootgeluk mine". This confirms that the groundwater flow is towards the dumpsite otherwise the purpose of drilling P5 here would not have been served.
- In light of the above it is concluded that the comment in the EXS report that the significant decline in concentrations of the chemical parameters implies less pollution to P4 and P5 is questionable. The results from P4 suggest that it is polluted but the extend and migration thereof are not monitored at all.
- The EXS report shows two tables reflecting a summary of the water quality results in P4 and 5. Each borehole show three samples adding up to an average for 2003 – is it three samples taken at the same depth in each borehole on the same day or different dates or is it three samples taken at different depths in each borehole?
- What is meant with the statement: "The electrical conductivity is 144 mS/m, meaning that there's a possible flow of sediments into the carbonaceous shale"?
- The Polokwane municipal laboratory used to analyse the samples from P4 and P5 is not an accredited lab. The Department had experienced problems with results obtained from this lab in the past and thus view the 2003 chemical results in the EXS report with a bit of doubt.
- In contrast with the EXS report the 2001 GHT report concluded that available evidence suggests that groundwater has been polluted in the vicinity of the dumpsite and it also highlighted the lack of monitoring boreholes. Why was this report not provided to EXS as it is not listed as a reference?
- GHT also identified the rock dump hosting the waste site and the fly ash present in the pit also to be contributing to the pollution on the site. Fly ash is regarded under the NWA of 1998 as waste, which would require a different procedure to close the site than that for a general waste site.

Should any concerns arise, please do not hesitate to contact this Department.

Yours faithfully

2005 -08- 17

MANAGER: NORTHERN CLUSTER DATE

APPENDIX 3:

Requirements as per Section 19 of the National Water Act.

17.AUG.2005 15:29 NO.865 P.5

Generic Remediation Process — Department of Water Affairs and Forestry

GENERIC PROCESS FOR THE REMEDIATION[1] OF CONTAMINATED LAND AREAS & DETERIORATED WATER RESOURCES

The involvement of the Department of Water Affairs and Forestry (DWAF) in remediation of contaminated land or deteriorated water resources originates from its mandate as custodian of South Africa's "*water resources*"[2], as defined in the National Water Act, no 36 of 1998 (NWA), and the definition of "pollution"[3] in the context of the provisions of ss19 & 20 of the NWA.

In accordance with this mandate, as well as in relation to the provisions of ss19 & 20 of the NWA, and ss28 & 30 of the National Environmental Management Act (NEMA), no 107 of 1998, DWAF has established a process to be followed by those embarking on an exercise aimed at the remediation of contaminated land areas and/or deteriorated water resources. This process is based on international trends[4], is aimed at achieving the holistic and sustainable long-term remediation of a situation, and makes use of a risk-analysis approach. The process is the same, irrespective the applicable legal control, e.g. a formal letter in terms of section 19(1) or 20(1) of the NWA, a License in terms of section 21 of the NWA, or a Permit in terms of section 20(1) of the ECA. The aim of this process is to conduct an investigation in accordance with these legal requirements in order to determine reasonable measures for the remediation of contaminated land areas and deteriorated water resources, and the process consists of five basic stages, following each other in series, namely:

- ⇒ **Stage 0:** Indication of intention to embark on this process towards determining and implementing options for remediation, containing an **indication of approximate timeframes** for the execution of each stage.
- ⇒ **Stage 1:** The determination of the **current status** of the situation (infrastructure and impacts), and the setting of **remediation objectives**, which are in accordance with the confirmed future use of the area;
- ⇒ **Stage 2:** The determination and evaluation of **remediation alternatives** insofar as agreed upon remediation objectives will be **met,** and the future use could be facilitated by the predicted implementation there-of, and an indication of the preferred option for implementation in the short-, medium- and long-term based on this comparison;
- ⇒ **Stage 3:** The determination of any **legal issues** that may be associated with the implementation of the preferred option, as well as the assessment of residual impacts, and compliance with associated legislation; and
- ⇒ **Stage 4:** The **application for authorisation** in terms of the NWA **or** the Environment Conservation Act (ECA), no 73 of 1989, to govern the implementation, maintenance and monitoring of the approved remedial action, and the **implementation** there-of in terms of the authorisation conditions, once it had been issued.

[1] **The concepts of Remediation, Restoration, Rehabilitation and Stabilisation** (Rutherfurd, Jerie and Marsh, 2000): **Restoration** is the term used to describe the improvement of a contaminated land area or degraded river ecosystem to its original status or use, where all aspects have been returned to the pre-disturbance level of structure and functioning. **Remediation** is a term used to describe the improvement of contaminated land areas or degraded river ecosystems to a situation where a new viable sequential land use or acceptable river ecosystem have been established. **Rehabilitation** describes the intervening actions which aims to improve the land area or river with the intention of either reinstating the original ecosystem processes or structures (restore), or facilitating the use of the contaminated land area or river ecosystem to a agreed upon new system (remediate). **Stabilisation** means the halt, or at least reduction in the rate of degradation through a specific rehabilitation activity. For discussion purposes, and due to the fact that river ecosystems or land-uses can seldom be restored to their original status, the term "**remediation**" will be used in this discussion.

[2] The NWA defines "**water resource**" to include "*a watercourse, surface water, estuary or aquifer*"; "**watercourse**" means "*(a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, lake or dam into which, or from which water flows; and (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse*". "**Aquifer**" means "*a geological formation which has structures or textures that hold water or permit appreciable water movement through them*".

[3] "**Pollution**" is defined in the NWA as: "*the direct or indirect alteration of the physical, chemical or biological properties of the water resource so as to make it– **(a) less fit** for any **beneficial purpose for which it is or may reasonably be expected to be used**; or **(b) harmful** or potentially harmful – (aa) to the **welfare, health or safety** of **human beings; (bb)** to any aquatic or non-aquatic **organisms; (cc) to the resource quality;** or (dd) to **property.**"*

[4] Asante-Duah, D.K., 1998: Management of Contaminated Site Problems. Lewis Publishers

The process to be followed for the management of an initiative aimed at the remediation of contaminated land areas and/or deteriorated water resources therefore entails five phases, the execution of which is aimed at obtaining a legal authorisation for conducting the remediation activity. The initial stage (stage 0) merely indicates intention and timeframes for the execution of the process. The details of each investigative stage of the process (stages 1 to 4) are as follows:

1. **Stage 1: Investigation of Site Status and Determination of Remediation Objectives**
   This stage would entail a complete **characterisation** of the contaminated land or water resource, and the development and refining of **remediation objectives** appropriate for the site contamination problems. It would therefore firstly entail conducting investigations and the preparation of a report that summarises the **current status** of the contaminated land or deteriorated resource in terms of the following:
   - Infrastructure;
   - reasons for the contamination;
   - volume, extent and type of contamination (including all possible constituents based on a full inorganic and organic analysis of contaminated soils and water, as well as of the original source of contamination); and
   - any existing and predicted future impacts of the situation or activity on all affected environmental components including:
     - ⇨ surface water (including stormwater);
     - ⇨ groundwater (which must be based on a geohydrological investigation, and a 3 dimensional numerical model indicating the extent of the pollution plume with regard to both organic and inorganic contaminants must be used for predictions);
     - ⇨ air quality; and
     - ⇨ any other environmental aspects, e.g. soils, etc.;
   - other relevant on- and off-site issues such as stability & freatic levels; or impacts on aspects such as ecosystems, flora and fauna, etc;
   - emergency actions that had been taken to prevent immediate risk to human safety and health; and
   - actions that had been taken to prevent a recurrence of similar incidents of contamination.

   Once these investigations are completed, non-value based **remediation objectives** must be formulated in consultation with interested and affected parties for each affected environmental aspect or other component that the situation or activity adversely impacts upon, which would ensure that these impacts would be managed and mitigated in accordance with the current and potential future use of the land or resource. These objectives would also correspond with specific resource quality objectives determined in accordance with the specific catchment management strategy.

   ⇒ Once the report is compiled, the party responsible for the remediation must submit the information generated during this stage to DWAF for evaluation. In the event that DWAF is satisfied that the stated remediation objectives will adequately ensure management and mitigation of the determined impacts on the environment to facilitate such current and potential future use of the land or resource, these **objectives are confirmed** in writing. (It could be advantageous to firstly discuss the report and remediation objectives with DWAF, and other authorities such as the Provincial Dept of Environment Affairs, before obtaining confirmation there-of by the affected community.)

2. **Stage 2: Alternative Options to ensure Future use and Objectives are achieved after Remediation**
   The second stage entails the following:
   - identification of technologies that can achieve the remediation objectives;
   - development and screening of alternatives for remediation, selection of those that are superior based on environmental, engineering and economic criteria (Best Practical

Environmental Option – BPEO), and that concurrently meet regulatory and community expectations;

- performing detailed analysis (including risk assessments) of remedial alternatives by scrutinising each alternative against remedial objectives;
- choosing, with proper motivation and justification, the preferred remediation alternative, and indicate a back-up option; and
- developing an action plan for the short-, medium and long term implementation of the preferred option.

Since the current status and existing impacts have been determined, and objectives to address these have been agreed upon between all parties (DWAF, the party responsible for the remediation and the affected parties) during the 1st stage, the party responsible for the remediation now **investigates alternative options** to reach these objectives during this 2nd stage. Such investigation into alternatives should address all available options, and may involve a literature review and/or a comparative risk assessment. Since different options could be available, each with different timeframes and cost implications, a **preferred remediation option** must be justified. Adequate motivation must be provided that the preferred option will indeed achieve the agreed upon remediation objectives and **facilitate the future use** following its implementation, with reasons why it should be considered as the BPEO. Differences between options for the short-, medium and long term must be highlighted. The short term would typically include investigations followed by engineering intervention, maintenance and monitoring would constitute the medium term, with continued monitoring in the long term until a predicted steady state (as agreed upon and corresponding with remediation objectives) has been achieved. Back-up options for engineering interventions (belts and braces) must also be indicated and included in the action plan for possible implementation in the event that monitoring results indicate the need for further intervention.

⇒ The party responsible for the remediation submits a report to the Department regarding the outcome of the investigation into alternative options, motivating the preferred option as the BPEO, and indicating the timeframes for its implementation, and conceptual designs if applicable. In the event that the Department is satisfied that the implementation of the preferred option will achieve the agreed upon objectives, the **option is accepted** in writing by the Department as the BPEO, and the party responsible for the remediation is informed regarding which legal requirements under NEMA, the NWA and/or ECA needs to be fulfilled as part of the implementation of this option.

3. **Stage 3: Legal and Impact Assessment**
Since the implementation of a specific option has been agreed upon, the **legalities and impacts** associated with the implementation of this option, and the identification of any residual impacts following such implementation, as well as long term legal liabilities and responsibilities, such as change in land use and/or ownership, responsibilities for maintenance and monitoring, etc are now investigated by the party responsible for the implementation of remedial measures. This may involve ensuring compliance with the EIA Regulations, but since the implementation of remedial work should result in a net positive effect, compliance with these Regulations is often not an extensive exercise.

⇒ The outcome of this assessment (and proof of compliance with the EIA Regulations if applicable) is submitted to DWAF. DWAF will then **confirm** whether the remediation will be authorised under the NWA (a letter in terms of s19(1) or s20(1), or a water use licence in terms of s21), or the Environment Conservation Act (an ECA s20 permit) as part of the next and final stage.

4. **Stage 4: Summarised Application for appropriate authorisation**
During this stage, and if applicable, the party responsible for the implementation of remedial measures submits the appropriate application forms for authorisation (where applicable) and a

summary authorisation application report, which should contain the information required by the relevant component of DWAF or another Department. Information required could include the following:

- Summary of the outcome of the site investigation, including geohydrological conclusions, stating approved remediation objectives;
- Public Participation details relating to the confirmation of rehabilitation objectives;
- Implementation Plan of accepted preferred option, including timeframes;
- Environmental Impact Assessment of such implementation;
- Detail Design plans of accepted remedial option;
- Operational Plans;
- Maintenance Plans;
- Water Management and Monitoring Plans;
- Final Rehabilitation Plans; etc

⇒ Upon receipt of this information, the appropriate authorisation (permit/license/s19/20-letter) is drafted, and issued to the party responsible for the implementation of remedial measures by the appropriate component in DWAF. Once issued, the remedial measures can be implemented according to the authorisation conditions, which leads to appropriate and cost effective remediation of the situation in accordance with the future use and remediation objectives.

APPENDIX: 4

Letter from DWAF referenced 16/2/7/A400/Z24/1 and dated 15/10/2003

FROM : ENVIROXCELLENCE SERVICES PHONE NO. : 0152956924 OCT. 16 2003 10:17PM

DW 6/1

DEPARTMENT: WATER AFFAIRS AND FORESTRY

REGIONAL OFFICE: LIMPOPO
P/Bag x 9506, **Polokwane**, 0700
Azmo Place, 49 Joubert St, Polokwane

– Sengani V.B
16/2/7/A400/Z24/1
015-290 1270
F - 015-295 3249
E - senganb@dwaf.gov.za

The Manager
Matimba Power Station
P/Bag X215
LEPHALALE
0555

Attention: Mr. P. Koekemoer

Re: CLOSURE OF SOLID WASTE DISPOSAL SITE

General comments

According to the Minimum Requirements for Waste Disposal Site of 1998, the following are the relevant Minimum Requirements for closure:

- Closure requirements
- Rehabilitation
- Proposed end-use
- Ongoing monitoring

Based on the investigation conducted on the 26 August 2003, the following must be considered:

- Delisting of the ash
- Cover material and compaction
- Re-vegetation
- Creating conditions to avoid damming
- Drilling monitoring borehole/s up gradient and down gradient of the solid waste disposal site
- Chemical results after drilling the boreholes
- Proposed end-use
- Ongoing monitoring programme

FROM : ENVIROXCELLENCE SERVICES PHONE NO. : 0152956924 OCT. 16 2003 10:17PM

Specific comments

1. Page 11, chemical analysis on soil samples is still pending
2. Indicate end-use plan after rehabilitation.
3. No further dumping should be done during closure process.

Acording to Nico Gewers of Environmental Co-ordinator, the site is classified as Class II Disposal Site with classification G:C:B-

This Department has no objection to issue a permit or closure certificate of the solid waste disposal site as per investigation and recommendations, however, care should be taken on issues stipulated above and it must be noted that s19 of the National Water Act (Act 36 of 1998) applies for any pollution contributed by any activity.

Should there be any query please feel free to contact this office.

p/ MANAGER: NORTHERN CLUSTER

DATE: 15/10/2003

APPENDIX 5:

Table 12 from the Minimum Requirements for Waste Disposal by Landfill (Second Edition, 1998)

TABLE 12
Minimum Requirements for Rehabilitation, Closure and End-use

LEGEND B^- = No significant leachate produced B^+ = Significant leachate produced R = Requirement N = Not a requirement F = Flag: special consideration to be given by expert or Departmental representative	CLASSIFICATION SYSTEM									
	G General Waste								H Hazardous Waste	
	C Communal Landfill		S Small Landfill		M Medium Landfill		L Large Landfill		H:h Hazard Rating 3 & 4	H:H Hazard Rating 1-4
MINIMUM REQUIREMENTS	B^-	B^+	B^-	B^+	B^-	B^+	B^-	B^+		
Determine/reassess End-use Requirements	N	N	R	R	R	R	R	R	R	R
Investigate landfill to determine closure requirements and to identify impacts	R	R	R	R	R	R	R	R	R	R
Obtain input on End-use Design by IAPs	N	N	R	R	R	R	R	R	R	R
Confirmation of End-use Design by Department	N	N	R	R	R	R	R	R	R	R
Design for upgrade/ rehabilitation, if necessary	R	R	R	R	R	R	R	R	R	R
Design final shaping and landscaping	N	N	R	R	R	R	R	R	R	R
Design final cover or capping	R	R	R	R	R	R	R	R	R	R
Design permanent storm water diversion	R	R	R	R	R	R	R	R	R	R
Design anti-erosion measures	F	F	R	R	R	R	R	R	R	R
Closure Report	N	N	R	R	R	R	R	R	R	R

LEGEND B^- = No significant leachate produced B^+ = Significant leachate produced R = Requirement N = Not a requirement F = Flag: special consideration to be given by expert or Departmental representative	CLASSIFICATION SYSTEM									
	G General Waste								H Hazardous Waste	
	C Communal Landfill		S Small Landfill		M Medium Landfill		L Large Landfill		H:h Hazard Rating 3 & 4	H:H Hazard Rating 1-4
MINIMUM REQUIREMENTS	B^-	B^+	B^-	B^+	B^-	B^+	B^-	B^+		
Compare actual condition of landfill to required condition	N	N	R	R	R	R	R	R	R	R
Written acceptance of Closure Report	N	N	R	R	R	R	R	R	R	R
Ongoing leachate management	N	N	F	R	F	R	F	R	R	R
Ongoing gas management	N	N	F	F	F	F	F	F	F	F
Ongoing inspection and maintenance	N	N	R	R	R	R	R	R	R	R
Implementation of Closure Report/Rehabilitation	N	N	R	R	R	R	R	R	R	R
Application for Permission to Close Letter approving closure	N	N	R	R	R	R	R	R	R	R
Inspection and Monitoring Frequency intervals (in months)	12	12	12	12	6	6	F	F	F	F
Cover integrity	R	R	R	R	R	R	R	R	R	R
Integrity of drainage	R	R	R	R	R	R	R	R	R	R
Control of ponding	F	F	R	R	R	R	R	R	R	R
Control of fire	R	R	R	R	R	R	R	R	R	R
Monitoring vegetation	N	N	R	R	R	R	R	R	R	R
Monitoring security and prevention of illegal dumping	R	R	R	R	R	R	R	R	R	R

APPENDIX 6:

Table 4 Showing results of chemical analysis taken from the Geohydrological Report

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.

APPENDIX 7:
Certificate of Analysis from Geohydrological Report

Analytical Services
UIS Analytical Services (Pty) Ltd • Reg. No. 2000/027788/07 • VAT No. 4920202969
13 Esdoring Nook • Highveld Technopark • Centurion
PO Box 8286 • Centurion • 0046
Tel. +27 12 665 4291 • Fax. +27 12 665 4294
info@uis-as.co.za • http://www.uis-as.co.za

Blue Rock Consulting
PO Box 24614
Gezina
0031
South Africa
M Levin
Tel : +27 12 993 2662
Fax : +27 86 684 6666
E-Mail : mlevin@mweb.co.za

ANALYSIS CERTIFICATE	
Date	2009/04/30
Request No	1144
Contract No	
Order/Ref No	20080113

SAMPLE ID :	80366	**SAMPLE MATRIX :**	Water
SAMPLE NO.:	P26/9/4/09	**DATE RECEIVED :**	2009-04-15

METHOD : pH
METHOD NO.: UIS-EA-T003 (Accredited) **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
pH	7.82	
pH Temperature	23.9	Deg C

METHOD : Electrical Conductivity
METHOD NO.: UIS-EA-T001 (Accredited) **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
Total Conductivity	180	mS/m
TC Temperature	23.9	Deg C

METHOD : Calculated Total Dissolved Solids from EC
METHOD NO.: UIS-CP-T001 **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
TDS by EC * 6.5	1170	mg/l
TDS by EC * 7	1260	mg/l

METHOD : Total Dissolved Solids
METHOD NO.: UIS-EA-T005 (Accredited) **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
Total Dissolved Solids	1450	mg/l

analysis (ə'nælɪsɪs) *n.* separation of something into its elements or components (*pl.* **-yses** (ɪsi:z)) — **chemical** *n./a.,* the analysis of material samples to gain an understanding of their chemical composition and structure

SANAS ACCREDITED LABORATORY T0184

Page 1 List of Directors available from the registered office

20080113

SAMPLE ID :	80366	**SAMPLE MATRIX :**	Water
SAMPLE NO.:	P26/9/4/09	**DATE RECEIVED :**	2009-04-15

METHOD : Calculated Total Dissolved Solids by Summation
METHOD NO.: UIS-CP-T003 **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
TDS by Summation	1420	mg/l

METHOD : Suspended Solids
METHOD NO.: UIS-EA-T004 (Accredited) **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
Suspended Solids	24.4	mg/l

METHOD : Turbidity
METHOD NO.: UIS-EA-T029 **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
Turbidity	15.3	NTU

METHOD : P and Total (M) Alkalinity
METHOD NO.: UIS-EA-T002 (Accredited) **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
P Alkalinity	<0.6	mg/l CaCO3
Total (M) Alkalinity	820	mg/l CaCO3

METHOD : Cations in Water by ICP-OES
METHOD NO.: UIS-TEA-T001 **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
Ag	<0.05	mg/l
Al	<0.05	mg/l
Ba	0.111	mg/l
Ca	74.9	mg/l
Cd	<0.05	mg/l
Co	<0.05	mg/l
Cr	<0.05	mg/l
Cu	<0.05	mg/l
Fe	<0.05	mg/l
K	17.9	mg/l
Li	0.068	mg/l
Mg	167	mg/l
Mn	<0.05	mg/l
Na	155	mg/l
Ni	<0.05	mg/l
Si	42.4	mg/l
Sn	<0.05	mg/l
Sr	1.72	mg/l
V	0.113	mg/l
Zn	<0.05	mg/l

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SAMPLE ID :	80366	**SAMPLE MATRIX :**	Water
SAMPLE NO.:	P26/9/4/09	**DATE RECEIVED :**	2009-04-15

METHOD : Calculated Hardness
METHOD NO.: UIS-CP-T004 **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
Ca Hardness	187	mg/l CaCO3
Mg Hardness	688	mg/l CaCO3
Total Hardness	875	mg/l CaCO3

METHOD : Anions by Ion Chromatography
METHOD NO.: UIS-EA-T008 (Accredited) **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
F	2.26	mg/l
Cl	67.5	mg/l
NO2	<0.2	mg/l
NO3	16.9	mg/l
NO3 as N	3.81	mg/l
SO4	311	mg/l

METHOD : Ion Balance Error
METHOD NO.: UIS-CP-T002 **DATE COMPLETED :** 2009-04-23

PARAMETER	VALUE	UNIT
Sum of Cations	24.7	me/l
Sum of Anions	25.5	me/l
Ion Balance Error	-1.42	%

METHOD : Chemical Oxygen Demand (COD)
METHOD NO.: UIS-EA-T030 **DATE COMPLETED :** 2009-04-30

PARAMETER	VALUE	UNIT
COD	12	ppm O2

AUTHORISED SIGNATURE