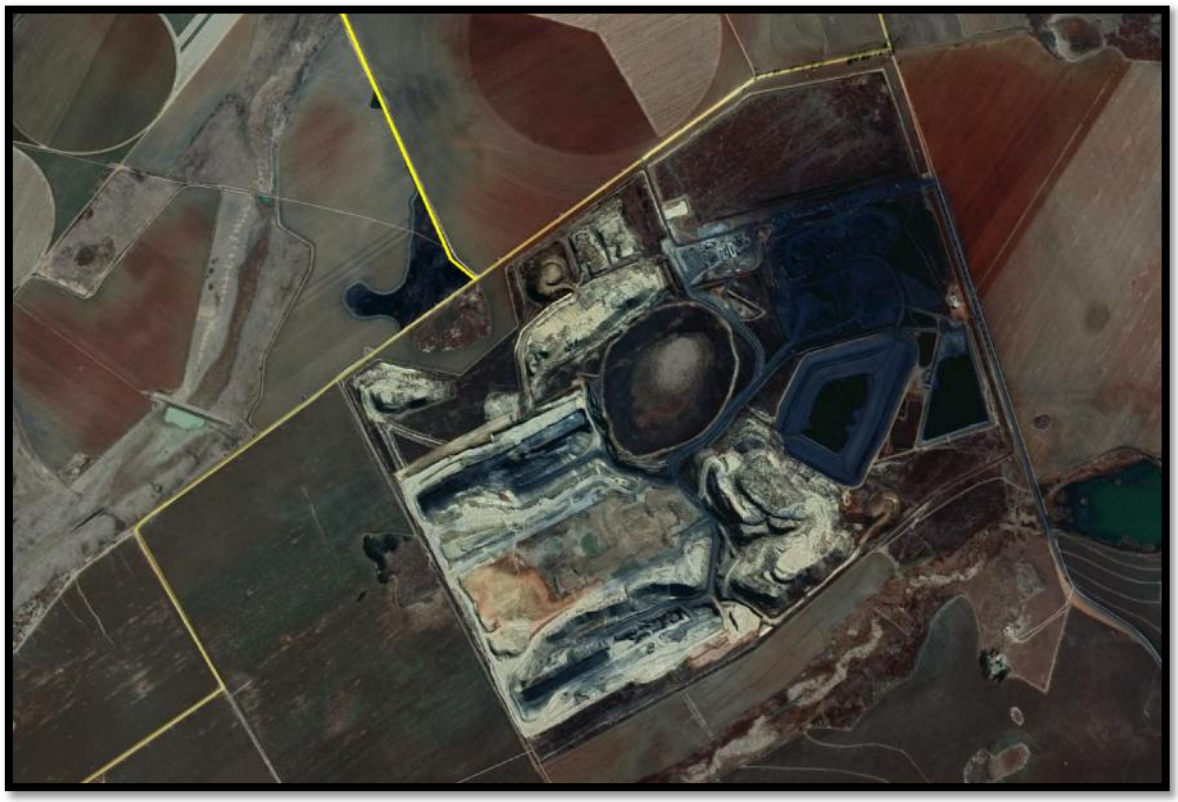
UNIVERSAL COAL DEVELOPMENT I - KANGALA COLLIERY
CO-DISPOSAL COAL DISCARD FACILITY



DESIGN REPORT

REPORT REF: TBS-201904002-UCKC

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1 Introductions

Triage Business Services was appointed by Universal Coal PLC to design a co-disposal discard facility that will accommodate the expansion of the mining into the neighbouring Middlebult and Eloff block mines. The facility will be taking approximately 14Mt of both coarse discard and slurry from the plant.

1.1 Scope of work

The scope can be summarised as follows;

- Design a co-disposal discard facility that will comply with current legislative requirements
- Produce a Design Report that will form part of the requirement for an Integrated Water Use Licence application
- Produce a Construction Quality Assurance (CQA) document

2 Site Description

2.1 Site Locality

Kangala Colliery is located approximately (~) 65 kilometres (km) east of Johannesburg and 5.0 km south of the town of Delmas in the Mpumalanga Province. The mine is located on the western boundary of the Witbank Coalfield. The Project mining areas are contiguous and lie to the east of the R42 provincial road and to the south of the R555 provincial road.

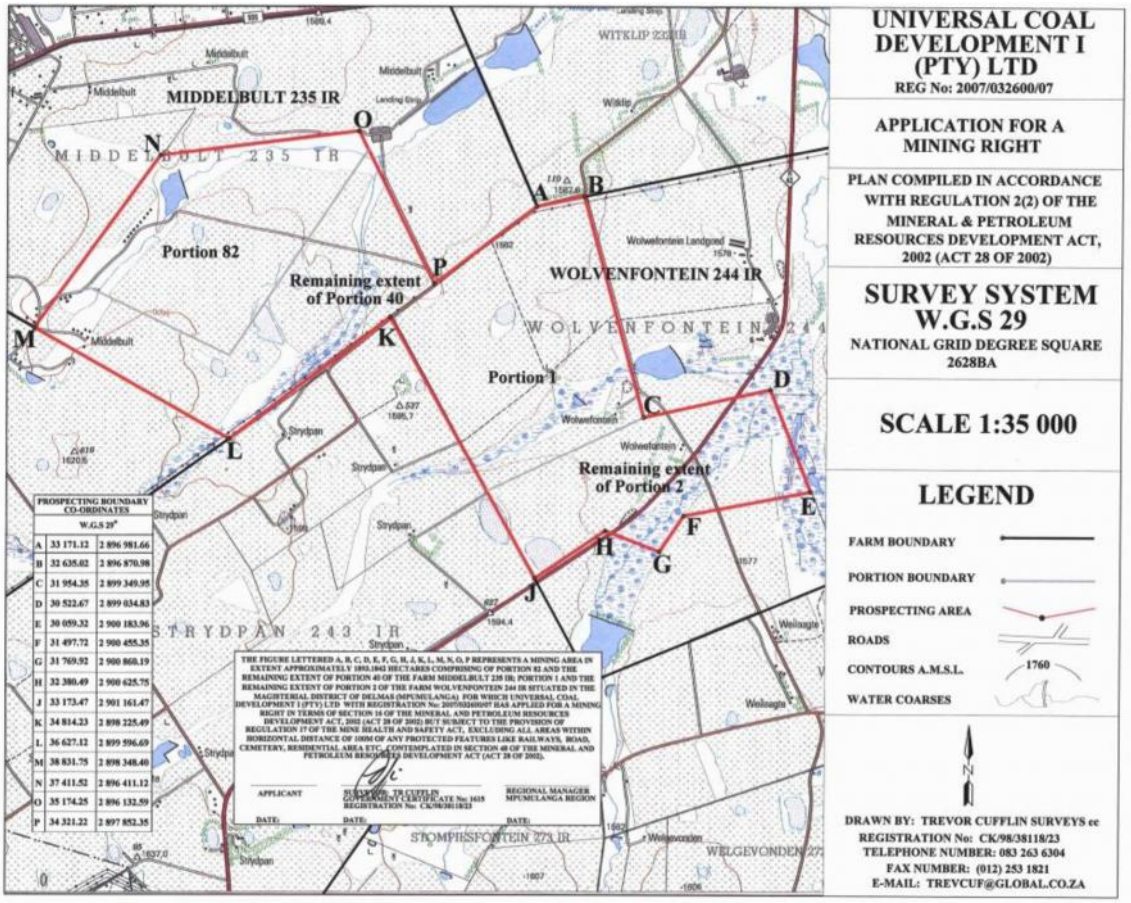

Figure 1: Topographical map showing both sites

The Coal Discard Facility is situated on farm Wolvenfontein 244 IR. The property is bounded by adjoining farms in the north, west, and south as well as small holdings on the east.

2.2 Topography

The topography of the site is slightly undulating with the lowest elevation at 1,567 metres above sea level (masl) and the highest elevation at 1,597 masl. The Kangala and Middelbult resources are separated by a perennial drainage channel that runs in a south-west to north-east direction with a second perennial drainage channel running on the western side of Middelbult also in a northwestern direction and joins with the perennial drainage that separates Kangala and Middelbult. The mining areas on both project areas fall outside of the 100-year flood line of this stream.

3 Geology

The area is characterised by undulating pre-Karoo paleo-topographic terrain. Some of these basement outcrops are indicated on the geological map and are predominantly of the Proterozoic Transvaal Supergroup. The underlying basement consists of dolomite and chert of the Malmani Group and typically displays karst features.

The site geology is characterised by hillwash, colluvium, aeolian deposits, alluvium, pedogenic materials and residual soils which overlie weathered shales and sandstones of the Vryheid Formation – refer to Figure 2

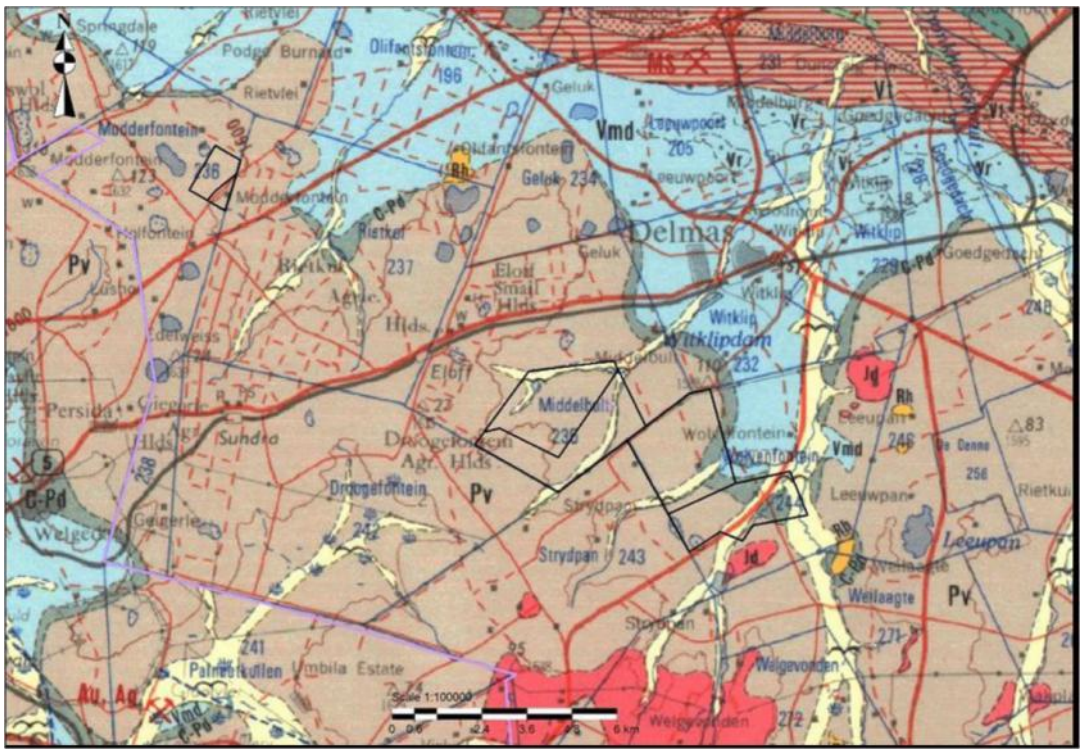

Figure 2: 1:250 000 Geological Map

4 Available information

The following information was available

- 1: 50 000 scale topographical maps
- 1:250 000 scale geological map of both sites
- Proposed Kangala Colliery Conceptual Study Report
- Geotechnical Study Report

5 Site Conditions

5.1 Surface water

The site is located approximately 1,6 km away from a water course and outside the 1:100 year floodline. The regional rainfall averages 710mm and regional average annual evaporation of 1600mm. The required design storm intensities and average rainfall are given in table below

24 Hour Rainfall (mm)		
1:20 Year	1:50 Year	1:100 Year
118	146	170

5.2 Groundwater

No shallow groundwater was encountered during the geotechnical investigations to the depth of 4,5m though a present ferricrete layer and nodules may indicate a perched water table.

5.3 Geotechnical profile

- Depth to pebble marker: None
- Transported soil: Hillwash, colluvium, Aeolian deposits, alluvium and pedogenic material
- Residual soil: weathered shales and sandstones of the Vryheid Formation
- Depth to hard rock: 4,5m

- Foundation rock description: sedimentary Karoo Series underlain at 70 m depth by dolomitic intrusions
- Collapsible structures: not undermined, nor collapsible matrix present
- Bearing capacity and consolidation: 5MPa and 40mm under 900 KPa
- Seismicity: 0,15 G

5.4 Topography

The topography of the site is moderately flat with an elevation level variance of only 20 metres (m) over the project area, which is representative of the entire region. Elevation on the site is highest towards the south western part of the project area at 1,597 masl and the lowest point being located on the north western boundary of the site at 1,567 masl.

There is a small, non-perennial stream, which runs between Kangala and the Middelbult resource in a south to north direction. The stream drains in a northern direction from the site. The project area has a gentle gradient for the bulk of the site. The minimum slope for waste containment facilities base liners to be 1v:50h (2%).

6 Material Properties

6.1 Clay for barrier system

The clay on site that will be used as a compacted clay liner (CCL) has the following properties;

- PI:10 to 18,
- Linear shrinkage: 4 to 9.4
- Standard Proctor density and OMC 1563 to 1779kg/m3 MDD and 18 to 22% OMC
- Percentage clay: Selected
- Maximum particle size: 100% passing 13,5mm sieve
- Permeability: less than 9,27x10-7cm/s
- Minimum Shear strength: c=5KPa and ignored and phi=18 degrees

6.2 Geomembrane

The geomembrane used on the barrier system will comply with SANS 1526 for High Density Polyethylene (HDPE)

6.3 Liner protection

A silty sand layer is proposed as the liner protection and shall have 100% passing 0,475mm sieve particle size distribution

6.4 Waste (Coal Discard)

6.4.1 Coarse material

- Particle size distribution: Broadly graded rock fill greater than 75mm
- Strength phi=34 degrees and C=0 KPa
- Free draining
- Density: 1800 kg/m3

6.4.2 Fines

- Density: 1120 to 1140 kg/m3
- Particles size distribution: 200 micron

7 Performance Criteria

The CDF design conforms to the criteria set below

- Minimum factor of safety for rock dumps: 1.5
- Frequency of overtopping: less than once in 50 years on average
- Action leakage rate: 20l/ha/day
- Strain limitation in GM less than 3%

The waste is assessed as type 3 waste (According to NEMWA 2013 Regulation 635). The waste is acid forming and has the potential for spontaneous combustion.

There were tests done for interface shear strength therefore parameters are assumed based on the extract from GRI Report number 30. The values are to be validated by the construction quality assurance (CQA)

8 Design considerations

Due to the geotechnical profile and presence of a ferricrete layer within the excavation depth below natural ground level (NGL), a perimeter subsurface drain is provided on the upslope side of the coal discard facility (CDF).

8.1 Subsurface drainage

The subsurface drainage system will comprise of a typical herringbone drainage with a central pipe leading into a manhole on the outside of the facility.

8.2 Floor and side slopes

The geotechnical profile allows for excavation to a depth of 1,5m within the highly weathered residual soil zone, and thus a minimum slope of 2% across the floor area will be provided. While material of the excavated material varies, it is not practical to place clay on a 1v:3h side slope (which has an incline of 18 degrees) as this influences veneer stability, and clay compaction energy requirements, as well as permeability. The inner side slopes of the perimeter wall will thus be 1v:4h.

The outer slopes of the perimeter embankment are selected taking rehabilitation into consideration and optimising structural stability as well as costs. An outer slope of 1v:3H is possibly the least suitable slope for rehabilitation by grassing due to high maintenance requirements for erosion mitigation. Experience in embankment dam engineering and in particular coal mine rehabilitation in northern KZN has shown side slopes of 1v:5h and are required if grassing is required for erosion protection. The on-site available material is however broadly graded and will be selected to have the semi-pervious material in the outer zone for both stability (increasing permeability towards the outer shell and erosion resistance of the surface.) Thus to minimise embankment volumes and related costs of materials placement and maintenance, an outer slope of 1v:2,0H is chosen. The crest width is 3m for construction practicality and slopes towards the inside with a 1% fall. Maximum crest height is 1,5m above NGL

Due to the waste rock material being broadly graded and variable, provision is made for perimeter paddocks of 0,5 m depth and 6m width to retain potentially polluted stormwater run-

off the operational period (and serve as an initial silt trap) with overflow leading to the existing polluted stormwater dam via concrete lined channel.

The concept design for the barrier system which comprises both drainage and liners recognises the available material for the CCL is variable in permeability and marginal, with a high risk of coarse fraction that will induce point load tensile strains in the adjacent geomembrane under the design load. It is suggested that a GCL is used a partial replacement of the CCL to provide both a protection function and contribute to seepage control. The site material will yield adequate liner protection by making use of sandy silt and silty sand with layer thickness influenced by the mean which by the pioneering layer is placed. The use of a semi-pervious silty material as a pioneering layer is selected for not only strain limitation, but also to reduce the risk of introducing air at a foundation level to minimise the risk of spontaneous combustion. A specified soil envelope is used in the 300mm thick layer above the liner prior to placement of discard. The discard is to be placed on the perimeter zone in advance of the inner tailings, maintaining a minimum freeboard of 800mm at all times.

The waste is programme to have a saturated central deposition with the perimeter dry placed material in an upstream construction. Decant is intended to be a combination of surface decant by floating barge with a base liner drainage layer intended to remain saturated. The intent of the saturated lower portion is to protect the barrier system from temperature effects in the event of spontaneous combustion, and clogging due to ultra-fines. Thus herringbone drains lead to a perimeter hill ring-drain which itself decants 0,8m below the liner level to an external collector pipe system that drains under gravity to the PCD.

In Conclusion the barrier system from the base upwards is 200mm rip and re-compact the in-situ material after excavation, to meet the grades required. Place one layer of selected silty clay to specification, recognising the variability in PI and permeability. Thereafter place a GCL and Geomembrane followed by a 300mm thick specified sandy silt ballast and protection layer. This ballast thickness is required to overcome potential panel shrinkage and provide immediate confining stress to the GCL, with simultaneous elimination of wrinkles in the GM due to the bar method of placement. This layer is compacted with a single pass of smooth drum roller following which the herringbone finger drain system is installed and allowed to be

submerged after placement of the pioneering waste layer. The decant pipe details maintain at least 1m pressure depth above the composite liner, but drain freely under gravity to the external leachate management system. The external system is an HDPE pipe that drains under gravity to the PCD.

The operational phase requires placement in accordance with the drawings which specify material properties within the zones varying from coarse on the outside through a gradation to fines on the insides. The outer slope stability is dependent on operational compliance. The outer slope has an eventual overall slope of 1v:3H with intermediate step backs of 4m width to accommodate slope drainage after every 15m of vertical rise i.e at 15m and 30m above NGL. Theses step back berms serve an additional precautionary function in the unlikely event of overtopping or seepage through side walls.

Instrumentation is to be provided to confirm performance. Movement monitoring beacons will be installed at each bench, making provision for monitoring of points of intersection by survey i.e at corners with intermediate beacons set to monitor by line of sight. Onsite rainfall records are maintained. Return flow volumes are measured by a combination of flow meters on decant pumps and either a flow meter on the external return water drainage pipe or by means of a v-notch at the entrance to the PCD. The subsurface drainage system monitoring will include both flow rates and water quality records.

APPENDIX A: DESIGN DRAWINGS

1. P17-08-D02: GENERAL LAYOUT PLAN
2. P17-08-D03: PHASE 1-GENERAL LAYOUT
3. P17-08-D04: PHASE 2-GENERAL LAYOUT
4. P17-08-D05: FINAL FILL MODEL LAYOUT PLAN
5. P17-08-D06: LONG SECTION & CROSS SECTION
6. P17-08-D07: TYPICAL SECTIONS & BERM DETAILS
7. P17-08-D08: TYPICAL LINER DETAILS
8. P17-08-D09: MANHOLE, SUBSOIL DRAIN PIPES & PIPE LINER PENETRATION