SPECIALIST STUDY

SOIL SURVEY REPORT FOR THE FARM WOLVENFONTEIN NEAR DELMAS IN MPUMALANGA PROVINCE

UNIVERSAL COAL (PTY) LTD

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Environmental Solutions Provider

Prepared By :
Digby Wells & Associates
Environmental Solutions Provider
Private Bag X10046,
Randburg, 2125,
South Africa
Tel : +27 (11) 789-9495
Fax : +27 (11) 789-9498
E-Mail : info@digbywells.co.za

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EXECUTIVE SUMMARY

The proposed project is a coal mine to be located on portions 1 and the remaining extent of portion 2 of Wolvenfontein 244 IR in the Delmas area of Mpumalanga Province. The proposed mining area is 951 hectares in total. Based on a prospecting programme, feasibility studies and accompanied by the current price and demand for coal, it was found that it is economically viable to undertake opencast mining operations on the above mentioned farm.

A soil survey of the potential opencast area was undertaken to determine the soil types, land capability (agricultural potential) and land use present on the property.

The dominant soils found on the property are Oakleaf and Tukulu soil forms. Shallow high clay content Katspruit soils are found in the pans and wetland areas. Shallow patches of Glenrosa and Mispah soil forms are in places. 71% of the farm consists of cultivated high potential Oakleaf and Tukulu soil forms while 10% of the cultivated area consists of low potential Katspruit soil form. The remaining 18% of the farm consists of mainly wetland uncultivated areas.

The land capability of the farm Wolvenfontein is classified as mainly arable, high potential farm land. 71 % of the total area consists of arable high potential soil. 29 % of the farm is occupied by low potential agricultural soil due to mainly depth restrictions on the one hand and imperfect drainage on the other hand. The exceptions to arable farm land being the shallow soil in the pan and wetland areas. A small portion namely 10 % of the total area comprising of pan and wetland areas, is cultivated. These areas will present the farmer with challenging problems especially during wet seasons due to the shallow soil and underlying waterlogged G horizon.

The dominant agricultural potential of the farm Wolvenfontein is classified as high potential farm land. There are however smaller areas of low agricultural potential present on the farm.

The predominant present land use in the wider area is arable agriculture. The farm Wolvenfontein is no exception and land use is dominated by arable crop production due to the dominant high potential soil. Current land use is estimated at 81 % of the available land being used for arable farming. 19 % of the total available farmland is un-used due to shallow soils and wetland areas.

Arable crop farming activities dominate at the farm Wolvenfontein. Only the wetland areas contain perennial vegetation potentially available for grazing. The wetland areas at Wolvenfontein are however not fenced off and are not used for grazing. The wetland areas were burnt during the winter thereby limiting potential grazing opportunities.

Considering the cumulative negative impacts of opencast coal mining on loss of land capability in general in Mpumalanga, then it must be emphasized that soil rehabilitation at Wolvenfontein should strive to proportionally emulate pre-mining land capability and land use. The well drained high potential agricultural soils should be put back in the higher landscape positions while the low agricultural potential wetland and pan area soil should be put back in lower landscape positions.

It is recommended that the planned opencast area should be rehabilitated to provide the same proportions of arable and wetland areas as existed pre-mining. To do this, soils must be stripped and stored in such a way that wetland and arable soil types are not mixed. In particular, heavy clay topsoil and subsoil materials from the pan areas (if mined) should not be mixed with other topsoil and subsoil material.

Soil fertility and acidity status should be established through representative soil sampling and analyses to ensure optimal post reclamation vegetative growth. Any nutritional or acidity problems should be corrected prior to any vegetation establishment on reclaimed soil.

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DEFINITIONS

Definitions *(used with permission of the Soil Science Society of South Africa and Coaltech 20/20)*

Topsoil

- The uppermost part of the soil ordinarily moved in tillage, or its equivalent in uncultivated soils, ranging in depth from about 100 to 300 mm. Frequently designated as the "plough layer", the "Ap layer", or the "Ap horizon"
- Soil material used to topdress road banks, gardens and lawns.

Reclamation

- The process of recovering disturbed and/or deteriorated land to its former uses or other productive uses.

Rehabilitation

- "Rehabilitation, from the mining industry perspective, means putting the land impacted by the mining activity back to a sustainable usable condition. It recognises that the restoration of what was previously there is simply impossible with current best practice. This definition (and implied intention) includes the concepts of minimisation of loss of land use capability and of net benefit to society. Section 38 (1) of the MPRDA refers to having the mine area restored to its natural or predetermined state but this is tempered by the qualification that rehabilitation must be practicable and also provides for a Public Participation Process to define "end use"".

Sandy soils

Sandy soils consist of visible loose grains and are very susceptible to wind and water erosion. Sandy soils are easily cultivated and make excellent seedbeds for germinating seeds and young plants. Sandy soils usually have low water-retaining capacity as well as fertility.

Clay soils

Clay soil consists of very fine particles that cling to each other when wet. Cultivation causes smearing when cultivated too wet and large clods when cultivated too dry ensuring a poor seedbed in both cases. Clay soils are slow to absorb water and can become waterlogged during the rainy season.

Loam soils

Loamy soils are regarded as the ideal type of soil for cultivation. Loamy soil exhibits none of the negative properties of sand and clay soils. Loamy soils are, easily cultivated, drain well, make a good seedbed and have a crumbly appearance.

1 INTRODUCTION

The proposed project is an opencast coal pit to be located on portions 1 and the remaining extent of portion 2 of Wolvenfontein 244 IR in the Delmas area of Mpumalanga Province. The proposed mining area is 951 hectares in total.

The mineral deposit is bituminous coal from the No. 2 and No. 4 seams of the Witbank Coalfield. The Kangala Coal Mine project area is classified as a multiple seam deposit and hosts an incomplete sequence of Witbank Coalfield coal seams, namely the Nos. 1, 2, 3 and 4 Seams, with the No. 1 and 3 Seams not developed in certain localities and/or joined to the No. 2 Seam.

The area under consideration hosts a gross in situ resource of 20.21 Mt (in situ before losses) that can be classified as multi-product coal that would yield a significant portion of export coal. All of the mineable coal at Wolvenfontein is accessible by open pit mining. The run-of-mine coal will be washed (beneficiated) to produce both export and local coal for Eskom. The planned life-of-mine is one year for the construction phase, followed by a 10-year operational (production) phase.

An initial boxcut will be established during the construction phase of the Project. Topsoil and overburden from the initial boxcut area will be stockpiled to be used for rehabilitation and reclamation. Opencast mining will use a conventional truck and shovel operation, assisted by roll-over dozing, to allow for continuous backfilling and rehabilitation of the mined out area. Expected mining conditions are good, due to favourable geology and good stormwater drainage. The final void will be backfilled with the overburden from the initial boxcut. Rehabilitation and final closure will be as specified in the Environmental Management Plan (EMP).

A soil survey of the potential opencast area was undertaken to establish the land capability (agricultural potential), land use and soil types present on the farm Wolvenfontein. The soil survey information is not only used for mapping but also to estimate topsoil and subsoil volumes to be stockpiled and re-used in a rehabilitation programme. The soil classification information is in addition used to guide stockpile soil groupings.

2 TERMS OF REFERENCE

Digby Wells & Associates (DWA) was appointed by Unicersal Coal (Pty) Ltd as environmental consultants to investigate the environmental aspects as required for the EIA phase for the proposed Kangala mine on the farms Middelbult 235 IR, Portion 40 & 82, Wolvenfontein 244 IR, Portion 1 and R/E of Portion 2 and Modderfontein 236 IR, Portion 1 in the Delmas area, Mpumalanga Province. Environmental study considerations for this study included the assessments of the soil types present in the study area.

3 STUDY AREA

The Wolvenfontein project area is located 80 km due east of the centre of Johannesburg. There are two other operating coal mines namely Leeuwpan and Stuart Coal in the district. Land use in the district is mainly arable agriculture. The area is located close to good road and railway infrastructure within a radius of 30-70 km from four coal-fired power stations. The nearest town is Delmas three km away,

4 EXPERTISE OF THE SPECIALIST

A CV and declaration of independence is attached in Appendix 2.

5 AIMS AND OBJECTIVES

A soil field survey was undertaken and the data gained from the study were used to create maps. These are:

- A soil distribution map,
- An agricultural potential map,
- A land use map.

6 METHODOLOGY

A study of the soils present at the site was conducted during field visits. The site was traversed by vehicle and on foot. A hand soil auger was used to determine the soil type and depth. Survey positions were recorded as waypoints using a handheld GPS. Other features such as existing open trenches were also helpful to determine the soil type and depth. The soil forms (types of soil) found in the landscape were identified using the South African soil classification system namely; Soil Classification: A Taxonomic System for South Africa (Soil Classification working group, 1991). Several photographs were taken and occur in the text as reference information.

6.1 Soil Sampling

The topsoil (0-300 mm) of the dominant soil forms was sampled. Samples were analyzed for soil acidity, fertility and textural indicators as follows:

- pH (water);
- Extractable cations and Na, K, Ca, Mg (Amm.Acetate);
- Cation exchange capacity;
- Carbon content;
- Phosphorus (Bray1);
- Soil texture namely sand, silt and clay were also determined.

7 KNOWLEDGE GAPS

No knowledge gaps are evident. A soil field survey was undertaken and the data gained from the study were used to create useful maps.

8 FINDINGS

The topography at the farm Wolvenfontein is relatively flat. Some areas of the property consist of shallow crest like shapes followed by mid, foot slope and valley bottom terrain units. The higher lying area is occupied by deep well aerated red soil representing the Oakleaf soil form. Depressions in the landscape are occupied by pans containing shallow Katspruit soils.

The valley bottom positions are occupied by wetlands. The wetland area dividing the farm from east to west, contains similar to the pans, also Katspruit soils. The main wetland next to the National road to Nigel, contains mainly Valsrivier and Arcadia soils. The occurrence of these soils in the main wetland area indicates that the wetland drains relatively quickly (water runs off) and the soils are not waterlogged for long periods. Opposed to this is that the pans do not have quick water runoff and drainage so stays waterlogged for longer times.

Additional soil information about the soils are contained in Appendix 1.

9 DISCUSSION

Table 1 contains the soil types and areas occupied by the various soil types while Plan 1 indicates the various soil groups found on the farm Wolvenfontein. It is evident from Table 1 that 70 % of the farm is dominated by high potential Oakleaf and Tukulu soils. 26 % of the property is occupied by wetlands and pans of which at least 10 % is cultivated. Pictures 1 and 3 indicate the typical high potential cultivated deep Oakleaf soil occurring on the farm while Pictures 2 and 4 contain examples of the wetland areas on the farm.

Picture 1: A cultivated field of an Oakleaf soil form is shown. The Oakleaf soil form is an example of a high potential arable agricultural soil at Wolvenfontein, Delmas, August 2009.

The topography at the farm Wolvenfontein is relatively flat with gentle slopes of 1 – 2 % in the cultivated areas followed by steeper slopes of 2 – 6 % towards the wetland area. Picture 3 indicates the flat topography of the survey area. Some areas of the property consist of shallow crest like shapes followed by mid, foot slopes and valley bottoms. The higher lying area is occupied by deep well aerated red soil representing the Oakleaf soil form, see Picture 3 and Plan 1.

Picture 2: Burnt wetland area at Wolvenfontein, Delmas, August 2009.

Picture 3: Animal burrows present in deep Oakleaf soil at Wolvenfontein, Delmas, August 2009.

Picture 4: Cultivation into the pan areas at Wolvenfontein, Delmas, August 2009.

Table 1: Soil types occurring on the farm Wolvenfontein.

Soil Types	Area (ha)	Area (%)	Average depth (m)
Oakleaf	285.6	32.3	1.4
Tukulu	340.8	38.6	0.8
Cultivated wetland areas (Katspruit)	87.8	9.9	0.35
Uncultivated wetland areas (Katspruit, Valsrivier, Arcadia)	140.3	15.9	0.35
Cultivated shallow soil (Dresden)	4	0.5	0.3
Uncultivated shallow soil (Mispah)	24.6	2.8	< 0.3
Total	**883.1**	**100**	

The valley bottom positions are occupied by wetlands. The wetland area dividing the farm from east to west, contains similar soils to the pans, also Katspruit soils. The main wetland next to the National road to Nigel, contains mainly Valsrivier and Arcadia soils. The occurrence of these soils in the main wetland area indicates that the wetland drains relatively quickly (water runs off) and the soils are not waterlogged for long periods. Opposed to this is that the pans do not have quick water runoff and drainage so stays waterlogged for long periods.

The mid and foot slope positions between the higher landscape positions and the valley bottom positions are dominated by similar red, well aerated soils. These soils, however, show indications of wetness in the subsoil. The presence of permanent wet subsoil changes the classification from an Oakleaf soil form to a Tukulu soil form. The wet area is present just above the parent material which is impervious to water therefore providing the conditions for the soil to stay wet for long periods. The B horizon is still a neocutanic subsoil horizon. The only difference is the presence of the wet zone at the bottom of the B horizon. Generally the Tukulu soil form is shallower than the Oakleaf soil form.

Small areas on the farm Wolvenfontein are very shallow containing Glenrosa and Mispah soil forms. These soil forms contain an orthic A horizon underlain by weathered or hard rock respectively. The shallow stony areas are left uncultivated due to the challenge stones pose to farming equipment (see plan 1). One area next to the east/west wetland contains the Westleigh/Dresden soil forms. These soil forms are characterized by orthic A horizons underlain by soft or hard plinthite respectively.

9.1 Soil Physical and Chemical Properties

Table 1 contains the soil analytical data of dominant soil forms. Organic carbon (C) ranges from 0.65 – 1.07 % for cultivated soils and 1.52 % uncultivated soil respectively. The lower carbon content of the cultivated soil can possibly be the result from cultivation causing aeration and loss of organic matter through oxidisation.

Phosphorus (P) status as contained in Table 1 shows that the P status has been improved by the addition of fertilizers. P is an important macro nutrient and the P content of 30.6 – 125.8 mg kg^{-1} in the cultivated soils is indicative of good P soil status. The uncultivated pan area has a P content of 14.3 mg kg^{-1}, lower than the cultivated soils because no addition of fertilizer is done in the uncultivated areas.

The soil pH is in the order of 6.5. This pH is indicative of good farming practises and compares well with the natural pH of the soil in the uncultivated pan. Managing soil pH is very important in arable farming operations because plant nutrition, and therefore yield is influenced by soil pH. A soil pH of 6.5 is considered to be optimal in crop production.

The cation exchange capacity (CEC) ranges from 5.6 to 6.5 cmol(+)kg^{-1} for the cultivated soils and 10.2 for the uncultivated Katspruit soil. The cultivated soil cation exchange capacity is an indication of the type of clay mineral present namely kaolinite. Kaolinite is a two layer clay silicate mineral and contains less negative charge than three layer clay minerals. Less charge also indicates lower fertility because less nutrients are retained. The CEC of the uncultivated Katspruit soil is higher than the CEC of the cultivated soil because the uncultivated soil also contains more organic C than the cultivated soil. Organic material also contains negative charges and therefore contributes towards the CEC of soil.

The size limits for sand, silt and clay used in the determination of soil texture classes are sand: 2,0 - 0,05 mm, silt: 0,05 - 0,002 mm and clay: < 0,002 mm. The clay content ranges from 16 – 22 % in the cultivated soils while the uncultivated Katspruit soil has a clay content of 26 %. Sand content ranges from 45 – 66.7 % and silt 15.9 – 28.9. The texture properties of the soils analyzed allow the soils to be classed as loam to sandy loam soils. Loam and sandy loam soils are easily cultivated using normal agricultural equipment.

Table 2: Soil chemical and physical analyses

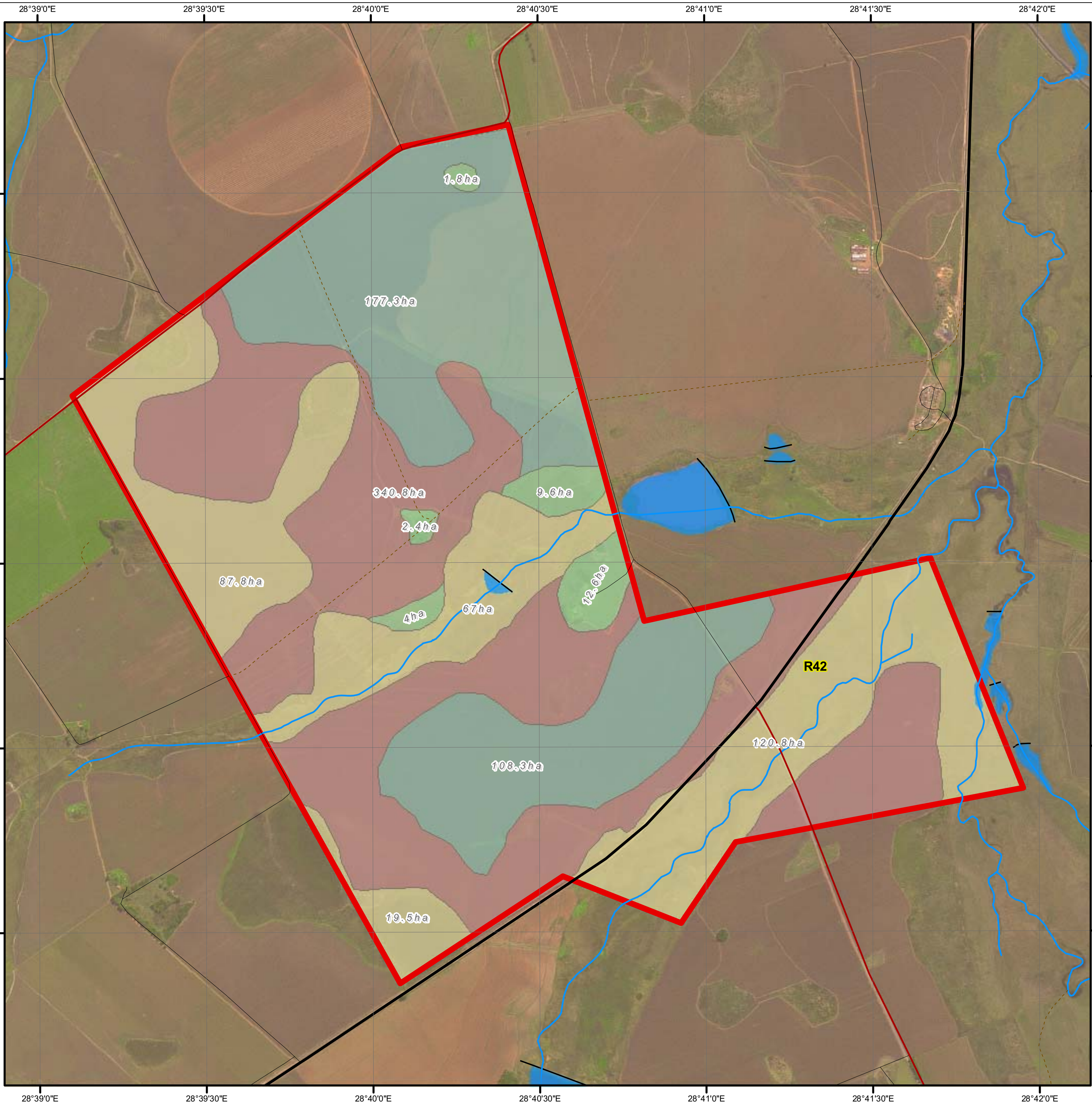
Sample Point	Soil Form	C %	CEC cmol(+)kg^{-1}	K mg kg^{-1}	P(Bray1) mg kg^{-1}	pH(H_2O)	Sand %	Silt %	Clay %
S1	**Katspruit Uncultivated**	.52	10.2	381	14.3	6.69	45.1	28.9	26
S2	**Tukulu Cultivated**	.07	6.5	196	45.5	6.63	58.6	19.4	22
S3	**Katspruit Cultivated**	.97	7.1	169	25.9	6.51	61	23	16
S4	**Tukulu Cultivated**	.66	5.6	120	30.6	6.57	66.7	17.3	16
S5	**Oakleaf Cultivated**	.65	5.2	54	125.8	6.44	66.1	15.9	18
S6	**Oakleaf Cultivated**	.83	6.5	117	98	6.68	58	20	22
S7	**Oakleaf Cultivated**	.98	6.0	247	33.7	6.18	61.4	20.6	18

Plan 1: Wolvenfontein Soil Distribution Map.

Plan 1

Universal Coal Kangala Coal Mine

Soil Types



Legend

- Project Area
- Arterial / National Route
- Main Road
- Minor Road
- Track
- Non-Perennial Stream
- Perennial Stream
- Dam Wall
- Dam / Lake

Soil Types

- High potential agricultural soil - Oakleaf soil form
- High potential agricultural soil - Tukulu soil form
- Low potential agricultural soil - Katspruit soil form
- Low potential agricultural soil - Mispah/Glenrosa soil forms

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Kilometres
1:20,000

Picture 5: Well managed soil conservation practise in place. Contoured fields prevent soil erosion by decreasing water runoff at Wolvenfontein, Delmas, August 2009.

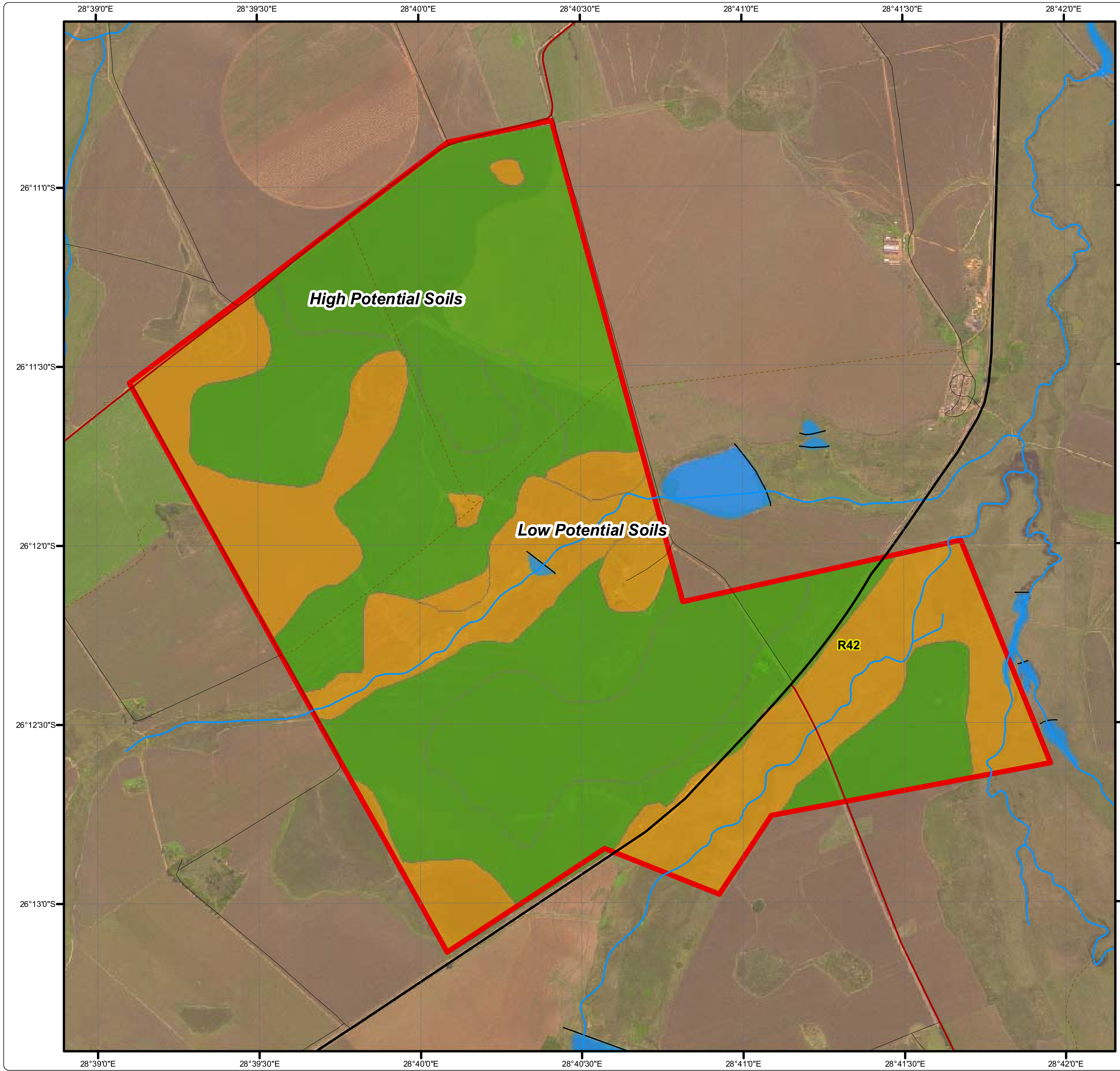
Picture 6: Well managed soil conservation in the form of a grassed water way, preventing runoff and erosion at Wolvenfontein, Delmas, August 2009.

9.2 Land Capability

Land capability is determined by a combination of soil, terrain and climate features. Land capability is defined as the potential intensive long term use of land under rain-fed conditions. At the same time an indication is given about the permanent limitations associated with the different land use classes.

The land capability of the farm Wolvenfontein is classified as mainly arable, high potential farm land (see Plan 2). 71 % of the total area consists of arable high potential soil. 29 % of the farm is occupied by low potential agricultural soil due to mainly depth restrictions on the one hand and imperfect drainage on the other hand. The exceptions to arable farm land being the shallow soil in the pan and wetland areas. A small portion, namely 10 %, of the total area comprising of pan and wetland areas, is cultivated. These areas will present the farmer with challenging problems especially during wet seasons due to the shallow soil and underlying waterlogged G horizon.

Plan 2: Wolvenfontein Agricultural Potential Map.



Plan 2

Universal Coal Kangala Coal Mine

Agricultural Potential

Legend

- Project Area
- Arterial / National Route
- Main Road
- Minor Road
- Track
- Non-Perennial Stream
- Perennial Stream
- Dam Wall
- Dam / Lake

Soil Types

- High potential agricultural soil
- Low potential agricultural soil

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Crops yields in the waterlogged areas will be low and using farm machinery on wet Katspruit soil is difficult.

9.3 Agricultural Potential

The agricultural potential of the soil in the survey area is determined by a combination of soil depth and favourable (high rainfall) climatic conditions. The high rainfall in combination with deep soil, result in high arable agricultural potential. Some of the cultivated areas however form part of the wetland areas, see Plan 2. The soils in the wetland areas are shallow and exhibit signs of waterlogging. Shallow waterlogged soil has a low agricultural potential.

The dominant agricultural potential of the farm Wolvenfontein is classified as high potential farm land. There are, however, some areas of low agricultural potential present on the farm. High and low agricultural potential are indicated on Plan 2. The agricultural potential is low because soil depth is very limited in addition to poor drainage and high clay content. Smaller areas of shallow soil containing rocks are also part of the low agricultural potential as shown on Plan 2. Shallow rocky soils cannot be easily cultivated using normal agricultural equipment.

The agricultural potential of the soil in the survey area is determined by the combination of soil depth and favourable (high rainfall) climatic conditions. The soil occurring in the potential opencast mining site, however, contains high clay content, is waterlogged and shallow.

9.4 Land Use

The predominant present land use in the wider area is arable agriculture. The farm Wolvenfontein is no exception and land use is dominated by arable crop production due to the dominant high potential soil. Plan 3 contains the land use information. Current land use is estimated at 81 % of the available land being used for arable farming. 19 % of the total available farmland is un-used due to shallow soils and wetland areas. The area is well serviced by tar roads as well as farm roads.

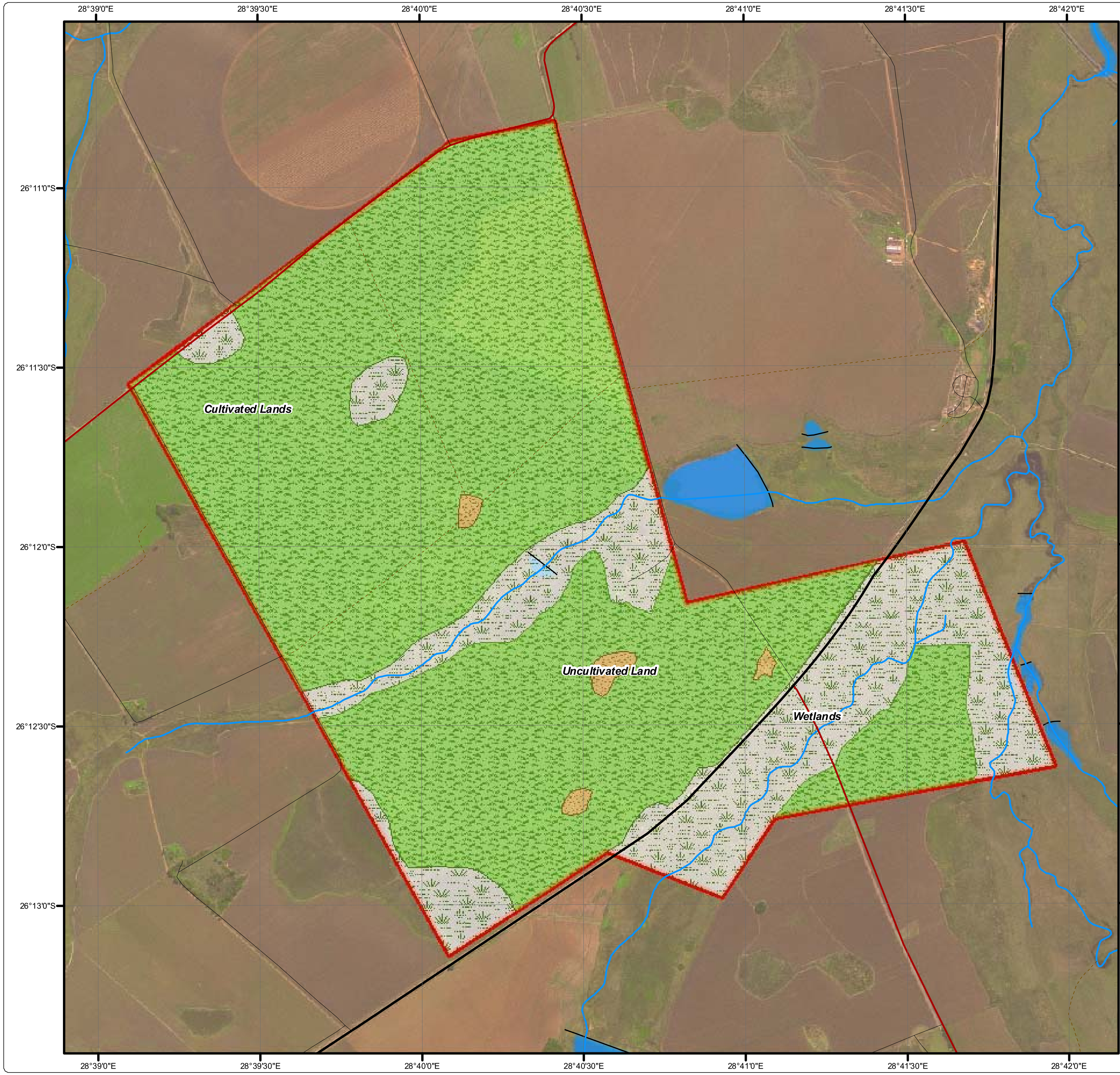
Arable crop farming activities dominate at the farm Wolvenfontein. During the time of the field survey the fields were cultivated but unplanted in anticipation of the rainy season. Only the wetland areas contain perennial vegetation potentially available for grazing. The wetland areas at Wolvenfontein are however not fenced off and are not used for grazing. The wetland areas were burnt during the winter thereby limiting potential grazing opportunities.

Plan 3: Wolvenfontein Land Use Map.

Plan 3

Universal Coal Kangala Coal Mine

Landuse



Legend

- Project Area
- Arterial / National Route
- Main Road
- Minor Road
- Track
- Non-Perennial Stream
- Perennial Stream
- Dam Wall
- Dam / Lake

Landuse

- Cultivated Lands
- Uncultivated Land
- Wetlands

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Kilometres

1:20,000

10 REHABILITATION

The rehabilitation process starts through proper placement of stripped materials from the start of the mining process. The following points are applicable to ease the flow of the rehabilitation process:

- Before mining begins, strip the topsoil and subsoil from the boxcut area and from the adjacent strips to be mined, and place these adjacent to the proposed location of the final void, so these can be used for final rehabilitation.
- Thereafter, mining commences, with the boxcut overburben also located next to the final void position.
- For subsequent cuts, overburden will be replaced into the opening boxcut void, reshaped to provide the final topography to ensure free drainage.
- The subsoil and topsoil stripped from the next cut is then placed directly onto the reshaped spoil.
- This process continues up to the final void which is to be filled with the stockpiled boxcut material, and then covered with the subsoil and topsoil stockpiled materials.(Chamber of Mines of South Africa, Coaltech 2020, 2007, Tanner, Personal communication, 2009)

Topsoil should be stripped and stockpiled first. Topsoil contains seed, organic carbon and nutrients (especially expensive P from intensive maize faming operations), more so than subsoil. The topsoil in this area is considered to be 0.35 m thick. Topsoil should be stockpiled separately from any other soil material using truck and shovel as the preferred method of soil stripping. Stripping of soil materials should be undertaken during the dry season to minimise compaction caused while stockpiling.

The topsoil stockpile height should be limited to 2 – 3 m. The limited height is important to preserve aerobic conditions in the topsoil thereby preventing future reclamation problems. Stripping and stockpiling the topsoil first will ensure that the source of post mining rehabilitation nutrients and seeds are retained. Table 3 contains the volumes and areas to be stripped and stockpiled. The topsoil must be protected against erosion. Erosion prevention and loss of soil can be ensured by not allowing steep slopes during stockpile construction and no unintentional soil removal should be allowed.

The following rehabilitation specifications for Wolvenfontein should be kept in mind (Goose, 2001):

- The sides of the soil stockpiles should be angled ensuring stability preventing erosion at 1:3 (18.5 degrees from horizontal).
- Stockpile height should be limited to 2 – 3 m for medium textured soil and 1 m for heavy clay soil.
- If possible immediately start reclamation programmes by redistributing soil.
- Do not strip or redistribute top or sub soils if too wet, cultivating wet soil destroys soil structure and can produce unwanted large clods in the case of clay soils. Use a farmer stick test to determine if soil is too wet to cultivate/redistribute. A sharpened broom sized stick must be pushed into and removed from the soil surface. If soil sticks to the stick then the soil is too wet to cultivate. Serious compaction may result if machine handling of wet soil continuous.

The demarcated soil types contained in Plan 1 complimented by Table 3 can be used as a guideline to strip and stockpile the soil. Stripping the red subsoil of the well aerated soil should follow topsoil stripping. The heavy clay soil cannot be stockpiled together with any red top or sub soil. The clay top soil should be stored separate from the clay subsoil in a stockpile not more than 1 m high.

Stockpiles for topsoil and subsoil should be kept separated. Any mixing will dilute nutrients and carbon content already contained in the topsoil. Stockpiles should be located away from operational areas. Stockpile height is not a problem where subsoil is concerned but erosion similar to topsoil, is a real threat.

Subsoil stripping and stockpiling should use truck and shovel as defined for stripping topsoil. It must be emphasized that sub soil material is unsuitable to be used as topsoil material. Care should be taken that the subsoil materials do not get mixed with materials earmarked for topsoil rehabilitation.

If stockpiles are stored for long periods then topsoil chemical and physical degradation is certain. Soil stockpiles must then be vegetated and maintained using vegetation adapted to site specific climatic conditions. Vegetation should only be established after obtaining soil stockpile analytical data to ensure that all fertility needs are met. It should be the objective of the mine to contain vegetation material (carbon) in the topsoil as far as possible.

10.1 Soil Replacement

Reclamation of opencast areas should follow the reverse order of stripping. Proper shaping of the spoil layer as close to the original topography as possible, should be attempted. This process should commence as soon as possible thereby preventing natural topsoil deterioration.

Topsoil should be dumped in sufficient quantities to allow levelling with as little vehicle movement as possible. The use of bull-dozers and bowl scrapers for spreading soil should be avoided and replaced with truck and shovel. Vehicle movement control is needed to prevent compaction of newly constructed soil profiles. Normal agricultural equipment cannot alleviate compacted soil profiles sufficiently. Traffic control precautions will ensure that the reclamation process meet EMP commitments for closure purposes.

Table 3 contains the area, stripping depth and available volumes of soil. Stockpile 1 should contain the Oakleaf and Tukulu topsoil only. Stockpile 2 contains all the Oakleaf and Tukulu subsoil while Stockpile 3 contains the Katspruit and other wetland clay soils. The Katspruit and wetland soils are very shallow and it will be difficult to separate the top and subsoil. It is recommended that the Katspruit top and subsoil be kept together in one stockpile.

The reclamation process should keep pre mining topography in mind. Tukulu soil should be rehabilitated in a high landscape positions while clay soil should be put back in a low landscape positions. Depth of rehabilitated soil can be 0.8 – 1 m to re-establish and emulate pre-mining arable land capability (Tukulu) soil in an area similar in size of 167 ha as occurred in pre-mining. Similarly clay soil should be reclaimed using an area of 87 ha at a depth of 0.5 m to emulate pre-mining as closely as possible.

Representative fertility status of reclaimed area should be determined by soil sampling and laboratory analyses. Any nutrient deficiencies should be rectified prior to the establishment of any vegetation or crops. Soil acidity through pH testing in addition to nutrient status, should be determined and rectified through liming if needed.

Post rehabilitation soil reclamation is not an easy task, especially when vegetation is already established. Reclamation of chemical problems namely low fertility and high soil acidity is possible but costly. Physical problems such as compaction and hardsetting are the real concern because normal agricultural equipment cannot be used to effectively alleviate compaction problems. Impacts from compacted soil on vegetation can be severe due to restricted root growth, low water penetration and low water holding capacity. Compacted shallow soils are commonly found after opencast mining rehabilitation resulting in poor vegetation and crop production. Any compaction induced by mining has to be alleviated before rehabilitation can be considered to be effective.

Table 3: Estimated Soil stripping volumes in the proposed opencast mining area.

Soil Types	Stockpile Number	Stripping Depths (m)	Area (ha)	Volume (m^3)
Topsoil (Oakleaf and Tukulu only)	1	0.35	626.4	2 192 400
Subsoil (Oakleaf and Tukulu only)	2	0.75	626.4	4 698 000
Cultivated topsoil and subsoil (Katspruit only)	3	0.5	87.8	439 000
Uncultivated topsoil and subsoil uncultivated wetland	3	0.5	140.3	701 500
Total estimated volume (m^3)				**8 030 900**

11 DESCRIPTION OF IMPACTS

Soil cover thickness, texture and sequence of soil horizons status vary across and down the slope in response to bedrock type, slope gradient, climate and organic inputs. The topsoil is regarded as the upper 0.3 m – 0.35 m of the soil profile. The topsoil, subsoil and weathered rock that constitutes the overburden must be removed and stockpiled during mining operations in most opencast mining situations.

The natural sequence of soil horizons are destroyed during opencast mining operations. It is normally intended that topsoil and subsoil materials are stored separately on stockpiles and that the rehabilitation process should occur in the reverse order of stripping. Some soils cannot be used as topsoil and should be kept separately for site specific applications. The section on soil rehabilitation in this report contains specific details regarding soil types to be used for rehabilitation. Topsoil stockpiles tend to degrade during long-term stockpiling and lose their organic content and fertility status. In the case of Wolvenfontein this is important to remember because the soil is used for arable agriculture. The pH and fertility status are therefore optimal for commercial crop production. Commercially viable soil fertility status, under arable farming conditions is expensive to reach and maintain and does not occur naturally. Rehabilitation should therefore take advantage of this by carefully separating top- and subsoil stockpiles. Rehabilitation should commence as soon as is practical possible.

Changing soil properties also changes land capability which is a function of the soil thickness and fertility status, slope, drainage, climatic regime and vegetation types. Wolvenfontein is classified as Class ii arable land with very few limitations regarding arable use. Soil rehabilitation should aim to at least rehabilitate back to land capability emulating pre-mining land capability proportionally. The mined land and the end use options should strive to keep post mining land use as arable agriculture because the surrounding land use in Delmas is arable agriculture.

12 MITIGATION MEASURES AND MANAGEMENT PLAN

The soil related mining activity impact mitigation measures are relevant in all opencast mining situations. The following list is used as an indication of the mitigation actions needed during the phases of mining and after closure:

C – Construction phase

O – Operational phase

D – Decommissioning phase

P – Post closure

(C, O) Compile accurate soil map showing classification, thickness, fertility status. Remove and stockpile 0.3 m- 0.35 m topsoil in berms or heaps less than 2 – 3 m high. Do not use as storm water control feature. Vegetate with diverse grass mix to control erosion. Wetland soils should only be stockpiled at heights of 1 – 2 m. Subsoil stockpiles can be bigger but must be protected against erosion similar to topsoil stockpiles.

(C, O) Remove and stockpile topsoil from roads, building platforms, stockpile and dam areas prior to construction.

(O) Petrochemical spillages to be collected in a drip tray and drum to store excavated spill affected soil for disposal at a registered facility.

(C, O) Stormwater diversion and erosion control contour berms separate clean and contaminated water systems around the pit and infrastructure areas. Design erosion control and diversion berms, terraces or drains with the runoff for a particular soil type and slope gradient.

(O, D) Analyse soils, treat to ameliorate salinity or contamination and dispose of untreatable soil at an approved disposal site.

(D, P) Restore overburden to recreate slope form and topsoil with optimal fertilisation based on soil analysis.

(D) Scarify roads and stockpile areas to a depth of 500mm and infrastructure areas and restore topsoil cover.

(D, P) Implement soil conservation measures.

(P) Integrate disturbed area to most appropriate landuse to ensure long-term stability of restored topsoil.

(C, O) Focus developments and avoid un-necessary subdivision of land and activities that could be sited on already disturbed land.

(C, O, D, P) Integrate available land with activities in adjacent areas.

(D, P) Rehabilitation must ensure long-term stability and not compromise post-mining land use objectives.

(C, O) Plan to focus developments through multi-use options and avoid splitting land and habitats. Integrate the mining area with regional land use planning objectives where possible.

(D, P) Take into account developments in surrounding areas and design post-mining land use options to support and enhance long-term development options.

Guidance is provided by:

The Mineral and Petroleum Development Resources Development Act, 2002 (Act No. 28 of 2002) regulation 56 (1) to (8); soil pollution and erosion control.

The Conservation of Agricultural Resources Act (Act No 43 of 1983) section 4(1) and regulation 6(1)

12.1 Impact and Management Plan

Table 4. Construction Phase

Activity	**Phase**	**Impact**	**Mitigation**	**Responsible person**	**Frequency Duration**	**Significance rating**	
						Before mitigation	**After mitigation**
Transport material Site clearing Construct infrastructure	Construction	Decrease available land area, compaction Erosion	Keep vehicles on roads to minimize compaction Ensure water runoff control measures are in place	Engineer & Environmental co-ordinater	Continuous	High	Moderate
Initial box cut	Construction	Soil compaction	Use truck and shovel to minimize compaction of non mined soil	Engineer & Environmental co-ordinater	Continuous	High	Moderate

Table 5. Operational Phase

Activity	Phase	Impact	Mitigation	Responsible person	Frequency Duration	Significance rating	
						Before mitigation	**After mitigation**
10 Soil, overburden removal, soil stockpiling	Operational	Soil compaction Erosion of road side	Keep vehicle traffic on roads Build contours and ensure integrity through maintenance	Engineer & Environmental co-ordinater	Continuous	Medium - low	Medium - low
13 Vehicle activity	Operational	Soil compaction	Keep vehicle traffic on roads	Engineer & Environmental co-ordinater	Continuous	High	Low
19 Monitor rehabilitation efforts	Operational	Improve soil plant inetraction	Ensure monitoring and remediate if necessary soil fertility, soil acidity and depths.	Engineer & Environmental co-ordinater	Annually	High	Moderate

Table 6. Decommissioning Phase

Listed Activity	Phase	Mitigation		Responsible person	Frequency/ Duration	Significance rating	
						Before mitigation	**After mitigation**
22 Final rehabilitation of opencast area	Decommissioning	Soil compaction Correct soil fertility & use adapted species	Spread using traffic control and truck and shovel Re vegetate using appropriate seed mixes	Engineer & Environmental co-ordinater	Post mining	High	Moderate

Table 7. Post Closure Phase

Listed Activity	Phase	Mitigation		Responsible person	Frequency/ Duration	Significance rating	
						Before mitigation	**After mitigation**
24 Monitoring and rehabilitation	Post closure	Soil compaction	Spread using traffic control and truck and shovel Re vegetate using appropriate seed mixes	Engineer & Environmental co-ordinater	Post mining	High	Moderate

13 MONITORING PROGRAMME

Progressive monitoring of the stripping, stockpiling, shaping of spoil surfaces and replacing of topsoil will ensure successful post-mining land and soil reclamation. Assessing post-mining soil characteristics and associated land capability and land uses is necessary but lack the opportunity to correct failures during the rehabilitation process.

The mine rehabilitation plan should contain the following important soil information:

- Location of soil types than can be stripped and stockpiled together.
- Stripping depths of different soil types.
- The location, dimensions and volume of planned stockpiles for different soil types.
- Progressive monitoring should take place on at least a quarterly basis and should involve the following:
- Inspection of stripping depths
- Inspection of stockpiles to check degradation and or pollution.
- Inspection of spoil surfaces before replacing soil to ensure that pre mined topography is emulated
- Random inspection of soil thickness on rehabilitated sections.
- Fertility analysis and amelioration procedures prior to re-vegetation.
- Evaluating and readjusting the rehabilitation plan.

A final post-mining rehabilitation performance assessment should be done and information should be adequate for closure applications which involves:

- Assessment of rehabilitated soil thickness and soil characteristics by means of auger observations on a 100 x 100 m grid.
- A post-mining land capability map based on soil thickness and characteristics
- A proposed post-mining land use map.
- Erosion occurrences.
- Soil acidity and salt pollution analyses (ph, electrical conductivity and sulphate) at 0-250 mm soil depth every 4 ha (200x200m).
- Fertility analysis (exchangeable cations K, Ca, Mg and Na and phosphorus) every 16 ha (400x400m).
- Bulk density analysis every 4 ha.

14 RECOMMENDATIONS

Considering the cumulative negative impacts of opencast coal mining in general in Mpumalanga then it must be emphasized that soil rehabilitation at Wolvenfontein should strive to proportionally emulate pre-mining land capability and land use. The well drained high potential agricultural soils should be put back in the higher landscape positions while the low agricultural potential wetland and pan area soil should be put back in lower landscape positions. Depth of arable soil should be while rehabilitated wetland soil can be shallow.

15 CONCLUSIONS

The dominant soils found on the property represent the Oakleaf and Tukulu soil forms. The Oakleaf soils are deeper than their Tukulu counterparts. Lower lying pans and wetland areas contain the high clay content Katspruit soil form. The potential opencast area is dominated by the occurrence of Tukulu and Katspruit soil forms.

The dominant land capability of the potential opencast mining area on the farm Wolvenfontein is arable crop farming. Present land use is commercial crop production. The agricultural potential is high on the Tukulu soil but low on the shallow waterlogged Katspruit soil.

Considering the cumulative negative impacts of opencast coal mining on loss of land capability in general in Mpumalanga, then it must be emphasized that soil rehabilitation at Wolvenfontein should strive to proportionally emulate pre-mining land capability and land use. The well drained high potential agricultural soils should be put back in the higher landscape positions while the low agricultural potential wetland and pan area soil should be put back in lower landscape positions.

It is recommended that land should be rehabilitated to pre-mining crop and wetland land capabilities on the planned opencast area. The heavy clay topsoil and subsoil material should not be mixed with the Tukulu topsoil and subsoil material either during stockpiling or reclamation. The heavy clay soil contains high clay content and should be used to rehabilitate lower lying areas rather than higher in the topography.

Compaction by vehicle traffic should be avoided when reclamation takes place. Soil physical problems are of real concern because impacts on reclaimed vegetation are severe due to restricted root growth, low water penetration and low water holding capacity. Compacted shallow soils are commonly found after opencast rehabilitation resulting in poor vegetation establishment and growth. The rehabilitation budget should include costs to cover intensive deep ripping, using custom-built, dozer-drawn ripping equipment.

Soil fertility and acidity status should be established through representative soil sampling and analyses to ensure optimal post reclamation vegetative growth and crop production. Any nutritional or acidity problems should be corrected prior to any vegetation establishment on reclaimed soil.

16 REFERENCES

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Appendix 1: Supplementary soil information

Two water related definitions are applicable for the influence waterlogged conditions have on soil properties namely:

Perched water tables – Perched water tables occur in E horizons of soil forms due to dense underlying B or G horizons respectively. Soil forms containing yellow E horizons (according to soil property definitions supported by Munsell soil color charts) are generally in a drier state than those with grey (according to soil property definitions supported by Munsell soil colour charts) E horizons.

Small areas were identified at Wolvenfontein containing E horizons namely Kroonstad and Longlands soil forms. These soil forms are normally present on slopes of 5 – 8% which represent steeper slopes than those found on average at Wolvenfontein. The Kroonstad soil form contains a sequence of an orthic A horizon overlying an E, in this case bleached, and a G horizon. The Longlands form soil horizon sequence is similar except the bleached E horizon overlies a soft plinthic horizon.

The farm Wolvenfontein contains large areas covering mid – and foot slope terrain unit positions. Soils in these positions are dominated by soil forms indicating signs of wetness namely the Tukulu soil form. This soil form is characterized by a sequence of an orthic A horizon over a neocutanic B horizon with signs of wetness.

Signs of wetness - Occur in subsoil diagnostic and non diagnostic soil horizons. Normally low water permeability due to low porosity (for example caused by impervious clay and parent material layers) causes waterlogged conditions. Water saturation leads to anaerobic soil conditions resulting in iron reduction, loss of reduced iron through leaching resulting in the development of bleached soil colors. Removal of iron also leads to clay loss and poor soil physical conditions for example high bulk density in addition to low porosity.

Dominant Soil Forms Contained in Land Type Ea (valley bottoms).

The Ea land type contains dark coloured clayey soils containing structured diagnostic soil horizons. The underlying geology consist of a combination of shale and dolerite of the Ecca group of the Karoo sequence. The Valsrivier and Arcadia soil forms are well represented in this land type especially on the lower parts of the landscape. These lower parts can be classified as wetlands. The wetland areas are occasionally flooded and therefore wet during the rainy season, but dry mostly out during winter when no rain occurs.

In the case of the Valsrivier soil an orthic (non structured) A horizon overlies a pedocutanic structured B sub soil horizon. In contrast the Arcadia soil consist of an A horizon containing vertic soil properties The clay content in the A horizon is in the order of 15 – 20% but can be higher where shale is present. Soil texture represents a clay loam textured soil.

Dominant Soil Forms Contained in Land Type Bb

The Bb land type contains typically soil catenas (soil type sequences) of red well drained soil in higher or crest terrain units followed by yellow less well drained soils in mid and foot slope positions. The lowest positions in the landscapes are usually occupied by waterlogged soil. Examples of soil forms normally present in a soil catena are Hutton, Clovelly and Katspruit soil forms. The soils found in the Bb land type are typically deep soil in the crest and mid-slope positions while shallow in the valley bottom positions.

Pans are a common occurrence on the Wolvenfontein property especially in the mid and foot slope terrain units. The dominating soil form in the pans is the Katspruit soil form. This soil form contains an orthic A horizon overlying a gleyed G horizon indicative of waterlogged soil. The areas occupied by the pans have been reduced significantly through normal farmland cultivation. These cultivated pan areas might pose challenging farming conditions especially during high rainfall years. High rainfall will cause the Katspruit soils to be saturated with water thereby negatively affecting crop production. The opposite is true for low rainfall years when these clay soils might contain enough water for normal crop production.

The dominant soils are non-structured or apedal in both the A and B soil horizons. The clay content in the A horizon is in the order of 15 – 20% but can be higher where shale is present. Soil texture represents a sandy clay loam textured soil.

Soil Characteristics of Soils Contained in Land Types Ea and Bb.

The A horizon contains low organic carbon (C) content while the B horizon consists of a uniform red pigmented layer in the case of well drained soil. In contrast waterlogged Katspruit soil contain higher C in the A horizon but grey waterlogged subsoil in the B horizon, conditions that negatively impact arable agriculture.

The well drained soil's red pigmentation is produced by iron (Fe) oxides present in the subsoil. The main soil properties indicated by the red pigmentation is that well drained aerated soil conditions prevail. Well aerated and well drained soil conditions are also good for arable agriculture. The red B horizons however, exhibit a neocutanic character. A neocutanic character is indicative of younger soils still undergoing soil formation. Neocutanic soil horizons are subsoil horizons containing evidence of clay movement and aggregation.

General Soil Chemical and Physical Properties

The red soils on the farm Wolvenfontein are considered to have an intermediate cation exchange capacity (CEC). A low CEC reflects low soil clay and organic matter content while the opposite is also true because CEC is a property of both clay and organic material.

A low CEC also reflects the type of clay mineral present in the soil matrix. Low CEC is associated with mainly kaolinitic silicate clay minerals which are generally considered as low activity clays. Low activity and CEC also imply a low natural fertility status because lower concentrations of nutrients can potentially be adsorbed by the soil matrix. Fertility status at Wolvenfontein can be influenced through loss of phosphate by fixation. Phosphate fixation is a common problem in red soils thereby depleting plant available phosphate.

Clayey soils hold more water in the soil profile than their sandy counterparts. The well drained red soils at Wolvenfontein generally contain 15 – 18% clay while the waterlogged Katspruit soil in the pan and wetland areas contain 20% or more clay. Water holding capacity and fertility is therefore naturally good but the cultivated shallow Katspruit soils may pose to be problematic during wet seasons. Too much water during high rainfall events will be a problem to crop production on the Katspruit soils causing waterlogged soil conditions and reduced yields.

Organic matter has a stabilizing effect on soil aggregates which in turn determine the erosion potential of soil. Two main mechanisms are responsible for loss of organic matter in soils. These are cultivation and over grazing. The main mechanism however, causing the biggest loss of organic material in the Wolvenfontein soils, is cultivation.

Appendix 2: Curriculum vitae (CV) and declaration of independence.

Hendrik Smith

2005 PhD (Interdisciplinary), Commonwealth Open University.

1990 MSc (Agric) Soil Science, University of Pretoria.

1983 BSc (Agric) Hons. SoiI Science, University of the Free State.

1978 BSc (Agric) Soil Science and Plant Nutrition, University of Pretoria.

AFFILIATIONS

1. Registered as a soil scientist with the South African Council for Natural Scientific Professions (Pr.Sci.Nat. Soil Science)

2. Member of the following relevant bodies:

- Soil Science Society of South Africa since 1981
- South African Soil Surveyors Organization

EMPLOYMENT

January 1981 -July 1999. Institute for Soil Climate and Water, Agricultural Research Council.

July 1999 – September 2003. Freelance soil consultant and franchise owner.

September 2003 – January 2008. University Pretoria, Department Plant and Soil Science.

January 2008 – February 2009. Free lance soil consultant.

February 2009. Joined Digby Wells and Associates.

EXAMPLES OF EXPERIENCE

- The effects of soil properties and electrolyte concentration on surface sealing and runoff.
- Reclamation of soil surface sealing and crusting using soil ameliorants.
- The effects of industrial effluents (water quality) on soils.
- Evaluation of organic composted products, lime, gypsum and fertilizers for heavy metals and other health-related micro-elements.
- The influence of heavy metals and health-related micro-elements on soil, plant and water system.
- Reclamation of a sacrificial sewage sludge dumping site.
- Reclamation of sodic and saline industrial sites.
- Reclamation of a coarse ash dump site.
- Reclamation of a kimberlite dump site.

- Soil surveys and agricultural potential studies.
- Wetland delineation soil surveys.
- Managing orchard root zone electrical conductivity and fertility using wetting front detectors.

Specialist Declaration of Independence

I,______________________________________, declare that I –

- Act as the independent specialist for the undertaking of a specialist section for the proposed project ;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- Do no have nor will have a vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006;

____

Name of the specialist

____

Signature of the specialist

____

Name of company

____

Date