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ENVIRONMENTAL

Environmental Impact Assessment for KPSX: Weltevreden

Soil Survey Report

Project Number:

BHP2690

Prepared for:

Billiton Energy Coal South Africa (PTY) Limited (BECSA)

January 2015

Digby Wells and Associates (South Africa) (Pty) Ltd
(Subsidiary of Digby Wells & Associates (Pty) Ltd). Co. Reg. No. 2010/008577/07. Fern Isle, Section 10, 359 Pretoria Ave Randburg Private Bag X10046, Randburg, 2125, South Africa
Tel: +27 11 789 9495, Fax: +27 11 789 9498, info@digbywells.com, www.digbywells.com

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Name	Responsibility	Signature	Date
Hendrik Smith	Surveyor and Report Compiler		December 2014
Wayne Jackson	Report Reviewer		January 2014
Danie Otto	Senior Review		January 2015

EXECUTIVE SUMMARY

BHP Billiton Energy Coal South Africa (Pty) Limited (BECSA) is the holder of an approved Mining Right (Ref No. MP 30/5/1/2/2/125 MR) and Environmental Management Programme (EMP) for Klipspruit Colliery (KPS), located near Ogies, Mpumalanga Province. The Klipspruit EMP was approved in 2003 in terms of Section 39 of the Minerals Act, 1991 (Act No. 50 of 1991) and in 2009 was subsequently updated to meet the requirements of the Mineral and Petroleum Resources Development Act, 2002 (Act No 28 of 2002) (MPRDA).

BECSA is proposing to extend the Life of Mine (LoM) of its operation by implementing the Klipspruit Extension (KPSX) Project which incorporates Klipspruit South (KPSX: South), as well as the Weltevreden Project. The Mining Right for KPS incorporates the Klipspruit Main Pit, the Smaldeel Mini-pit, Bankfontein Project, and KPSX: South sections.

Digby Wells Environmental (Digby Wells) has been appointed by BECSA as the independent Environmental Assessment Practitioner (EAP) to conduct an Environmental Impact Assessment (EIA) and the associated specialist studies for the proposed opencast mining operation for its KPSX: Weltevreden Project.

This report discusses the soil types, land capability, present land use, and rehabilitation considerations within the KPSX: Weltevreden Project site. The KPSX: Weltevreden Project site is dominated by the presence of high potential agricultural soils such as Hutton, Clovelly, Pinedene and Oakleaf soils.

The KPSX: Weltevreden Project site was traversed by vehicle and on foot. A hand soil auger was used to determine the soil type and depth. The soil was augered to the first restricting layer or to a 1.5 m depth. Survey positions were recorded as waypoints using a handheld GPS. 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).

The project site is dominated by the presence of high potential agricultural soils such as Hutton, Clovelly, Pinedene and Oakleaf soils, which represent 60% of the totalarea. Forty percent of the project area consists of wetland soils. The Hutton, Avalon, Pinedene, Oakleaf and Clovelly soil types present within the project site can all be stripped and stockpiled together because the inherent soil properties are similar. The soil types are dominated by deep well drained red and yellow soils.

However the Avalon and Longlands soils do contain a soft plinthic layer in the subsoil. This soft plinthic layer should not be stripped with the brown Avalon and grey Longlands subsoil, because this layer hardens to a rock like consistency when exposed to air. Fernwood wetland soils should be stripped, if allowed and agreed upon by the authority, and stockpiled separately from all other soils.

The soil fertility status of KPSX: Weltevreden is augmented through annual fertilisation to sustain commercial crop production as can be seen from the phosphorous (P) content in the

topsoil. Natural soils (uncultivated) within the Ogies region is expected to contain 1 – 5 mg kg^{-1} P in the topsoil. The cultivated soils within the project site contain 25 – 37 mg kg-1 P in the topsoil. This is a clear indication that the soil fertility was adjusted to ensure commercial successful maize production on these high agricultural potential soils. The high agricultural potential is proven through farmers records over the past 25 years of maize production. The average yield over the 25 year period is 7 tons maize per ha on the farm.

The land capability within the KPSX: Weltevreden Project site varies between wetlands and arable land. Wetlands are covering 40% while 58% of the soil types present represent Arable Class II and the remaining 2% Arable Classes III and IV.

The project area is located within existing commercial farm land and the land use is dominated by 57% grazing and 42% arable crop.

Potential impacts on soil

Construction Phase

During the construction phase the work carried out will mainly be the construction of the opencast mine and supporting infrastructure. This will entail the clearing of areas and the disturbance of the topsoil through excavations as well as the construction of a soil stockpile. The topography and natural drainage lines will be disturbed. The overall impact will be loss of topsoil as a result of erosion and possible contamination of the soil by coal dust, fuel and oils as a result of excavation activities. Soil compaction caused by heavy vehicles and machinery surrounding the pit areas may be a problem.

Soil stripping will require the removal of all soil materials to a depth of at least 1.0 m. This activity will provide needed soil cover material for rehabilitation purposes. Construction activities will change the land use from arable farming to mining causing unsuitable conditions for any further commercial farming.

Operational Phase

Soil erosion through wind and storm water run-off and soil pollution by means of hydrocarbon contamination and potentially coal dust may be encountered during the operational phase. Water runoff from roads must be controlled and managed by means of proper storm water management facilities in order to prevent soil erosion. Diesel and oil spills are common at mine sites due to the large volumes of diesel and oil consumed by mine vehicles. Pollution may however be localised. Small pockets of localised pollution may be cleared up easily using commercially available hydrocarbon emergency clean-up kits.

Backfilling of soil will impact on the land capability by restoring land capability to some extent. The quality of rehabilitation depends on the management of soil materials. Yellow and red soils have to be replaced in upland landscape positions while wetland soils have to be replaced in low landscape positions. Red and yellow topsoil (top 0.35 m) must be replaced last overlying the subsoil 0.5 m. The red and yellow soil represents arable soil and the thickness of the soil cover is recommended to be 0.5 m subsoil underlying 0.35 m topsoil providing a profile depth of 0.85 m. Wetland soil should also be replaced in lower landscape positions such as 0.3 m wetland topsoil overlying 0.3 m wetland subsoil providing a soil cover depth of 0.6 m.

Decommissioning Phase

All foundations and remaining opencast excavations must be backfilled and then covered with subsoil material first and then topsoil, sampled, tested, fertilised and re-vegetated.

The mitigation success for the impacts will largely depend on the soil management from pre-mining phase right through to decommissioning phase. If soils are managed properly, as per the recommendations, then the impacts will be significantly reduced.

Maize production has been continuing for decades in the Ogies region and can continue for decades more on the same soils. Mining will however change the soil and land capability resulting in yield losses of at least 25% if rehabilitation of the opencast coal mined areas can emulate pre-mining arable land capability.

High fertilizer cost, reductions in crop yields in addition to difficulty of cultivating rehabilitated land, makes the land use option of commercial arable farming on rehabilitated land questionable.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLANS

1 Introduction

BHP Billiton Energy Coal South Africa (Pty) Limited (BECSA) is the holder of an approved Mining Right (Ref No. MP 30/5/1/2/2/125 MR) and Environmental Management Programme (EMP) for Klipspruit Colliery (KPS), located near Ogies, Mpumalanga Province. The Klipspruit EMP was approved in 2003 in terms of Section 39 of the Minerals Act, 1991 (Act No. 50 of 1991) and in 2009 was subsequently updated to meet the requirements of the Mineral and Petroleum Resources Development Act, 2002 (Act No 28 of 2002) (MPRDA).

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In order to identify soils accurately, it is necessary to undertake a soil survey, in accordance with standard soil survey procedures using the published soil classification system for South Africa (Taxonomic Soil Classification System for South Africa, 1991).

The aim was to provide a record of the soil resource occurring at the proposed project site. Land capability/potential and land use were also surveyed. The objective of determining the land capability/potential is to identify and classify the most sustainable use of the soil resource without degrading the system.

The soil types found within the Ogies region have high agricultural potential and have been commercially farmed for decades. Farming includes arable crop production and animals but arable farming dominates due to the favourable climatic conditions in combination with high potential agricultural land.

2 Terms of Reference

The following tasks were undertaken in the compilation of the soil assessment, land capability and land use study:

2.1 Soil Study

- A baseline soil and impact assessment of the proposed project sites and impact assessment of the proposed activities associated with the KPSX: Weltevreden opencast coal mine sites. The soil survey information is also discussed within the rehabilitation plan.

- The soil classification was done according to the Taxonomic Soil Classification System for South Africa, 1991;
- Current land use;
- Land capability;
- Soil samples of top soil and sub-soil were collected and analysed. The soil analysis include the following:
  - Phosphorus (Bray 1);
  - Exchangeable cations – Na, K, Ca, Mg (Amm. Acetate); and
  - pH.

3 Expertise of the Specialist

Dr Hendrik Smith is a registered Professional Natural Scientist (Soil Science) with the South African Council for Natural Scientific Professions registration number 400206/08. His present area of focus is soil surveying. He also assists with the relevant sections of Rehabilitation Guidelines, EIAs and EMPRs. He is part of the Bio-physical Department at Digby Wells Environmental.

4 Project Description

BECSA has identified coal reserves adjacent to its current Klipspruit Colliery at the proposed KPSX: Weltevreden Project area, situated close to Ogies in Mpumalanga, see Figure 4-1. It is understood that BECSA currently holds three prospecting rights for the project area and is undertaking an Identification Phase Study (IPS) (also known as Conceptual Phase). The aim of the IPS is to identify a value-creating investment and determine potential strategic alternatives to be assessed further during a Selection Phase Study (SPS) (equivalent to Pre-feasibility).

The activities proposed to occur on the KPSX: Weltevreden project site include a combination of opencast and underground mining, the construction and use of haul roads, drag line, the storage of coal discards and other associated infrastructure.

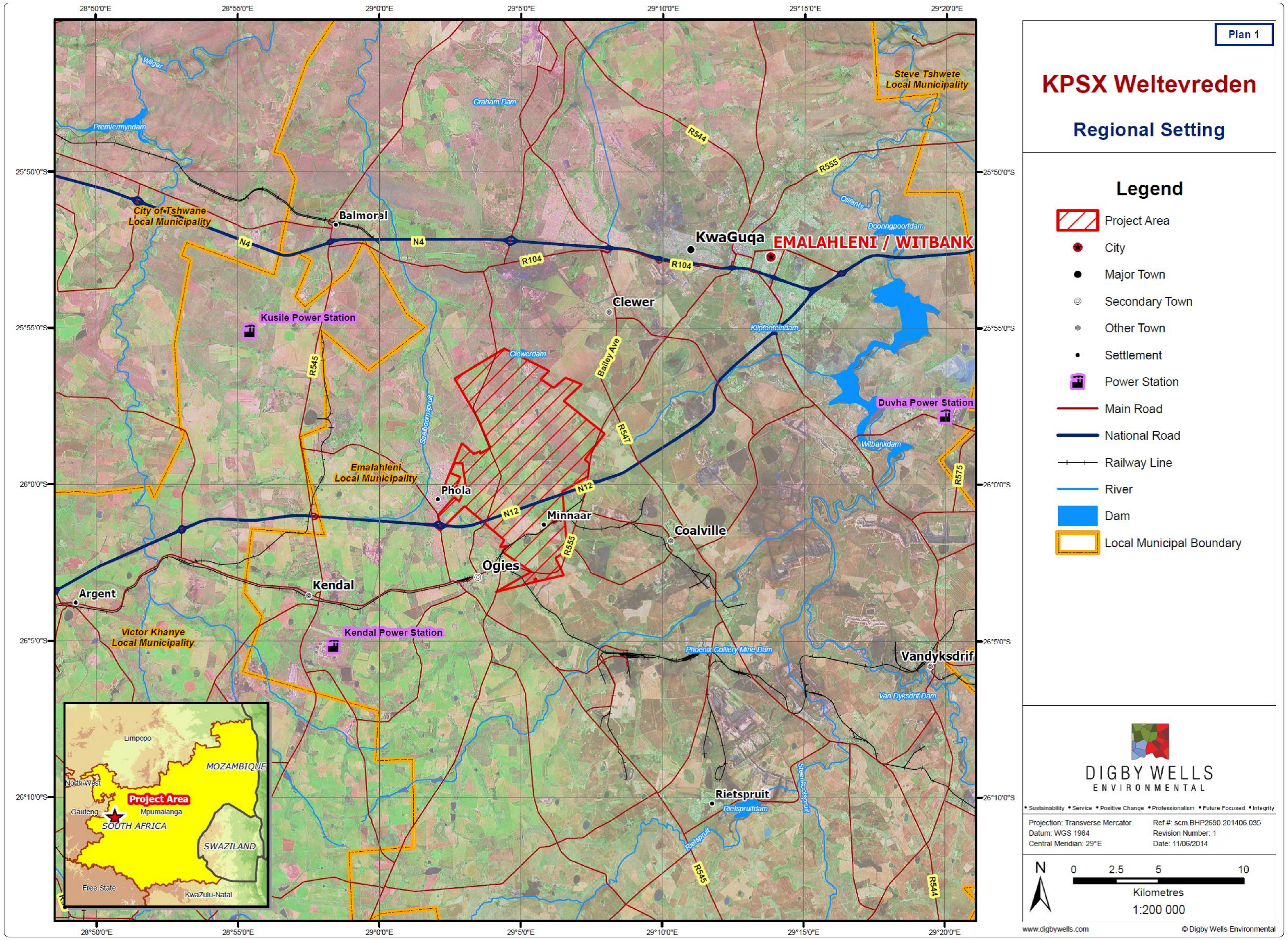


Figure 4-1: Local setting of the KPSX: Weltevreden project site

5 Methodology

5.1 Soils

Land type information and maps relevant to the terrain, soils and climate of the area were obtained from the Institute for Soil, Climate and Water (ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 – 2006).

A land type denotes an area that can be shown at 1:250 000 scale and that displays a marked degree of uniformity with respect to terrain form, soil pattern and climate. One land type differs from another in terms of one or more of terrain form, soil pattern and climate.

The KPSX: Weltevreden project site was traversed by vehicle and on foot. A hand soil auger was used to determine the soil type and depth. The soil was augered to the first restricting layer or to a 1.5 m depth.

Survey positions were recorded as waypoints using a handheld GPS. 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).

The topsoil (0-30 cm) and subsoil (30-60 cm) of only dominant soil groups were sampled. The samples were analysed at Intertek Laboratory, Bapsfontein for soil acidity and fertility indicators.

5.2 Soil and Land Capability

Land capability is determined by a combination of soil, terrain and climatic features. The land capability classification used in this survey indicates sustainable long term use of land under rain-fed conditions while soil properties implicating agricultural production limitations associated with the various land use classes are taken into consideration.

Land Capability as defined in South Africa can be classified using three approaches. The first approach is used in agriculture and is recommended by Schoeman et al, 2000.

The second and third approaches are contained in the Coaltech Research Association and the Chamber of Mines of South Africa Guidelines for the Rehabilitation of Mined Land, 2007.

Schoeman et al (2000) defined land capability to be determined by the collective effects of soil, terrain and climatic features. The defined land capability shows the most intensive long-term use of land for rain-fed agriculture and at the same time indicate the *permanent limitations* associated with the different land-use classes. The classification system is made up of four orders and eight classes namely:

- Order A: Arable land – high potential land with few limitations (Classes I and II);
- Order B: Arable land – moderate to severe limitations (Classes III and IV);
- Order C: Grazing and forestry land (Classes V, VI and VII); and

- Order D: Land not suitable for agriculture (Class VIII).

The 2007 Guidelines for the Rehabilitation of Mined Land recommend the classification criteria for pre-mining rehabilitated land to be arable, grazing, wilderness and wetland. The following criteria are used for the land capabilities mentioned are as follows:

- Wetland, Class I;
- Arable land, Class II;
- Grazing land, Class III, and
- Wilderness land, Class IV.

In addition the 2007 Guidelines for the Rehabilitation of Mined Land recommend the classification criteria for post mining rehabilitated land to be arable, grazing, wilderness and wetland. The following criteria are used for the land capabilities mentioned above and I quote:

- Arable: The soil depth exceeds 0.6 m, the soil material must not be saline or sodic and the slope (%) will be such that when multiplied by the soil erodibility factor K, the product will not exceed 2.0;
- Grazing: The soil depth will be at least 0.25 m;
- Wilderness: The soil depth is less than 0,25 m but more than 0.15 m; and
- Wetland: The soil depths as for grazing are used but wetland soils must be used for the construction of wetlands. These wetland soils should have been separately stockpiled.

Land capability depends on soil capability in combination with climate. The land capability depends on soil depth which was determined at soil survey positions using the land capability as defined by Schoeman et al (2000) discussed above, see Plan 3. Survey positions were recorded as waypoints using a handheld (Global Positioning System (GPS)).

5.3 Land Use and Land Capability

Present land use was determined using aerial imagery and then verified during the soil survey and is depicted in Plan 4.

5.4 Environmental Impact Assessment

The methodology utilised to assess the significance of potential social and heritage impacts is discussed in detail below. The significance rating formula is as follows:

Significance = Consequence x Probability

Where

Consequence = Type of Impact x (Intensity + Spatial Scale + Duration)

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

Type of Impact = ***+1*** *(Positive Impact) or* ***-1*** *(Negative Impact)*

The weight assigned to the various parameters for positive and negative social and heritage impacts is provided for in the formula and is presented in Table 10-1. The probability consequence matrix for social and heritage impacts is displayed in Table 5-2, with the impact significance rating described in Table 5-3.

Table 5-1: Impact Assessment Parameter Ratings

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem. Persistent severe damage. Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Noticeable, on-going social and environmental benefits which have improved the livelihoods and living standards of the local community in general and the environmental features.	International The effect will occur across international borders.	Permanent: No Mitigation The impact will remain long after the life of the Project.	Certain/ Definite. There are sound scientific reasons to expect that the impact will definitely occur.
6	Significant impact on highly valued species, habitat or ecosystem. Irreparable damage to highly valued items of cultural significance or breakdown of social order.	Great improvement to livelihoods and living standards of a large percentage of population, as well as significant increase in the quality of the receiving environment.	National Will affect the entire country.	Beyond Project Life The impact will remain for some time after the life of a Project.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread positive benefits to local communities which improves livelihoods, as well as a positive improvement to the receiving environment.	Province/ Region Will affect the entire province or region.	Project Life The impact will cease after the operational life span of the Project.	Likely The impact may occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense social benefits to some people. Average to intense environmental enhancements.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years.	Probable Has occurred here or elsewhere and could therefore occur.
3	Moderate, short-term effects but not affecting ecosystem function. Rehabilitation requires intervention of external specialists and can be done in less than a month. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some.	Local Extending across the site and to nearby settlements.	Medium term 1-5 years.	Unlikely Has not happened yet but could happen once in the lifetime of the Project, therefore there is a possibility that the impact will occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by very few of population.	Limited Limited to the site and its immediate surroundings.	Short term Less than 1 year.	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.
1	Limited damage to minimal area of low significance that will have no impact on the environment. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level social and environmental benefits felt by very few of the population.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month.	Highly unlikely/None Expected never to happen.

Table 5-2: Probability Consequence Matrix for Social and Heritage Impacts

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
	Consequence																																					

Table 5-3: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact which may be sufficient by itself to justify implementation of the Project. The impact may result in permanent positive change.	**Major (positive)**
73 to 108	A beneficial impact which may help to justify the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and/or social) environment.	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the Project. These impacts will usually result in positive medium to long-term effect on the social and/or natural environment.	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the social and/or natural environment.	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the social and/or natural environment.	Negligible (negative)
-36 to -72	An important negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the Project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the social and/or natural environment.	Minor (negative)

Score	Description	Rating
-73 to -108	A serious negative impact which may prevent the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe effects.	Moderate (negative)
-109 to -147	A very serious negative impact which may be sufficient by itself to prevent implementation of the Project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects.	Major (negative)

6 Results and Discussion

The proposed project will be located east of the R555, north of the town of Ogies, on either side of the N12 national road approximately 65 km east of Johannesburg and 50 km west of Witbank in the Mpumalanga Province of South Africa.

6.1 Land Types

The land types occupying the KPSX: Weltevreden area are the Ba 4, Ba 5 and Bb 13 land types of the 2528 and 2628 Pretoria and East Rand Land Type maps (Land Type Survey Staff, 1989). The presence of a plinthic catena dominates these land types, see Plan 1.

A very large area of Mpumalanga Province is occupied by plinthic catena that in its perfect sequence is represented by (in order from highest to lowest in the upland landscape crest, midslope and foot slope positions). Red well drained soils for example Hutton soil types, yellow Clovelly soils in the midslope landscape position and less well drained soil in foot slope and valley bottom positions such as the Fernwood and Longlands soil forms.

In addition, shallow Glencoe and Dresden soils, underlain by hard plinthite, occur in some places within the landscape.

6.1.1 Dominant Soil Forms contained in Land Type Ba 4

The underlying geology of land type Ba 4 consists mainly of shale and sandstone of the Ecca Group, Karoo Sequence.

The land area occupied by the Ba4 Land Type is 93 300 ha. The Ba4 Land Type is dominated by 45% crest and 40% mid-slope terrain unit positions in the landscape. Other positions in the landscape are foot-slope and valley bottom positions occupying 10% and 5% of the landscape positions respectively see the representative terrain sketch in Figure 6-1.

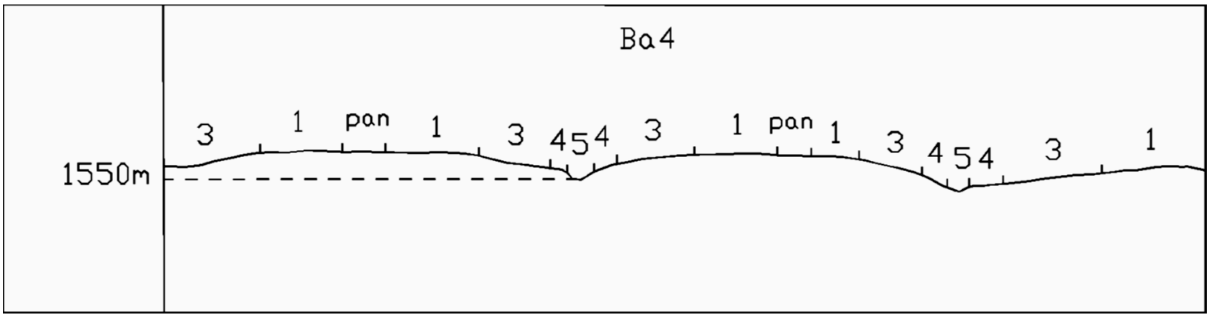


Figure 6-1: Representative terrain form sketch of land type Ba 4

The Ba 4 Land type is dominated by deep well drained red/yellow-brown apedal soils, with about 60% of the land type having these soils; the average slope is estimated at 1.5 %. The following list of soil types occur within the crest position (45%) of this land type:

- Hutton (Hu) - 35%
- Avalon (Av) – 10%
- Glencoe (Gc) and other shallow soils – 55%

The following list of soil types occur within the midslope position (40%) of this land type:

- Hutton (Hu) - 50%
- Avalon (Av) – 15%
- Glencoe (Gc) and other shallow soils – 35%

6.1.2 Dominant Soil Forms contained in Land Type Ba 5

The underlying geology of land type Ba 5 consists of Shale, hornfels and chert of the Silverton Formation, Pretoria Group; tillite and shale of the Dwyka Formation, diabase, shale, shaly sandstone, grit, sandstone and conglomerate of the Ecca Group, eruptive breccia, agglomerate and lava.

The land area occupied by the Ba 5 Land Type is 77 663 ha. The Ba 5 Land Type is dominated by 20% crest and 60% mid-slope terrain unit positions in the landscape. Other positions in the landscape are foot-slope and valley bottom positions occupying 15% and 5% of the landscape positions respectively see the representative terrain sketch in Figure 6-2.

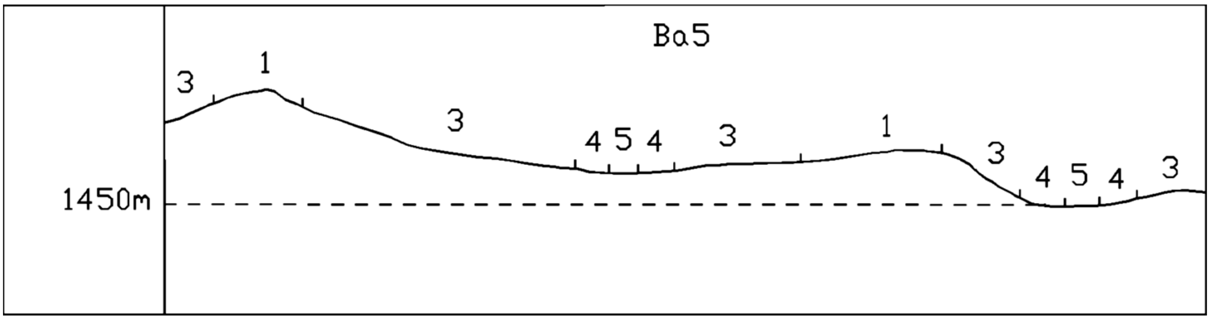


Figure 6-2: Representative terrain form sketch of land type Ba 5

The Ba 5 Land type is dominated by deep well drained red/yellow-brown apedal soils, with about 60% of the land type having these soils; the average slope is estimated at 1.5 %. The following list of soil types occur within this land type in the crest (20%) of the landscape:

- Hutton (Hu) – 60%
- Clovelly (Cv) – 10%
- Shallow rocky soil – 30%

The following list of soil types occur within this land type in the midslope (60%) of the landscape:

- Hutton (Hu) – 40%
- Clovelly (Cv) – 10%
- Avalon (Av) – 10%
- Other shallow rocky soil – 40%

6.1.3 Dominant Soil Forms contained in Land Type Bb 13

The underlying geology of land type Bb 13 consists of sandstone, grit, shaly sandstone and shale of the Ecca Group, Karoo Sequence.

The area occupied by the Bb 13 land type is 40 316 ha. The Bb 13 land type is, is dominated by 40 % crest and 45 % midslope positions, the remainder (15 %) is occupied by valley bottom landscape positions see the representative terrain form sketch in Figure 6-3.

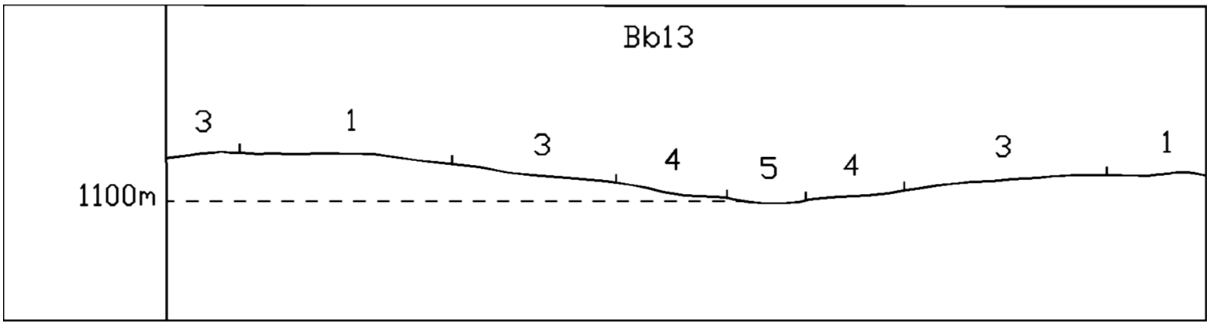


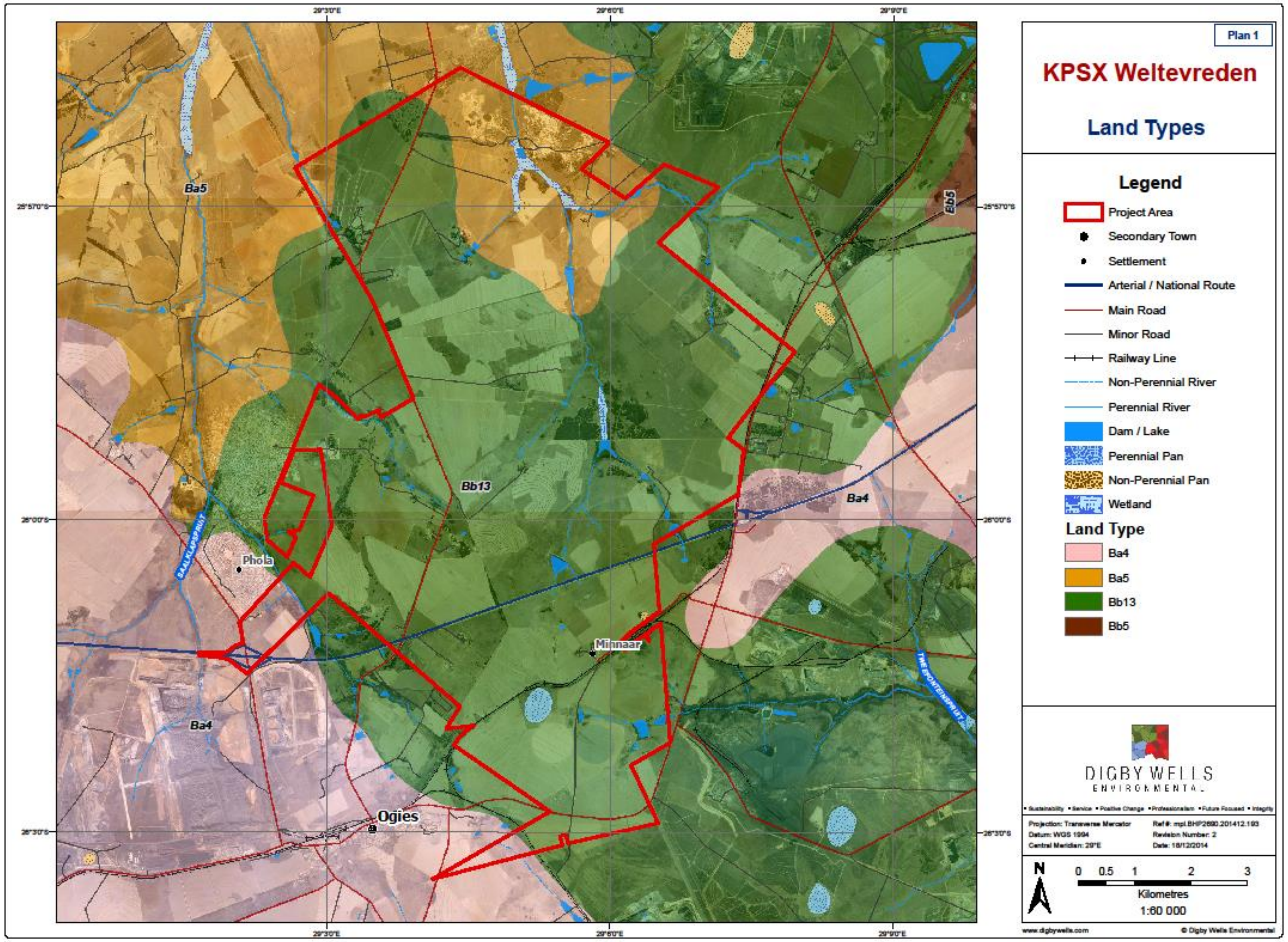
Figure 6-3: Representative terrain form sketch of land type Bb 13

The Bb13 Land type is dominated by deep well drained yellow-brown apedal soils, with about 70% of the land type having these soils; they have an average slope of around 3 %. The following list of soil types occurs within the crest (40%) in this land type:

- Clovelly (Cv) – 45%
- Avalon (Av) – 15%
- Other shallow soil types such as the Glencoe (Gc) soil – 40%

The following list of soil types occurs within the midslope (45%) in this land type:

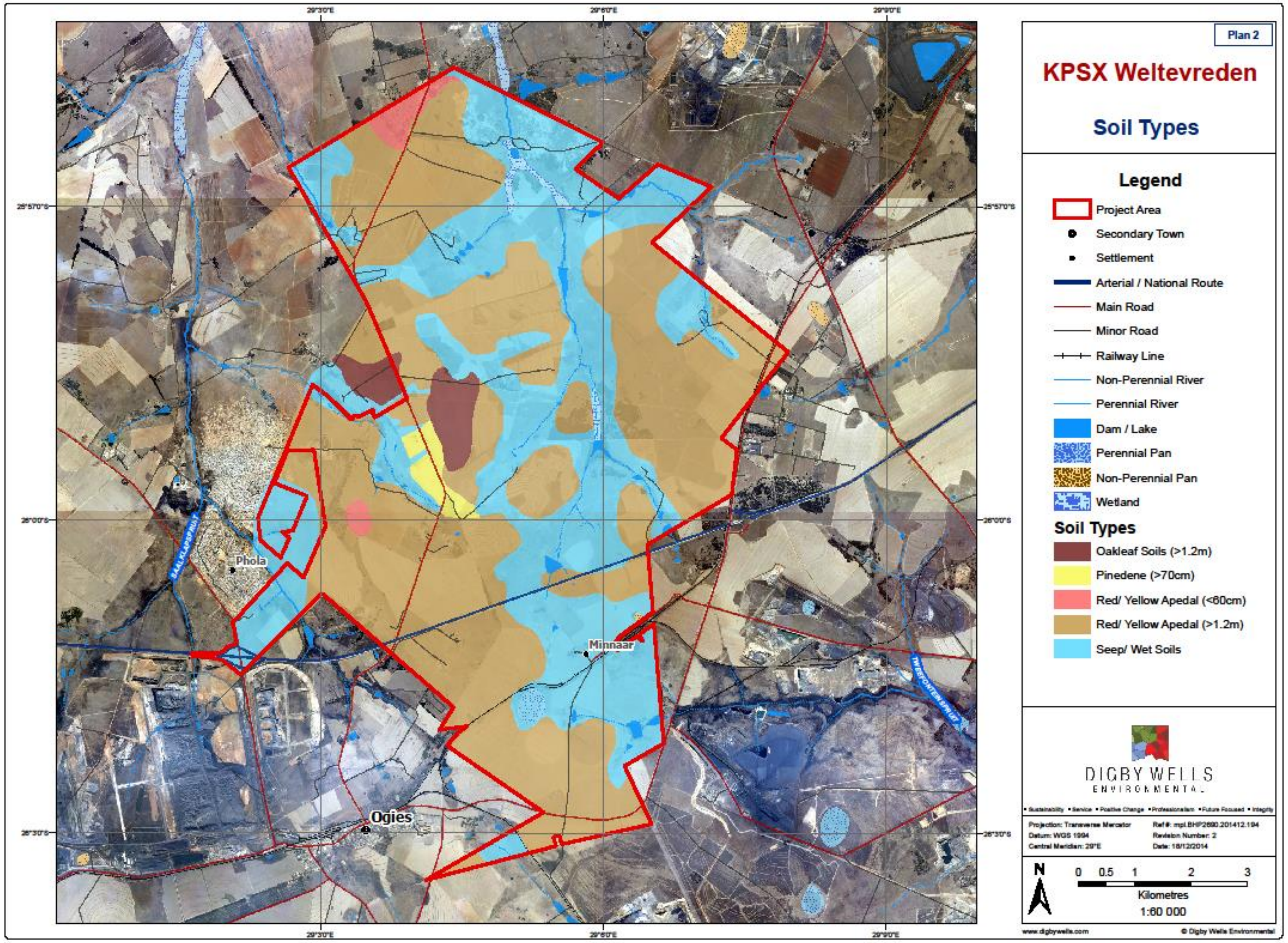
- Clovelly (Cv) – 35%
- Avalon (Av) – 35%
- Other shallow soil types such as the Glencoe (Gc) soil – 30%



Plan 1: Dominant land types present within the KPSX Weltevreden project site

6.2 Soil types present within the KPSX Weltevreden project site

The major soil types found during field surveys are presented in Plan 2 below. The project site is dominated by the presence of high potential agricultural soils such as Hutton, Clovelly, Pinedene and Oakleaf soils which represent 60% of the project site. Forty percent of the project consists of wetland soils.



Plan 2: Major soil types found during the field survey of the KPSX Weltevreden project site

6.2.1 Descriptions of dominant soil forms found at the KPSX: Weltevreden project site

6.2.1.1 Hutton soil form (Hu)

The Hutton soil form comprises an orthic A horizon overlying a red apedal B horizon, underlain by unspecified material. The red apedal B horizon has a macroscopically weak developed structure or is altogether without structure and reflects weathering under well drained, oxidised conditions. The clay fraction is dominated by non-swelling 1:1 clay minerals and the red colour of the soil is ascribed to iron oxide coatings on individual soil particles that consist of at least 15% hematite (Fe_2O_3).

The soils of this form in the study area developed on silica rich parent material (sandstone). This resulted in sandy profiles with low clay content, ranging from mostly deep soils of high agricultural potential (>50cm) to soil of medium agricultural potential and intermediate depth (30 – 50cm) in limited locations.

6.2.1.2 Clovelly soil form (Cv)

The Clovelly soil form comprises an orthic A horizon overlying a yellow-brown apedal B horizon, underlain by unspecified material. The yellow-brown apedal B horizon is essentially similar to the red apedal B horizon and is distinguished purely on the basis of its yellow or brown colour.

The soils of this form in the study area similar to the red soils developed on silica rich parent material (sandstone). This resulted in sandy profiles with low clay content, ranging from mostly deep soils of high agricultural potential (>50cm) to soil of medium agricultural potential and intermediate depth (30 – 50cm) in limited locations.

6.2.1.3 Glencoe soil form (Gc)

The Glencoe soil form comprises of an orthic A horizon overlying a yellow brown apedal B horizon on hard plinthite.

6.2.1.4 Dresden soil form (Dr)

The Dresden soil form comprises of an orthic A horizon overlying hard plinthite. Dresden soils are shallow and are regarded as soils of low agricultural potential.

6.2.1.5 Mispah soil form (Ms)

The Mispah soil form comprises an orthic A-horizon overlying hard rock. These shallow soils mainly occur in areas dominated by rock outcrops and are regarded as soils of low agricultural potential.

6.2.1.6 Fernwood (Fw) and Longlands (Lo), soil forms

The Fernwood soil form comprises an orthic A-horizon overlying an E horizon. This sequence of horizons indicates a waterlogged soil indicating a potential lateral water movement in the soil profile on the low water permeability of the sandstone layer underlying the soil observed in low lying areas (seepage zones).

The Longlands soil form comprises an orthic A horizon over an E horizon, over a soft plinthic horizon. Although Fernwood and Longlands soils can be very deep, agricultural activities are not recommended due to low nutrient/water holding capacities and more importantly the role they play in natural water drainage and filtration.

6.3 Baseline Soil Quality

The fertility status of the KPSX: Weltevreden project site is annually adjusted through fertilisation to sustain commercial crop production as can be seen from the Phosphorous (P) concentrations in the topsoil as shown in Table 6-1. Natural soils (uncultivated) within the Ogies region is expected to contain 1 – 5 mg kg^{-1} P in the topsoil. The cultivated soils within the Klipspruit project site contain 25 – 37 mg kg^{-1} P in the topsoil. This is a clear indication that the soil fertility was adjusted to ensure commercial successful maize production on these high agricultural potential soils. The high agricultural potential is proven through farmers records over the past 25 years of maize production. The estimated average yield over the 25 year period is 7 tons maize per ha on the farm. The Hutton soil occupying the higher landscape positions yields 10 tons of maize per ha, proving that the climate, soil and crop combination on this farm is ideal for maize production.

The soil pH tends to be low except for sample 1 where lime was recently added, see Table 6-1. Any cultivation of soils needs to take cognisance of the natural acidification process through monitoring and subsequent neutralisation of acidity through liming.

The fertility content of the topsoil is a resource and enough reason to strip and stockpile the topsoil which is the first 0.3 m of the soil profile, separately, followed by subsoil stripping and stockpiling.

Table 6-1: Basic soil fertility indicators of the major soil groups found within the proposed project sites

Sample Number	Description	pH (KCl)	P mg kg^{-1}	K mg kg^{-1}	Na mg kg^{-1}	Ca mg kg^{-1}	Mg mg kg^{-1}
1	Hutton topsoil	7.02	33	133	3	1931	100
2	Hutton subsoil	6.00	5	97	3	596	92
3	Pinedene topsoil	4.89	20	74	7	287	56
4	Pinedene subsoil	4.48	3	27	4	172	30
5	Hutton topsoil	4.71	26	64	3	306	51
6	Hutton subsoil	3.63	3	33	5	199	33
7	Fernwood topsoil	4.90	37	56	3	213	34
8	Fernwood subsoil	4.83	11	38	4	223	31
9	Clovelly topsoil	4.64	25	121	3	372	51
10	Clovelly subsoil	5.01	2	48	8	576	97

Note: The use of stripped stockpiled soil for rehabilitation purposes needs to include detailed post rehabilitation but pre-vegetation soil analysis as well as detailed liming and fertiliser recommendations based on the soil analytical results, as well as the type of vegetation to be established.

6.3.1 Soil Fertility Guidelines

Fertility is based around guidelines for crop production with lower and upper limits. If a soil is limiting in a certain macro nutrient plant production will be stunted.

The fertilizer handbook (Fertilizer Society of South Africa, 2007) gives guidelines for healthy soil macro nutrient ranges as shown in Table 6-2. These guidelines are used to compare the current fertility of the soils in an area as shown in Table 6-1.

Table 6-2: Shows the recommended fertility ranges for the various macro nutrients as well as pH (Fertilizer Society of South Africa, 2007)

Guidelines (mg/kg)					
			Low	High	
Calcium (Ca)			<200	>3000	
Magnesium (Mg)			<50	>300	
Potassium (K)			<40	>250	
Phosphorus (P)			<5	>35	
Sodium (Na)			<50	>200	
pH (KCl)					
Very Acid	Acid	Slighly Acid	Neutral	Sligly Alkline	Alkaline
<4	4.1-5.9	6-6.7	6.8-7.2	7.3-8	>8

6.4 Land Capability

Land capability is determined by a combination of soil, terrain and climatic features. Land capability classification indicates sustainable long term use of land under rain-fed conditions while soil properties implicating limitations associated with the various land use classes are also taken into consideration.

The following paragraphs contain detailed listed limitations as used in the classification of Arable Class II, III, IV and Grazing Class V land capabilities of the KPSX: Weltevreden project site. Grazing wetlands are covering 40% while 58% represents Arable Class II and the remaining 2% Arable Classes III and IV, see Plan 3.

6.4.1 Arable, Class II

Land in Class II has some limitations that reduce the choice of plants or require moderate conservation practices. It may be used for cultivated crops, but with less latitude in the choice of crops or management practices than Class I. The limitations are few and the practices are easy to apply.

Limitations may include singly or in combination the effects of:

- Gentle slopes;
- Moderate susceptibility to wind and water erosion;
- Less than ideal soil depth;
- Somewhat unfavourable soil structure and workabability;
- Slight to moderate salinity or sodicity easily corrected but likely to recur;
- Occasional damaging flooding;
- Wetness correctable by drainage but existing permanently as a moderate limitation; and
- Slight climatic limitations on soil use and management.

Limitations may cause special soil-conserving cropping systems, soil conservation practices, water-control devices or tillage methods to be required when used for cultivated crops.

6.4.2 Arable Class III

Land in Class III has severe limitations that reduce the choice of plants or require special conservation practices, or both. Land may be used for cultivated crops, but has more restrictions than Class II. When used for cultivated crops, the conservation practices are usually more difficult to apply and to maintain. The number of practical alternatives for average farmers is less than that for soils in Class II. Limitations restrict, singly or in combination, the amount of clean cultivation, time of planting, tillage, harvesting, choice of crops.

Limitations may result from the effects of one or more of the following:

- Moderately steep slopes;
- High susceptibility to water or wind erosion or severe adverse effects of past erosion;
- Frequent flooding accompanied by some crop damage;
- Very slow permeability of the subsoil;
- Wetness or some continuing waterlogging after drainage;
- Shallow soil depth to bedrock, hardpan, fragipan or claypan that limit the rooting zone and the water storage;
- Low water-holding capacity;
- Low fertility not easily corrected;
- Moderate salinity or sodicity; and
- Moderate climatic limitations.

6.4.3 Arable, Class IV

Land in Class IV has very severe limitations that restrict the choice of plants, require very careful management, or both. Land may be used for cultivated crops, but more careful management is required than for Class III and conservation practices are more difficult to apply and maintain. Restrictions to land use are greater than those in Class III and the choice of plants is more limited. It may be well suited to only two or three of the common crops or the harvest produced may be low in relation to inputs over long period of time.

In sub-humid and semiarid areas, land in Class IV may produce good yields of adapted cultivated crops during years of above average rainfall and failures during years of below average rainfall. Use for cultivated crops is limited as a result of the effects of one or more permanent features such as:

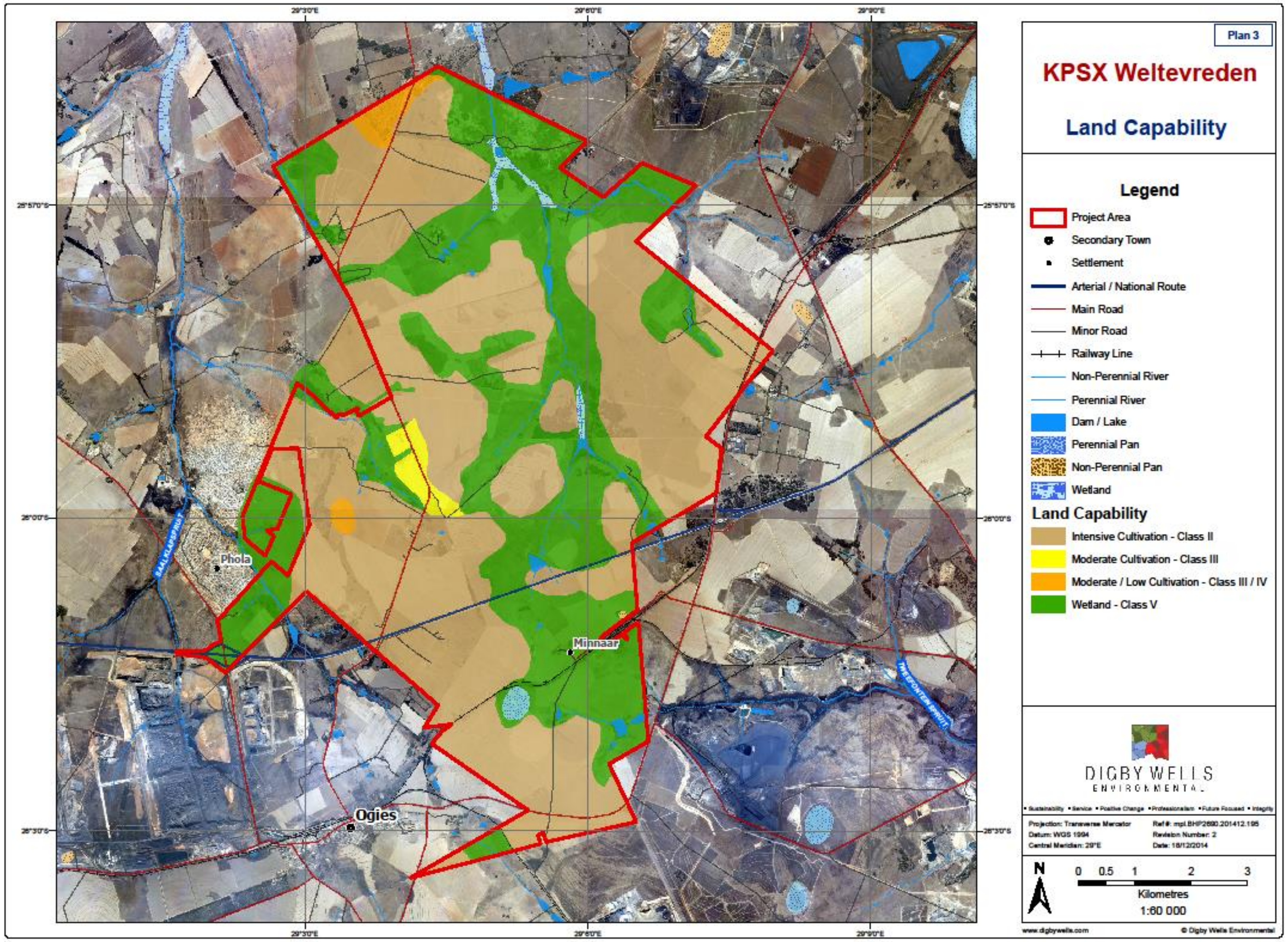
- Steep slopes;
- Severe susceptibility to water or wind erosion or severe effects of past erosion;
- Shallow soils;
- Low water-holding capacity;
- Frequent flooding accompanied by severe crop damage;
- Excessive wetness with continuing hazard of waterlogging after drainage;
- Severe salinity or sodicity; and
- Moderately adverse climate.

6.4.4 Grazing Class V

Land in Class V has little or no erosion hazard but have other limitations impractical to remove that limit its use largely to pasture, range, woodland or wildlife food and cover. Limitations restrict the kind of plants that can be grown and prevent normal tillage of cultivated crops. Pastures can be improved and benefits from proper management can be expected. Land is nearly level. Some occurrences are wet or frequently flooded. Other are stony, have climatic limitations, or have some combination of these limitations.

Examples of Class V are:

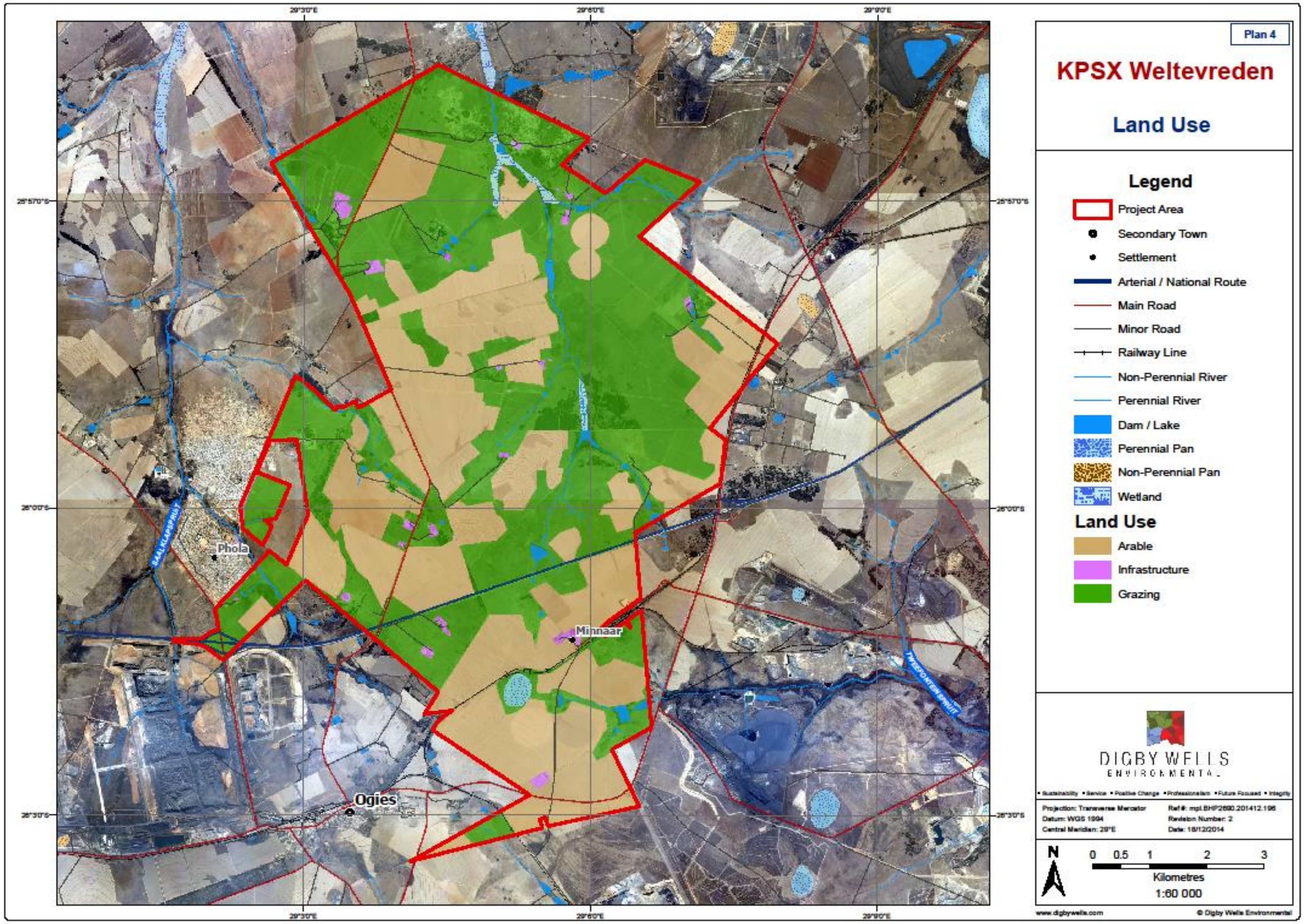
- Valley bottoms subject to frequent flooding that prevents the normal production of cultivated crops;
- Nearly level land with a growing season that prevents the normal production of cultivated crops;
- Level or nearly level stony or rocky land; and
- Ponded areas where drainage for cultivated crops is not feasible but which are suitable for grasses or trees.



Plan 3: Land capability classification of the KPSX: Weltevreden project site

6.5 Current Land Use

The predominant present land use within the KPSX: Weltevreden project site is agriculture, dominated by grazing (57%) and commercial dry-land (arable) farming occupying 42% of the project site, see Plan 4. The wetlands and water body areas within the project site are used for grazing purposes.



Plan 4: Present Land Use at the KPSX: Weltevreden project site is dominated by commercial agricultural maize production

7 Potential Environmental Impacts

7.1 Construction Phase

During the construction phase the work carried out will mainly be the construction of the opencast mine and supporting infrastructure. This will entail the clearing of areas and the disturbance of the topsoil through excavations as well as the construction of a soil stockpile. The topography and natural drainage lines will be disturbed. The overall impact will be loss of topsoil as a result of erosion and possible contamination of the soil by coal dust, fuel, and oils due to the excavation activities. Soil compaction caused by heavy vehicles and machinery surrounding the pit areas could also be a problem.

Soil stripping will require the removal of all soil materials to a depth of at least 1.0 m. This activity will provide needed soil cover material for rehabilitation purposes. Construction activities will change the land use from arable farming to mining causing unsuitable conditions for any further commercial farming.

7.2 Operational Phase

Soil erosion through wind and storm water run-off, and soil pollution by means of hydrocarbon contamination and potentially coal dust, may be encountered during the operational phase. Water runoff from roads must be controlled and managed by means of proper storm water management facilities in order to prevent soil erosion. Diesel and oil spills are common at mine sites due to the large volumes of diesel and oil consumed by mine vehicles. Pollution may however be localised. Small pockets of localised pollution may be cleared up easily using commercially available hydrocarbon emergency clean-up kits.

8 Cumulative Regional Impacts

The following brief summary emphasises the importance of mine related land use in Mpumalanga:

- Total area of arable soils to produce crops in Mpumalanga is estimated at 993 301 ha;
- 46.4 % of the total high potential arable soils in South Africa are found in Mpumalanga;
- At the current rate of coal mining in Mpumalanga 12 % of South Africa's total high potential arable land will be degraded;
- A further 13.6 % high potential soil is under prospecting in Mpumalanga;
- The expectation is that 326 000 ha of cultivated land is already occupied by current mines, that is 33 % of available cultivated land already impacted by mining;
- An additional 439 000 ha arable land has been approved for prospecting, that equates to an additional 44 % of the available arable land in Mpumalanga;

- At the present rate of Mining Right Applications being granted an estimated 77 % of all available arable land in Mpumalanga will be affected and occupied by mining.
- Food security is impacted on because available arable land is lost to mining; and
- The quality of rehabilitated land cannot emulate pre-mining land capability in the short term.

The major impacts associated with opencast mining are the disturbance of natural occurring soil profiles consisting of layers or soil horizons. Rehabilitation of opencast areas aims to restore land capability to pre-mining land capabilities, but the South African experience is that post mining land capability usually decreases compared to pre-mining land capability. Soil formation is determined by a combination of five interacting main soil formation factors. These factors are time, climate, slope, organisms and parent material. Soil formation is an extremely slow process and soil can therefore be considered as a non-renewable resource.

Soil quality deteriorates during stockpiling and replacement of these soil materials into soil profiles during rehabilitation cannot imitate pre-mining soil quality properties. Depth however can be imitated but the combined soil quality deterioration and resultant compaction by the machines used in rehabilitation, leads to a net loss of land capability. A change in land capability then forces a change in land use. Typically the Mpumalanga experience taught us that arable land capability changes to grazing land capability.

The opencast area is located in an existing mine area. The impact on soil is high because natural soil layers are stripped and stockpiled for later use in rehabilitation. Soil fertility is impacted on because stripped soil layers are usually thicker than the defined topsoil layer. The topsoil layer is the layer where most plant roots are found and is generally 0.35 m thick in the Ogies region. Topsoil contains active microbes which are responsible for nutrient cycles, thereby improving soil fertility.

9 Impact Assessment

The environmental impact assessment is designed to identify impacts related to various mining activities as provided in Table 9-1. However with the correct mitigation measures being put in place these impacts can be reduced. The activities impacting on soil as the receiving environment are shaded (**Brown**) and discussed within the related impact discussions.

Table 9-1: Proposed project activities at KPSX: Weltevreden

Activity No.	Activity
Construction Phase	
1	The recruitment, procurement and employment of construction workers, engineers and contractors.
2	The transportation of construction material to the Project site via national, provincial and local roads.
3	Storage of fuel, lubricant and explosives in temporary facilities for the duration of the construction phase. These substances are classified as hazardous in terms of the Hazardous Substances Act, 1973 (Act No. 15 of 1973) and will be managed accordingly.
4	Site clearance and topsoil removal prior to the commencement of physical construction activities, as well as the open pit mining. This activity refers to the conversion of undeveloped, vacant land into industrial use.
5	Construction of surface infrastructure will take place, including the offices and fuel bay, haul roads, a PCD and stormwater catchment dams, coal tip and conveyor belt, pipelines and clean water canals.
6	The construction of stockpiles, including topsoil, overburden and emergency coal stockpiles.
7	The establishment of the initial boxcut and access ramps to the open pit mining areas.
Operational Phase	
8	Limited employment of skilled and unskilled labour will be required for the operation of the mine and support infrastructure.
9	Storage of fuel in diesel tanks, as well as lubricant and explosives in facilities for the duration of Project. These substances are classified as hazardous in terms of the Hazardous Substances Act, 1973 (Act No. 15 of 1973) and will be managed accordingly.
11	Drilling and blasting of the overburden rock for easy removal by excavators and dump trucks.
12	Coal removal by truck and shovel methods from the exposed coal seams. The coal is removed with shovels and transported to the plant by conveyor belt by trucks.
13	Vehicular activity on the proposed haul roads. Mining equipment will utilise the haul roads to access open pit areas, as well as to transport coal from the opencast pit to the plant and conveyor belt. The haul road will consist of two wetland and stream crossings.
14	Mine water, or dirty water that is located within the opencast pits will need to be diverted by channels and berms to the PCD to prevent clean water resources from being contaminated.
15	Use of conveyor belts to transport the coal to the stockpiles at the KPS plant.

Activity No.	Activity
16	A PCD will be constructed to store all dirty water that has come into contact with the opencast pit, overburden stockpiles or emergency coal stockpile.
17	Waste and sewage generation and disposal. All domestic, industrial and hazardous waste is produced during the mining process. Waste includes cans, plastics, used tyres and oil which must be disposed of in an appropriate manner by a contractor at a licensed waste disposal site. Sewage produced from the office buildings and ablutions will be treated at a sewage plant, septic tank or French drain system.
18	Concurrent replacement of overburden and topsoil and the re-vegetation of mined out strips. The mined strip will be backfilled with the overburden and compacted. Subsequently, the topsoil will be placed on top of the overburden and the area will be vegetated.
Decommissioning phase	
19	Retrenchment of mine employees and staff will take place following the cessation of the mining operations and coal beneficiation activities.
20	Demolition of infrastructure will take place and includes the PCDs, haul roads, coal tip and conveyor belts, pipelines and mine offices and workshop.
21	Removal of fuel, lubricant and explosives will be required following the cessation of the mining activities to ensure that there is no health and safety risk to the environment and to people.
22	Final replacement of overburden and topsoil and the establishment of vegetation on the final open cast void. Overburden will be backfilled into the final void and compacted. Subsequently, topsoil will placed and the area vegetated.
23	Waste handling of scrap metal and used oil as a result of the decommissioning phase will be undertaken.
Post-closure Phase	
24	Post-closure monitoring and rehabilitation will determine the level of success of the rehabilitation, as well as to identify any additional measures that have to be undertaken to ensure that the mining area is restored to an adequate state. Monitoring will include surface water, groundwater, soil fertility and erosion, natural vegetation and alien invasive species and dust generation from the coal discard dumps.

9.1 Construction Phase

When topsoil is removed from a soil profile, the profile loses effective rooting depth, water holding capacity and fertility. The largest volumes of topsoil will be removed in preparation for opencast mining.

9.1.1 Impact: loss of topsoil as a resource

Criteria	Details / Discussion				
Description of impact	Activities 4, 5, 7 and 16 (construction of PCD dam) impact on soil through removal and stockpiling of soil.				
Mitigation required	▪ The topsoil should be stripped by means of an excavator bucket, and loaded onto dump trucks; ▪ Stockpiles are to be kept to a maximum height of 4m (the practical tipping height of dump trucks); ▪ Topsoil is to be stripped when the soil is dry, as to reduce compaction; ▪ The topsoil 0.3 m of the soil profile should be stripped first and stockpiled separately; ▪ The subsoil approximately 0.7 – 0.9 m thick will then be stripped and stockpiled separately; ▪ Soils to be stripped according to the rehabilitation soil management plan and stockpiled accordingly; ▪ Foundation excavated soil should also be stockpiled; ▪ Stockpiles are to be maintained in a fertile and erosion free state by sampling and analysing annually for macro nutrients and pH; ▪ The handling of the stripped topsoil will be minimized to ensure the soil's structure does not deteriorate; ▪ Compaction of the removed topsoil should be avoided by prohibiting traffic on stockpiles; ▪ Prevent unauthorised borrowing of stockpiled soil; ▪ The stockpiles will be vegetated (details contained in rehabilitation plan) in order to reduce the risk of erosion, prevent weed growth and to reinstitute the ecological processes within the soil; ▪ Soils will be stripped using the delineated soil types as guide. Yellow and red soils may be stripped together. Wetland soils (if allowed) should be stripped and stockpiled separately but also in the order topsoil (0.3 m) then subsoil separately; and ▪ Access should be limited to prevent any unnecessary compaction from occurring.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3 (Local)	5 (Project Life)	5 (Very Serious)	7 (Certain)	-91
Post-Mitigation	2 (Limited)	5 (Project Life)	3 (Moderate)	3 (Unlikely)	-30

9.1.2 Impact: Hydrocarbon Pollution

Criteria	Details / Discussion				
Description of impact	Activities 3 and 9 (storage of fuel, lubricants and explosives) can impact on soil quality while hydrocarbon spills can occur when heavy mining machinery is used because big machines contain large volumes of oils and diesel. There is a chance of the machines breaking down and/or leaking during mining and removal of topsoil.				
Mitigation required	▪ Prevent any spills from occurring; ▪ If a spill occurs it is to be cleaned up immediately and reported to the appropriate authorities; ▪ All vehicles are to be serviced in a correctly bunded area or at an off-site location; and ▪ Leaking vehicles will have drip trays place under them where the leak is occurring.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	7 (Permanent)	7 (Very Serious)	6 (very Likely)	-90
Post-Mitigation	1 (Very Limited)	1 (Immediate)	7 (Very Serious)	5 (Likely)	-45

9.1.3 Impact: Loss of land capability

Criteria	Details / Discussion				
Description of impact	Removal of soil layers will impact on the land capability because vegetation can no longer be supported.				
Mitigation required	▪ No land capability mitigation is possible during the construction and operational phases because the land use is changed from agriculture to opencast coal mining; and ▪ Mitigation of land capability post mining is required through legislation through land rehabilitation by following the 2007 Coaltech Guidelines.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	5 (project life)	6 (Significant)	7 (definite)	-84
Post-Mitigation	1 (Very Limited)	5 (project life)	5 (Very Serious)	6 (almost certain)	-66

9.2 Operational Phase

9.2.1 Impact: loss of stockpiled topsoil as a resource

Criteria	**Details / Discussion**				
Description of impact	Topsoil losses can occur during the operational phases as a result of rain water runoff and wind erosion, especially from roads and soil stockpiles where steep slopes are present. Prevention is especially important because the dominant soils in the KPSX: Weltevreden project site are sandy and prone to erosion.				
Mitigation required	▪ Stockpiles are to be maintained in a fertile, vegetated, and erosion free state; ▪ Stockpiles are to be clearly demarcated; ▪ Ensure proper storm water management designs are in place; ▪ Access routes are to be kept to a minimum as to reduce any unnecessary compaction from occurring; ▪ If erosion occurs, corrective actions must be taken to minimize any further erosion from taking place; and ▪ Unauthorised borrowing of stockpiled soil materials should be prevented.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3 (Local)	5 (Project Life)	5 (Very Serious)	7 (Certain)	-91
Post-Mitigation	2 (Limited)	5 (Project Life)	3 (Moderate)	3 (Unlikely)	-30

9.2.2 Impact: Hydrocarbon Pollution

Criteria	**Details / Discussion**				
Description of impact	Hydrocarbon spills can occur where heavy machinery are parked such as the hard park area because they contain large volumes of lubricating oils, hydraulic oils, and diesel to run. There is always a chance of these breaking down and/or leaking.				
Mitigation required	▪ Prevent any spills from occurring; ▪ If a spill occurs it is to be cleaned up immediately and reported to the appropriate authorities; ▪ All vehicles are to be serviced in a correctly bunded areas or at an off-site location; and ▪ Leaking vehicles will have drip trays place under them where the leak is occurring.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	7 (Permanent)	7 (Very Serious)	6 (very Likely)	-90

Criteria	**Details / Discussion**				
Post-Mitigation	1 (Very Limited)	1 (Immediate)	7 (Very Serious)	5 (Likely)	-45

9.2.3 Impact: Loss of Land Use and Land Capability

Criteria	Details / Discussion				
Description of impact	Activity 18, 20, 22 and 24 impact on the rehabilitation of soil, soil quality and land capability. Backfilling of soil layers will impact on the land capability by restoring the land capability to some extent because vegetation will be supported and therefore returned to the planned post mining land capability such as arable and or grazing.				
Mitigation required	▪ Mitigation is possible because the land use is changed from mining back to agriculture as follows: ▪ The spoil should be shaped taking the pre-mining landscape into consideration; ▪ The designed post mining landforms should be modelled to establish the post mining landscape stability by using a combination of GIS and erosion modelling techniques by a suitably qualified expert using site specific soil quality data; ▪ The soil layers should be put back in the reverse order of stripping namely subsoil first then topsoil; ▪ The yellow and red soils should be replaced in upland landscape positions; ▪ Wetland soils should be put back in the reverse order of stripping; ▪ Wetland soils should be placed in lower landscape positions; ▪ The pre-mining dominant soil and land capability is Class ii for the KPSX: Weltevreden project site. This classification indicates high potential arable land supporting commercial agricultural production at an average maize production of 7 tons per ha over 25 years; ▪ The soil cover should be at least 0.85 m in depth consisting of at least 0.5 m subsoil and 0.35 m topsoil on top of the reconstructed profile. Rehabilitation should strive to rehabilitate the soil and land capability back to emulate pre-mining land capability; ▪ The soil quality should be investigated prior to establishing vegetation on the rehabilitated soil through representative sampling and laboratory analysis; ▪ The analytical data should be evaluated by a suitably qualified expert and vegetation fertility and or soil acidity problems should be corrected prior to vegetation establishment; ▪ Clear targets incorporating medium to long term post mining land capability influencing land use, should be part of a potentially successful closure plan; and ▪ From a national food security viewpoint, ways need to be found of rendering land rehabilitated to arable standards suitable for the economic production of cash crops.				
Parameters	Spatial	*Duration*	*Intensity*	*Probability*	*Significant rating*

Criteria	Details / Discussion				
Pre-Mitigation	1 (Very Limited)	5 (project life)	6 (Significant)	7 (definite)	-84
Post-Mitigation	1 (Very Limited)	5 (project life)	4 (Serious medium term)	6 (almost certain)	-60

10 Soil Management Plan

10.1 Background

The KPSX: Weltevreden project landscape is dominated by a relatively flat topography. Crests (1) and midslope (3) positions dominate the landscape. The soil was formed through weathering *in situ* from sandstone parent material. The majority of soils found in the 1 and 3 landscape positions are therefore red and yellow apedal sandy soils. The soil types present are homogeneous in nature, especially those that occupy the crest and midslope positions in the landscape. The dominating soil type is red high agricultural potential Hutton soil.

Care must be taken during the reclamation process to prevent compaction on the one hand and to replace soil volumes back to a representative arable pre-mining soil and land capability while emulating the pre mining landscape.

Considering the importance and time of formation of the soil properties then it is clear that managing soil stockpiles properly should have a high priority in opencast mining operations. Topsoil (the first 0.3 m) should be stored separately from subsoil because it contains more nutrients and microbes than subsoil. The topsoil stockpiles should be limited in height because aeration can be compromised which in turn influences microbial activity and therefore soil quality.

Allowing subsoil to contaminate topsoil dilutes the nutrient and organic matter content causing soil infertility. Infertility imbalances then have to be reclaimed and optimised by using costly fertilizers.

More important than chemical imbalances which can be easily restored at cost, is soil compaction and volumes of replacement during soil reclamation. Heavy mining equipment is used during soil reclamation and soil is compacted beyond agricultural reclamation leaving behind areas of low soil and land capabilities. Such areas have limited land use options and specialized management needs.

10.1.1 Physical mitigation

Opencast coal mining degrades the natural environment. An assessment of potential environmental physical risks and their physical mitigation throughout the mining life cycle should minimize the impacts on the physical environment.

10.1.1.1 Successful rehabilitation

The following must be part of any rehabilitation project to enhance the chances for success (Lubke, 2014):

- Obtain the baseline status of the receiving environment through field studies to determine changes and mitigation needs;
- Design a goal priority framework;
- Establish the methodology to evaluate the success of the project such as soil cover depth and vegetation establishment for example;
- Monitor project results and compare to the project goals.

Post mining soil reclamation is very difficult or near impossible if the stockpiled topsoil materials are of inferior quality due to mismanagement during storage. Good quantity and quality topsoil is an essential ingredient in the process of soil reclamation. Factors leading to decay in soil quality are:

- Contamination impacts on soil quality;
- Erosion impacts on soil volume;
- Indiscriminate storage impacts on soil quality; and
- Indiscriminate use impacts on soil volume.

An important factor in the management of stockpiles impacting on soil quality is the storage height of topsoil. The topsoil stockpile should be constructed with great care to keep within accepted limits for example:

- The stockpile sides should be angled ensuring stability at 1:3 (18.5 degrees from horizontal);
- The geographic location of the stockpile should be indicated within the rehabilitation plan document;
- The stockpile area should be clearly demarcated, fenced and strict access control practised to prevent vehicles driving on the stockpile as well as unwanted borrowing of soil material for other purposes than rehabilitation; and
- Stockpile height should be limited to 4 m.

Soil should not be stripped or redistributed if the top or subsoil is too wet. Use the stick test to determine if soil is too wet to 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 handle. Serious compaction may result if machine handling of wet soil occurs.

10.1.2 Soil quality and post mining land capability indicators

"The first rule of sustainability is to align with natural forces, or at least not try to defy them."

— Paul Hawken

Figure 10-1 provides an overview of the development principles of a disturbed ecosystem. Soil is an integral part of an ecosystem and rehabilitation should provide momentum within the indicated upward path in terms of structure and function (Bradshaw, 1984, 1996), taking into account what the state of the environment was prior to mining and post mining (Lubke, 2014) for:

- The soil - physical and chemical properties;
- The biota and ecology**;**
- Establish the aims for post mining land use of the site by recognising the aims for the Province and Region which will allow a firm statement of the purpose of rehabilitation;
- Then set policies for site management; and
- Consultation should be undertaken with and between surface right owners, communities and or users of rehabilitated sites taking cognisance of the past land use of the site.

The planned post mining land capability of the opencast rehabilitated areas should emulate the pre-mining land capability namely 80% arable and 20% grazing.

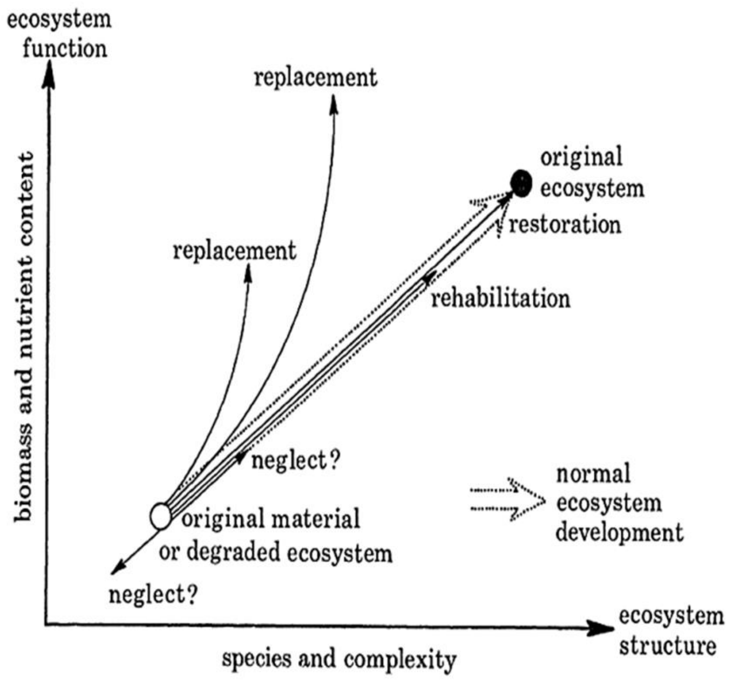


Figure 10-1: The pathway of ecosystem development as indicated by Bradshaw (1984)

10.1.3 Post mining agricultural potential

During the early nineties an Interdepartmental Liaison Committee on High Extraction Coal Mining was established to guide research regarding agricultural aspects of rehabilitation (Agricultural research on rehabilitated coal mined land (1994-2001) conducted in terms of the Kraai van Niekerk report) research was conducted by the Agricultural Research Council. Three relevant research projects and their findings are listed below (Schoeman, 2001):

10.1.3.1 The evaluation of existing pastures on rehabilitated mine land for economical animal production: Agronomic Evaluation

The following bulleted points provide a summary of the research findings from the agronomic evaluation:

- The productivity of most pastures tested was within accepted norms;
- Productivity stayed constant over the study period since rehabilitation;
- Soil nutrients were found to be adequate;
- Nutrient levels in the hay were within accepted limits except for P, K and Na;
- The nutritive value of the pastures was low due to high cellulose, lignin, pectin and low N content;
- Predicted animal production in terms of dry matter intake and average daily gain was low due to the low nutritional value of the hay; and
- Pastures on rehabilitated land can be productively incorporated into farming systems although it would be difficult to use large quantities of fertilized low quality hay in farming systems. It was recommended that the pastures should be allowed to revert back to natural veld.

10.1.3.2 Evaluation of existing pastures on rehabilitated mine land for economical animal production: Ecological evaluation

The following bulleted points provide a summary of the research findings from the ecological evaluation:

- Dominant naturally establishing species, in terms of cover and frequency were found to be the following grass species:
- Eragrostis curvula;
- Eragrostis plana;
- Cynodon dactylon;
- Pennisetum clandestine; and
- Panicum coloratum.
- Continued fertilization suppress the following grasses:

- Themeda triandra;
- Heteropogon contortus;
- Setaria sphacelata; and
- Some Eragrostis species while:
- Digitaria eriantha;
- Medicago sativa; and
- *Lotus corniculatus* will tend to dominate within fertilized areas*; and*
- Vegetation of rehabilitated areas will probably never return to its original state.

10.1.3.3 The potential of rehabilitated mine soils for the production of maize and sunflower

The following bulleted points provide a summary of the research findings from the production of maize and sunflower:

- Maize yields varied between 55 (uneconomical 2014) and 5 300 kg ha^{-1} (marginal economical 2014) for the 1994 – 1999 growing seasons;
- Normal commercial farming practises were emulated using normal farm implements. The resulting crop yields were classified as low or very low due to induced low soil water-holding capacity and or poor drainage as a result of soil compaction and hardsetting;
- Insufficient effective soil depth was found to be the number one critical soil property in restricting crop production;
- Sufficiently deep cover soils proved to be ineffective to support good plant production due to machine-induced compaction. Ordinary farm implements were found to be ineffective to alleviate compaction to a level that enhance root growth;
- The need for heavy expensive equipment such as a D 9 bulldozer and 0.8 m ripper to alleviate compaction was recommended; and
- Trial site rehabilitated mine soils cannot be regarded as suitable for economical or sustainable crop production and methods to reclaim soil productivity should be investigated.

10.1.4 Case study for Umlilo Opencast Project: Successful rehabilitation through mining innovation

Soil erosion might pose a problem once vegetation cover is removed due to the sandy nature of the dominating Hutton soils present. Table 10-1 contains a summary of the erosivity of the soil forms present.

Table 10-1: Soil type erosion potential

Soil Form	Soil Horizon	Water and Wind Erosion Potential
Hutton	A	High
Avalon	A	High
Clovelly	A	High
Pinedene	A	High
Fernwood	A and B	High

10.2 Soil Types for Stripping and Stockpiling

The Hutton, Avalon, Pinedene, Oakleaf and Clovelly soil types present within the project site can all be stripped and stockpiled together because the inherent soil properties are similar. The soil types are dominated by deep well drained red and yellow soils. However the Avalon and Longlands soils do contain a soft plinthic layer in the subsoil. This soft plinthic layer should not be stripped with the brown Avalon and grey Longlands subsoil respectively, because this layer hardens to rock like consistency when exposed to air. Wetland soils should be stripped, if allowed and agreed upon by the authority, and stockpiled separately from all other soils.

11 Conclusion

The majority of the soils present within the proposed project site are represented by deep yellow and red Hutton, Avalon, Pinedene, Oakleaf, and Clovelly soils. These soils are however dominated by Hutton and Clovelly soil types. The present soil fertility status is good due to farmer intervention resulting in high maize yields.

Maize production has been continuing for decades in the Ogies region and can continue for decades more on the same soils. Mining will however change the soil and land capability resulting in yield losses of at least 25% if rehabilitation of the opencast coal mined areas can emulate pre-mining arable land capability.

High fertilizer cost, reductions in crop yields in addition to difficulty of cultivating rehabilitated land, makes the land use option of commercial arable farming on rehabilitated land questionable.

The wetland areas present at the KPSX: Weltevreden project site may prevent the full extent of the planned opencast mining due to the buffers needed to protect the wetlands. If however the project is approved by the authorities then these wetland areas should be stripped and stockpiled separately from all other soil types.

The potential impacts associated with open cast mining on soils are broken up into the following;

- Loss of Topsoil;
- Erosion;
- Misplacement of stockpiles;
- Incorrect usage of stockpiles;
- Incorrect stripping of topsoil;
- Stockpiling well drained soils with wetland soils;
- Compaction;
- Loss of Land Capability;
- Soil contamination through hydrocarbon spills;
- Replacement of topsoil not to pre-land capability specifications; and
- Low soil fertility.

12 References

Bradshaw, A. D., 1984. Ecological principles and land reclamation practice. *Landscape Planning* 11: 35-48.

Bradshaw, A. D., 1996. Underlying principles of restoration. *Can. J. Fish. Aquat*. *Sci*. 53 (Suppl. 1):3-9.

Chamber of Mines of South Africa/Coaltech. (2007). *Guidelines for the Rehabilitation of Mined Land, 2007.*

Land Type Survey Staff. 1972 – 2006. Land Types of South Africa: Digital map (1:250 000 scale) and soil inventory databases. ARC-Institute for Soil, Climate and Water, Pretoria.

Lubke, R., 2014. What constitutes a successful rehabilitation project? Paper presented at the Second Annual Land Rehabilitation Society of Southern African Conference 11 and 12 September 2014, Land Rehabilitation: Successes and Failures held at Glenburn Lodge, Muldersdrift, Gauteng.

Schoeman, J. L., 2001. Synopsis of agricultural research on rehabilitated coal mined land (1994-2001) conducted in terms of the Kraai van Niekerk report.

Schoeman, J.L., van der Walt, M., Monnik, K.A., Thackrah, A., Malherbe, J. and le Roux, R.E., 2000. The development and application of a land capability classification system for South Africa. ARC-ISCW Report No GW/A/2000/57, ARC-Institute for Soil, Climate and Water, Pretoria.

Soil Classification Working Group, 1991. Soil Classification – a taxonomic system for South Africa. ARC-Institute for Soil, Climate and Water, Pretoria.

Tolmay, J. and Tolmay, S., 2014. The Umlilo Opencast Project: Successful rehabilitation through mining innovation. Paper presented at the Second Annual Land Rehabilitation Society of Southern African Conference 11 and 12 September 2014, Land Rehabilitation: Successes and Failures held at Glenburn Lodge, Muldersdrift, Gauteng.