APPLICATION TO CONSTRUCT A HYDROELECTRIC POWER GENERATION PLANT (MIDDLE KRUISVALLEI) ON THE FARM KRUISVALLEI 190 MAGISTERIAL DISTRICT OF BETHLEHEM FREE STATE PROVINCE

REPORT ON AGRICULTURAL IMPACT ASSESSMENT
FEBRUARY 2018

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1. INTRODUCTION

Zevobuzz (Pty) Ltd intends to develop a hydroelectric power generation scheme in the Ash River in the Bethlehem Magisterial District, Free State Province. The proposed development will take place on the farm Kruisvallei 190.

The Ash River is fed by the Trans Caledon Transfer Tunnel, which transfers water from the Katse Dam high up in the Maluti Mountains in Lesotho. Being very predictable, this is one of the greatest small hydro resources in the country, allowing for conditions suited to electricity production. In addition (also a result of the flow regulation), comprehensive information on current and future flow is available, making the potential highly foreseeable.

A basic impact assessment is being conducted for authorisation of the proposed facility and an agricultural impact assessment undertaken as part thereof.

2. SPECIALIST DETAILS

This report was prepared by an independent agricultural consultant:

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He has 43 years of experience in planning and managing natural resources to ensure optimal utilisation, without exploiting such resources to the detriment of future generations.

The past 15 years he has spent as a soil consultant, doing mainly soil surveys, terrain classification and agricultural potential studies. Reports include a variety of maps and GIS aspects, which play an important role in these surveys and studies.

Mr Lubbe also has 17 years of experience as an agricultural engineering lecturer at the Tshwane University of Technology, teaching Soil Conservation Techniques I, II and III. These modules deal with the surveying, design and drawing of soil conservation structures. During this time, Mr Lubbe also lectured in Farm Planning, which deals with optimal resource utilization, as well as in Agricultural Mechanization, which dealt with the implements and machinery used to mechanize farming.

Mr Lubbe started his career with 10 years in the agricultural environment, which he spent on the survey, design and supervision of the construction of soil conservation structures in the agricultural field, mainly for farm planning.

A curriculum vitae is attached as Appendix A.
CR Lubbe is not a subsidiary, or in any way affiliated to Zevobuzz (Pty) Ltd, nor does he have any interest in secondary developments that may arise from the authorisation of the proposed project.

The site investigation was conducted in winter, on 23 and 24 July 2017, the dry season. There are no crops on cultivation land, which enables a better assessment of drainage patterns. This is important for rehabilitation after construction and decommissioning, and serves as a benchmark for mitigation measures.

3. SCOPE AND PURPOSE OF STUDY

The purpose of the study was to:
- Establish the agricultural potential of the site that is to be leased on long-term basis from the existing farms.
- Estimate the potential and existing arability and carrying capacity of the study areas;
- Establish the availability and condition of the existing agricultural resources and agricultural infrastructure;
- Describe past and current agricultural practices/activities on the site;
- Identify possible constraints to the proposed land use in terms of agricultural potential; and
- Consider and evaluate possible impacts on the existing agricultural resources and activities.

4. APPROACH AND METHODOLOGY

4.1. Approach

The approach to the study was:
- To identify and describe the existing agricultural environment of the study area;
- To identify and describe the risks and possible impacts of the proposed project on the agricultural environment;
- To assess the severity of the possible impacts;
- To consider alternatives to avoid the impacts; and
- To identify and describe mitigation measures to avoid or reduce the impacts of the project on the existing agricultural environment.

4.2. Desktop Study

A desktop study was conducted to review existing data and literature sources.

The desktop review provided a baseline agricultural and land use profile, focusing on the specific geographical area potentially impacted by the proposed project.
Climatic conditions, land uses, land type, and terrain are readily available from literature, GIS information and satellite imagery.

As far as regional information is concerned, this is primarily a desktop-based study.

4.3. Field Survey

A field survey was carried out on 23 and 24 July 2017 and was aimed at verifying the information obtained from the desktop study and further information about the site and its immediate surroundings. This, inter alia, included a soil survey.

4.4. Impact identification

Potential impacts of the proposed project on agriculture were identified and assessed. Particular attention was paid to the following issues:

- The possibility of permanent loss of high potential agricultural land;
- Impairment of land capability due to construction; and
- Analysis of erosion risk because of altered drainage patterns and potential for poor rehabilitation in erosion-sensitive areas.

5. ASSUMPTIONS AND UNCERTAINTIES

A study of this nature will inherently contain various assumptions and limitations.

As far as regional information is concerned, this is primarily a desktop-based study. Many adjustments were made to infer climatic conditions, land uses, land type and terrain by extrapolating from available land use data, GIS information and satellite imagery.

Notwithstanding these limitations, the site-specific field studies confirmed most of the desktop findings and it can be noted with confidence that the findings provide sufficient detail to inform the agricultural impact assessment reported in this document.

6. DESCRIPTION OF PROPOSED PROJECT

Zevobuzz (Pty) Ltd intends to develop a hydroelectric power generation scheme in the Ash River on the farm Kruisvallei 190, Bethlehem Magisterial District, Free State Province.

The proposed hydroelectric power generation plant will be known as Middle Kruisvallei (MK). The existing DWS weir (Weir 26) will be used to divert the water into a canal system (Headrace), through the powerhouse, and returned to the river via another canal system (Tailrace). The plant will have a footprint of ±4 ha, constructed on an area of 22.73 ha. The total footprint of the MK scheme and all its associated infrastructure will be 20.4ha.

The complex will entail the construction of two canals parallel to each other with a progressive length of 450m. The headrace will be 240m in length, 20m wide and ±3.2m deep, while the tailrace will be 160m long, 34m wide and 4m deep. The depth of the canals will depend on actual rock bed level. The powerhouse will have a height of 21m.
The proposed connection of the power line to the Eskom grid is at the Node substation.

7. PHYSICAL DESCRIPTION OF THE SITE

7.1. Locality

The farm Kruisvallei 190 lies two kilometres west of the tarred road linking Bethlehem and Clarens (R711), as indicated on Figure 1.

![Figure 1: Locality map](image)

The development site is reached by exiting from the R711 onto the S217 and travelling to the entrance marked *Kruisvallei Guest Farm*. This unit is situated next to the DWS Weir 26 in the Ash River. Refer to Figure 2 for coordinates.
7.2. Natural Agricultural Resources

7.2.1. Climate

See Table 1 for available information about the climate of the site.

<table>
<thead>
<tr>
<th>Month</th>
<th>Precipitation</th>
<th>Evaporation</th>
<th>Temperature</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>107 mm</td>
<td>5mm/day</td>
<td>Mean Max</td>
<td>25.1-27° C</td>
</tr>
<tr>
<td>February</td>
<td>87 mm</td>
<td>4.9mm/day</td>
<td>Mean Min</td>
<td>&lt;0° C</td>
</tr>
<tr>
<td>March</td>
<td>77 mm</td>
<td>3.9mm/day</td>
<td>Start frost</td>
<td>01 – 10 May</td>
</tr>
<tr>
<td>April</td>
<td>37 mm</td>
<td>2.6mm/day</td>
<td>End Frost</td>
<td>11 - 20 Sept</td>
</tr>
<tr>
<td>May</td>
<td>20 mm</td>
<td>1.7mm/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>8 mm</td>
<td>1.3mm/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>6 mm</td>
<td>1.5mm/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>18 mm</td>
<td>1.8mm/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>36 mm</td>
<td>2.6mm/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>59 mm</td>
<td>3.7mm/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>79 mm</td>
<td>4.5mm/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>90 mm</td>
<td>4.9mm/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>624 mm</td>
<td></td>
<td></td>
<td>1152.3mm</td>
</tr>
</tbody>
</table>

Source: Institute for Soil Climate and Water: Land Type Memoir
7.2.2. Topography
From the topographical map 2828 JORDAAN RIVIER, the local topography was interpreted as plains and wetlands with high hills. The plains are utilized as arable land and the wetlands and hills for grazing. The Ash River flows through the farm towards the Sol Plaatjies Dam. Two prominent weir structures in the Ash River are noticed: one on farm Kruisvallei 190, weir 26, and one on Middelvallei 130, weir 34. The streams draining towards the river also have weir structures. A marsh area exists upstream of these structures. The lowest contour line is at 1700 m above sea level.

7.2.3. Terrain
“Terrain” describes the relief or variation in height of the land surface. The surface is divided into morphological units as shown in Figure 3.

Figure 3: Terrain morphological units

The terrain form of the site on Middle Kruisvallei is illustrated in Error! Reference source not found..
Figure 4: Terrain form on the site at Middle Kruisvallei

The cross section in Figure 4 provides information regarding the shape of the slope of the development footprint. It shows a lower mid slope (3¹) and eventually into a straight shape for the foot slope (4).

This information is valuable when interpreting the land type data as this will indicate what soil forms can be expected in each terrain unit.

The terrain slope can be calculated using the difference in vertical height (1720m-1700m) divided by difference in horizontal distance (1401 - 1063) X 100. The slope is 5.9% for the 3¹-section and 2.3% for the 4 and 3¹ slope combination.

It is expected to find shallower soils on convex slopes and deeper soils on concave soils with water locked soils at foot slopes and valley bottoms.

When planning the water run off outlay, the information obtained is used to guide the planning. The water run-off is influenced by the size of the catchment. This area is contained within the boundaries from the ridge to the valley bottom.

The placing of the conservation structures is also influenced by the terrain features:

- **Waterway**
  The preferred position to place the waterway is on the natural drainage line (Valley bottom). Run off must be conveyed on the quickest way down slope and that is perpendicular on the contour line that ends in the valley bottom. Waterways must be able to accept all deposits of contour banks. The topography could prevent this and special techniques are required to enable it to happen.
• **Stormwater furrow**
  The stormwater furrow must be placed as close as possible to the top of the land to divert run off into the waterway. Design specifications such as size of catchment, basal cover and slope, depend on terrain data.

• **Contour bank**
  Must deposit run off in a waterway. Ensure the contour outlet is placed so that it will not deposit run off water onto the contour underneath. Keep contours within the catchment area

When assessing the impact the proposed construction will have on the existing farming practices, these principles will be applied.

### 7.2.4. Soils

Soils do not occur randomly in the landscape, but follow a pattern determined by factors such as geology and topographic position. Normally, soil forms follow each other downhill in a specific sequence. This is called a catena, with well-drained soils on top and water-locked soils at the bottom.

Such a system, where terrain form and soil pattern displays a marked degree of uniformity, is called a pedosystem.

This inter-relationship between soils and landform is a good reason for relating soils to the landscape position in which they occur.

The land type map 2828 HARRISMIT of the Department of Agriculture and the accompanying memoir was identified appropriate for use in the desktop study for this project.

The map shows that the pedosystem Bd53 was allocated to the site.

**Bd** represents the land type in respect of the terrain form, soil pattern and climate. This indicates a plinthic catena with upland duplex and margalitic soils (rare) and valley bottoms occupied by one or other gley soil type. In this case, the catena from highest to lowest would be identified as Hutton, Bainsvlei, Avalon and Longlands, while Rensburg, Willowbrook and Katspruit would occur in the valley bottom.

The **53** indicates the numerical number of occurrence of this pedosystem and the soil types expected on site (according to the inventory) and will be one or more of those indicated in Table 2.
Refer to Figures 5 and 6, which indicate that the affected area will be on the lower mid slope (3¹), including the foot slope (4) and valley bottom (5). See Figure 6.

From the inventory of the Land type memoir, the predicted soil types are shown in Table 2.

<table>
<thead>
<tr>
<th>Terrain unit</th>
<th>Dominant soil</th>
<th>Effective depth</th>
<th>Clay A</th>
<th>Clay B</th>
<th>Limiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>3¹</td>
<td>Avalon</td>
<td>450-1000mm</td>
<td>8-20%</td>
<td>13-35%</td>
<td>Plinthic</td>
</tr>
<tr>
<td>4</td>
<td>Estcourt</td>
<td>250-600mm</td>
<td>9-20%</td>
<td>40-65%</td>
<td>Structured</td>
</tr>
<tr>
<td>5</td>
<td>Inhoek</td>
<td>1000-1500mm</td>
<td>10-40%</td>
<td>15-35%</td>
<td>Saprolite</td>
</tr>
</tbody>
</table>
7.2.5. Geology

Literature describes the geology as Elliot mudstone and sandstone: Molteno grit and sandstone with inliers of Tarkastad Subgroup mudstone and sandstone at places. Narrow dolerite dykes may be present. Several very small outliers of Clarens sandstone may occur.

7.2.6. Vegetation

Information from the Department of Agriculture, Forestry and Fisheries, and other relevant literature, indicates that the site may have some of the following vegetation characteristics:

- Acocks veld type: Pure grassveld types.
- Vegetation biome: Grassland.
- NDVI (Normalized Difference Vegetation Index) long-term annual average: Moderate to high.
- Grazing capacity: 3-4 ha/LSU (large stock unit).

7.2.7. Land Capability

Land capability classification strives to group land that will allow the most intensive agricultural use without risk of soil degradation. In the USDA system, also used in South Africa, land is divided into eight classes (I – VIII), of which the first four are suitable for cultivation and the other unsuitable.

According to available literature, the land capability of the area where the development footprint of MK is proposed, fall within Class III. This entails the following:

- Moderate potential arable land.
- Agricultural region: Grain.
- Suitable crops:
  - Maize: 30 % (suitable expected yield of 3-4 ton/ha).
  - Sorghum: 10% suitable.
  - Soya beans: 50% suitable.

7.3. Past and Present agricultural activities

Past and present agricultural activities were established by comparing an Orto-photo dated 2001 to a satellite image of 2016. The comparison included Lower Kruisvallei (C) and Middle Kruisvallei (B) - see Figure 7 and Figure 8.

The general agricultural activity of the area in which this study was conducted was mixed farming. Dryland cash crop production and livestock farming on non-arable areas. Production of crops under cover also takes place.

The agricultural activities did not change much in this period, except for the new shade structures (N) and removal of trees (T).
Figure 7: Orto-photo 2001
Looking on a bigger scale and more specifically at Middle Kruisvallei (B), some land use differences were identified (Figure 9 and Figure 10).
The agricultural activities have changed, the orchard shown in 2001 no longer exists and a bridge over the Ash River was since constructed.
8. FIELD SURVEY

The field survey took place on 23 and 24 July 2017. In the following sections, the desktop findings are compared to the findings of the field survey.

8.1. Existing infrastructure

Figure 11 shows existing infrastructure on the farm.

![Existing infrastructure diagram]

This infrastructure was developed to enable formal agricultural practices. The potential impact of the proposed development on local agricultural practices must be assessed.

The Middle Kruisvallei Hydroelectric power station is reached by traveling on the R 712 from Bethlehem to Clarence up to the S217 exit. From the S217 the entrance is made at the Kruisvallei Guest Farm marker on the right. This route is illustrated by the photos in Figure 12.

This is a well-maintained provincial dirt road and provides access to the R26 and R712 for landowners.
Figure 12: Road to Middle Kruisvallei

Figure 13: Reference to infrastructure on site

(1) This storage facility falls outside the proposed development site and is not related to the proposed facility or its associated infrastructure.

(2) The overhead transmission lines borders the proposed development area on three sides while the Ash River runs on the fourth side.

(3) The access road is an existing farm road and in good condition. The road exits the development area on the north-west corner, north of the existing DWS weir, while another road connects with a bridge over the Ash River – see Figure 14. The bridge connects to Lower Kruisvallei and is in daily use.

(4) The cultivated land is used to propagate dry land maize. Water runoff is managed with contour banks draining from the ridge (landing strip) to the south and discharged into the wetland area.
Weir 26 (Figure 15) is in prime condition and will be the centre pin for development of the hydro station.
A hydrant indicates the presence of a sub-surface water pipeline (Figure 16). The exact location and route of the pipeline must be determined to find out whether the proposed development will have an impact on it. The hydrant may have to be relocated.

A pump line to pump water from the weir to a destination over the mountain was installed (Figure 17). The suction pipe between the pump house and existing maintenance road runs underneath the bridge. From the pump house, the pipeline runs upwards over the mountain. This location must be noted if any alterations will be made during access road construction.
8.2. **Assessment of soil potential**

The site was augered on a random basis and observations noted on a prescribed *Soil Observation Form* for each augering point. Photos were also taken at most augering points. The soil observation forms were then used to compile inventories of soils. The map in Figure 18 shows the augering points while the inventory for the soil types appear in **Error! Reference source not found.**.

In the tables, photos taken at the observation point are shown first, followed by a copy of the *Soil Observation Form*. Then follows a description of the soil properties.

**NOTE:** Only one augering point of a specific soil type appears in the table, representing all other occurrences of the same soil type on site.

---

**Figure 18: Soil observation points for Middle Kruisvallei**

**Table 3: Inventory of soils on Middle Kruisvallei**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avalon Avondale</td>
<td><img src="image_url" alt="Image" /></td>
</tr>
</tbody>
</table>
Soil Properties

### A Horizon
- **Topsoil**
  - Texture: Fine Sand
  - Consistency: Crumbly
  - Structure: Weak crumbly
  - Colour: Yellowish brown
  - Horizon Depth: 300mm

### B Horizon
- **Sub-soil**
  - Texture: Fine Sand loam
  - Consistency: Crumbly
  - Structure: Apedal
  - Colour: Yellowish brown
  - Horizon Depth: 500mm

### C-Horizon
- **Sub-strata**
  - Texture: Fine Sand clay loam
  - Consistency: Slightly solid and hard
  - Structure: Weak crumbly
  - Colour: Dark yellowish brown
  - Horizon Depth: >500mm

**Depth limitation**
- Soft plinthite
- >500mm

**Effective Depth**
- 500mm

**Terrain position**
- Upper mid slope

**Geology**
- Sandstone

**Slope shape**
- Convex

**Slope gradient**
- 4%

**Moisture availability**
- Low

**Erosion potential**
- Low

**Soil Form**
- Avalon

**Soil Family**
- Avondale

---

Oakleaf Buchuberg

---

Soil Properties

### A Horizon
- **Topsoil**
  - Texture: Fine Sand clay loam
  - Consistency: Slightly solid and hard
  - Structure: Weak crumbly
  - Colour: Dark yellowish brown
  - Horizon Depth: 200mm

### B Horizon
- **Sub-soil**
  - Texture: Fine Sand Clay Loam
  - Consistency: Slightly solid and hard
  - Structure: Weak blocky
  - Colour: Dark yellowish brown
  - Horizon Depth: 300mm

### C-Horizon
- **Sub-strata**
  - Texture: Saprolite
  - Consistency: Slightly solid and hard
  - Structure: Weak blocky
  - Colour: Dark yellowish brown
  - Horizon Depth: >500mm

**Depth limitation**
- Saprolite
- >500mm

---

Data provided for each horizon includes:
- **Soil Texture**
- **Soil Consistency**
- **Soil Structure**
- **Soil Colour**
- **Soil Horizon Depth**
- **Depth Limitation**
- **Effective Depth**
- **Terrain Position**
- **Geology**
- **Slope Shape**
- **Slope Gradient**
- **Moisture Availability**
- **Erosion Potential**
- **Soil Form**
- **Soil Family**
Effective Depth 500mm
Terrain position Lower mid slope
Geology Sandstone
Slope shape Convex
Slope gradient 4%
Moisture availability Low
Erosion potential Moderate
Soil Form Oakleaf
Soil Family Buchuberg

Arcadia Lonehill

Soil Properties

<table>
<thead>
<tr>
<th>Texture</th>
<th>Fine Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency</td>
<td>Slightly solid</td>
</tr>
<tr>
<td>Structure</td>
<td>Weak crumbly</td>
</tr>
<tr>
<td>Colour</td>
<td>Black</td>
</tr>
<tr>
<td>Horizon Depth</td>
<td>500mm</td>
</tr>
<tr>
<td>Depth limitation</td>
<td>Prismacutanic horizon</td>
</tr>
<tr>
<td>Effective Depth</td>
<td>300mm</td>
</tr>
<tr>
<td>Terrain position</td>
<td>Footslope</td>
</tr>
<tr>
<td>Geology</td>
<td>Dolerite</td>
</tr>
<tr>
<td>Slope shape</td>
<td>Concave to regular</td>
</tr>
<tr>
<td>Slope gradient</td>
<td>2%</td>
</tr>
<tr>
<td>Moisture availability</td>
<td>Low</td>
</tr>
<tr>
<td>Erosion potential</td>
<td>Low</td>
</tr>
<tr>
<td>Soil Form</td>
<td>Arcadia</td>
</tr>
<tr>
<td>soil Family</td>
<td>Lonehill</td>
</tr>
</tbody>
</table>
Sterkspruit Bethulie (sub-dominant soil)

<table>
<thead>
<tr>
<th>Soil Properties</th>
<th>A Horizon Topsoil</th>
<th>B 1 Horizon Sub-soil</th>
<th>B2-Horizon Sub-soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texture</td>
<td>Fine sand clay loam</td>
<td>Fine sand clay</td>
<td>Fine sand clay</td>
</tr>
<tr>
<td>Consistency</td>
<td>Loose</td>
<td>Solid</td>
<td>Solid</td>
</tr>
<tr>
<td>Structure</td>
<td>Weak crumbly</td>
<td>Strong blocky</td>
<td>Strong blocky</td>
</tr>
<tr>
<td>Colour</td>
<td>Dark Yellowish Brown</td>
<td>Dark reddish grey</td>
<td>Black</td>
</tr>
<tr>
<td>Horizon Depth</td>
<td>200mm</td>
<td>400mm</td>
<td>400mm</td>
</tr>
<tr>
<td>Depth limitation</td>
<td>Prismacutanic horizon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective Depth</td>
<td>300mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terrain position</td>
<td>Footslope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geology</td>
<td>Dolerite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slope shape</td>
<td>Concave to regular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slope gradient</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture availability</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion potential</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Form</td>
<td>Sterkspruit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Family</td>
<td>Bethulie</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the information in the tables, soils were grouped and a soil map compiled to indicate the occurrence of the various soil types on Middle Kruisvallei. See Figure 19.
8.3. Land Capability

The soils found on site were assigned to their appropriate classes, as shown in Table 4.

Table 4: Soil classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Soils with few limitations that restrict their use</td>
</tr>
<tr>
<td>II</td>
<td>Soils with some limitations that reduce the choice of plants or require</td>
</tr>
<tr>
<td></td>
<td>moderate conservation practices</td>
</tr>
<tr>
<td></td>
<td><strong>Hutton, Clovelly</strong></td>
</tr>
<tr>
<td>III</td>
<td>Soils with severe limitations that reduce the choice of crops or require</td>
</tr>
<tr>
<td></td>
<td>special conservation practices</td>
</tr>
<tr>
<td></td>
<td><strong>Avalon, Oakleaf</strong></td>
</tr>
<tr>
<td>IV</td>
<td>Soils with severe limitations that restrict the choice of crops and require</td>
</tr>
<tr>
<td></td>
<td>special management</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Glenrosa (irrigated), Pinedene</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
</tr>
<tr>
<td>Usually wetlands or very rocky areas</td>
</tr>
<tr>
<td>Arcadia, Sterkspruit and Willowbrook</td>
</tr>
<tr>
<td>VI</td>
</tr>
<tr>
<td>Steep and often rocky areas</td>
</tr>
<tr>
<td>Glenrosa Mispah</td>
</tr>
<tr>
<td>VII</td>
</tr>
<tr>
<td>Steep or rocky areas with limited grazing potential</td>
</tr>
<tr>
<td>VIII</td>
</tr>
<tr>
<td>Steep and rocky areas best suited to conservation</td>
</tr>
</tbody>
</table>

8.4. Land suitability for agriculture

Suitability depends on the soil properties such as effective rooting depth and permeability as key factors and climate attributes such as rainfall and temperature. High wind, frost and hail pose constraints to suitability.

8.4.1. Soil

Effective rooting depth is the depth to which roots can penetrate into the soil profile without any obstructions. In the example of the Avalon profile (Figure 20) the effective depth is within the orthic top soil. It further shows yellow apedal sub soil and Soft Plinthic as the depth restriction layer.

Figure 20 shows the diagnostic soil horizons and positions in profile where the porosity samples were taken.

![Figure 20: The profile of a soil (Avalon)](image)

Permeability refers to the ease with which roots and liquids penetrate and pass through soil and is influenced by the properties of the soil profile. The permeability of each soil layer is calculated using the Loxton table (Table 5).
Table 5: Loxton Table

<table>
<thead>
<tr>
<th>GUIDE FOR THE CALCULATION OF PERMEABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permeability Class</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Code</td>
</tr>
<tr>
<td>Texture</td>
</tr>
<tr>
<td>Structure</td>
</tr>
<tr>
<td>Colour</td>
</tr>
<tr>
<td>Motley</td>
</tr>
<tr>
<td>Water absorption tempo</td>
</tr>
</tbody>
</table>

The effective rooting depth and permeability calculation for the soils identified on site is set out in Table 6. P1 refers to the top layer and P2 to the sub layer. With this information known, a correction factor can be calculated for the term yield of a specific crop.

Table 6: Effective depth and permeability

<table>
<thead>
<tr>
<th>Soil form</th>
<th>Effective Depth</th>
<th>Permeability</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hutton</td>
<td>700mm</td>
<td>Good</td>
<td>2.8</td>
</tr>
<tr>
<td>Clovelly, Pinedene</td>
<td>700mm</td>
<td>Good</td>
<td>2.19</td>
</tr>
<tr>
<td>Avalon</td>
<td>600mm</td>
<td>Good</td>
<td>4.4</td>
</tr>
<tr>
<td>Glenrosa</td>
<td>400mm</td>
<td>Slightly slow</td>
<td>2.4</td>
</tr>
<tr>
<td>Oakleaf</td>
<td>600mm</td>
<td>Slightly slow</td>
<td>6.4</td>
</tr>
<tr>
<td>Sterkspruit, Willowbrook, Arcadia</td>
<td>300-400mm</td>
<td>Extremely slow</td>
<td>16.45</td>
</tr>
<tr>
<td>Mispah</td>
<td>300mm</td>
<td>Good</td>
<td>1.1</td>
</tr>
</tbody>
</table>

8.4.2. Land Capability

This climate restricts the choice of crops to be cultivated. The rainfall is 624 mm annually with a low temperature as indicated in Table 1.

8.4.3. Expected yield

The average yield for Maize is a good reference to determine agriculture potential.

Example: Maize production

Production potential (kg/ha) according to Möhr (1977):

\[
\text{Mean annual rainfall} \times \text{soil depth in cm} = 12.8
\]

Taking the best soil, namely Hutton, with a loamy sand texture and an average soil depth of 70cm,

\[
\frac{624 \times 70 \text{ cm}}{12.8} = 24
\]
The result would be 3412.5 kg/ha (3.4 ton).

The same calculation for the structured soils would result in a long-term yield of less than a ton per hectare for dryland production.

Although irrigation is possible and therefore makes the structured soils manageable, the terrain position still poses a high risk for cultivation. Permanent pastures are rather recommended.

Local information on expected yield is 4 ton/ha dry land and 6 ton/ha irrigated land.

8.4.4. Agricultural environment

Middle Kruisvallei can be divided into two utilization units, as indicated on Figure 21.

**Figure 21: Agricultural environment map – Middle Kruisvallei**

**Unit 1**

The soils in this unit are grouped based on similarity in cultivation and production properties.
Soils grouped in this unit are similar in capability for cash crop production. The texture and structural properties are compatible, and they generally have a root depth limitation between 600 and 700mm. The soil does not have any mechanical cultivation restrictions.

The unit has a medium agricultural potential (capability III), due to effective rooting depth and climatic environment.

The water management is sufficient and satisfy the principles of stormwater management.

- Discharge runoff in a natural waterway (Wetland);
- Discharge without danger that discharged water will reach underlying contour;
- Keep water in the catchment area;
- Area between last contour and riparian area /wetland have a slope less than 2% runoff from this area is intercepted by vegetation, which reduces flow speed before reaching the streambank.

**Unit 2**

This unit is classified as a riparian area because of its association with the watercourse, terrain position, soil and vegetation. It is separated with a fence from Unit 1.

A vertic character is dominant for this soil unit. This soil type has an extremely strong structure and the tendency to shrink and swell with changes in water content. For crop production purposes, this is very demanding. When dry, the soil profile is very hard and cracks develop. The shrink and swelling movement in the soil may break roots of crops not suitable to withstand these movements within the soil. During the raining season, the soil becomes unworkable due to excessive wetness and stickiness. Cultivating practices are restricted to a small climatic window when implements can operate without difficulty.

This unit is mainly suitable for extensive grazing or cultivated pastures.

The abrupt change in soil form on knife-edge is typical of vertic soils and the internal fence indicates the line of separation for cultivation practices between the two units. The position in landform is also an indication for restricted cultivation.

Although there are indications on photo history of some cultivation that took place previously on this unit, it is currently utilized for grazing.

The soil characteristics of this unit will influence engineering projects, such as construction of canals. Special care must be taken in the design of foundations to compromise for the shrink and swell properties in the soil. This soil is ideal as a liner or conduit to transport water and is often used for the core of earth dams, preventing water seeping through the base.

Sensitive areas are important in the agricultural environment. It relates to soil conservation, which is an inherent part of agricultural management. The sensitivity map (Figure 22) shows an area where possible impacts may be inflicted on the agricultural environment during construction. Construction must be carried out with the necessary care, and mitigation measures proposed in this report must be implemented.
Wetlands are sensitive to pollution. Petroleum based products are predominantly non-polar compounds with low water solubilities. With spillages, they tend to bond with soil organic matter, which leaches to the wetland and reaches humans through the food chain (water-human, water-animal-human, and water-plant-human). The heavier compounds are serious threats because they remain in the soil and effect plant growth. Therefore, spillage on or near a wetland should be regarded very hazardous.

The powerline will cross the wetland and the necessary precautions to avoid soil pollution must be applied during the construction period.

The sensitivity rating is low to medium.
8.5. **Assessment of Power line and service road**

The alignment for the overhead transmission is planned to be on existing servitudes and on the borders of the individual farms. The line will cross S217 and R712 provincial roads – see Figure 23.

The approach was to determine what impacts the proposed line might pose on agricultural resources and practices.

The general classification of the terrain is plains with open hills and ridges. Soils with plinthic catena and effective rooting depth less than 750 mm are dominant. The land cover is annual crop production with cultivated pastures as rotational crop.

The proposed alignment is on existing servitudes mainly within the road reserve. This will ensure that production is not lost. The service roads will be well maintained and have the advantage of serving as firebreaks.

The backdrop in Figure 24 is used to compare the potential impact of the powerline on the agricultural environment.

8.5.1. **Assessment with thematic maps**

The powerline alignment was not subjected to a field study per se, but general observations during the field study were incorporated into a desktop study.

When determining whether a development may have negative impacts on the agricultural milieu (for this purpose the alignment of the powerline), the themes shown in Figure 24 play a dominant part.
Land Capability
Land Capability is the comprehensive result of soil and climate. A soil with limitless properties but in an area with harsh climatic conditions will not be able to produce the same as one with in a temperate climate zone. This assessment will focus on what extent the loss of this land will have on the farming enterprise as a whole.

Land Cover.
This shows the land use and its expected agricultural activity. The denser populated the land cover is, the higher projected value of exclusiveness is awarded to the land. The assessment focuses on how the development will effect the land cover compilation and the cultivation practices.

Wetlands
Development near wetland areas has to be investigated for possible impacts of erosion, pollution and change of drainage lines.

Vegetation
The vegetation biome reflects the potential for grazing and is normally associated with soil and climate. Two biomes are predicted: The orange indicates Basotho and Montane Shrubland and the light purple represents Eastern Free State Sandy Grassland.

When comparing the four maps, there is a distinctive similarity between the position of the powerline and the thematic properties.

<table>
<thead>
<tr>
<th>Colour of powerline</th>
<th>Capability Class</th>
<th>Land cover</th>
<th>Presence of Wetlands</th>
<th>Veg Biome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>VI</td>
<td>Not cultivated</td>
<td>Present</td>
<td>Basotho shrub</td>
</tr>
<tr>
<td>Maroon</td>
<td>III</td>
<td>Cultivated</td>
<td></td>
<td>E Free State</td>
</tr>
</tbody>
</table>
On the map, yellow is classified as capability III, but it occurs near the transition to capability VI. Capability VI is also associated with ridges in this study area and bottomland at the foot slope.

The Basotho and Montane shrubland is associated with capability VI (non-arable) soil properties where Eastern Free State Sandy Grassland preferring the arable soil properties.

This map reference can be used as a predicative source for assessment.

8.5.2. Assessment on satellite image:

Figure 25: Middle Kruisvallei Powerline

Stretch AD resembles Soil unit 2 in terrain form, namely floodplain with riparian buffer along the river.
Streach BC
The wetland will be crossed along this stretch (± 170 m). The pylons can be spaced with a 100 m interval, resulting in one pylon being erected in the wetland.

Streach CD
Streach CD is on the bottom of the land on the foot slope. No high potential soil is expected, as can be seen on the photo. Interference with agricultural activities will therefore be low. The powerline will cross near the bridge on the S217 (Refer to figure 12). Point D is close to the proposed Boston Hydro station.

Streach DE
The possibility to interrupt cultivation practices is kept low by using existing roads, servitudes and farm boundaries for the alignment. At point E, a wetness hazard is identified which require special mitigation measures for the construction of the powerline.

Streach E to Node Sub station
Cultivated land is not sub divided with powerline but intersect on existing separation between lands Erosion at F must be respected when construction of service road takes.

9. ASSESSMENT OF POTENTIAL IMPACTS ON THE AGRICULTURAL ENVIRONMENT

Structures that may pose impacts on the agricultural environment are:

- Hydro electrical plant;
- Laydown area;
- Access roads; and
- Powerline.

These are shown in Figure 26.
Figure 26: Proposed structures on Middle Kruisvallei

9.1. Methodology to assess impacts

Potential impacts of the proposed project on agriculture were identified and evaluated. Impacts identified through the study were rated in terms of the following criteria:

- The nature, which shall include a description of what causes the effect, what will be affected and how it will be affected.

- The extent, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).

- The duration, wherein it will be indicated whether:
  * the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  * the lifetime of the impact will be of a short duration (2–5 years) – assigned a score of 2;
  * medium-term (5–15 years) – assigned a score of 3;
* long-term (> 15 years) - assigned a score of 4; or
* permanent - assigned a score of 5.

- The magnitude, quantified on a scale from 0-10, where a score is assigned:
  * 0 is small and will have no effect on the environment
  * 2 is minor and will not result in an impact on processes
  * 4 is low and will cause a slight impact on processes
  * 6 is moderate and will result in processes continuing but in a modified way
  * 8 is high (processes are altered to the extent that they temporarily cease)
  * 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

- The probability of occurrence, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale, and a score assigned:
  * Assigned a score of 1–5, where 1 is very improbable (probably will not happen)
  * Assigned a score of 2 is improbable (some possibility, but low likelihood)
  * Assigned a score of 3 is probable (distinct possibility)
  * Assigned a score of 4 is highly probable (most likely)
  * Assigned a score of 5 is definite (impact will occur regardless of any prevention measures).

- The significance, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
  - the status, which will be described as either positive, negative or neutral,
  - the degree to which the impact can be reversed,
  - the degree to which the impact may cause irreplaceable loss of resources,
  - the degree to which the impact can be mitigated.

The significance is calculated by combining the criteria in the following formula:

\[
S = (E+D+M)P
\]

- **S** = Significance weighting
- **E** = Extent
- **D** = Duration
- **M** = Magnitude
- **P** = Probability

The significance weightings for each potential impact are as follows:

- **<30 points**: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- **30-60 points**: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
9.2. Impacts during Construction

9.2.1. Hydro electrical plant

The construction of the plant will be mainly on soil Unit 2. The land use is natural grazing. Construction will entail the clearing of vegetation, excavation for the canal and construction of the plant. This may result in destruction of habitat and loss of arable soil. The vertic character of the soil will influence engineering projects, such as construction of canals. Special care must be to be taken in the design of foundations to compromise for the shrink and swell properties in the soil.

9.2.1.1 Loss of agricultural land.

| Nature: The establishment of the Hydro electrical plant will be done at the expense of agricultural land. Area to be lost would be for the construction of canal and powerhouse structure, internal service roads and temporary laydown area. |
|---|---|
| **Without mitigation** | **With mitigation** |
| **Extent** | Local (2) | Local (1) |
| **Duration** | Short term (2) | Short term (2) |
| **Magnitude** | Low (4) | Low (4) |
| **Probability** | Probable (3) | Probable (3) |
| **Significance** | Low (24) | Low (21) |
| **Status (positive or negative)** | Negative | Negative |
| **Reversibility** | Low | Low |
| **Irreplaceable loss of resources?** | No | No |
| **Can impacts be mitigated?** | Yes | Yes |

**Mitigation:** Respect all existing conservation and agricultural practices. Maintain all structures and prevent interference with normal farming activities as far as possible.

**Cumulative impacts:**
No cumulative impacts are expected to occur as all impacts will be site bounded.

**Residual Risks:**
No. Effected areas will be rehabilitated as the impact will only be applicable during construction phase and be non-existent once construction has ceased.

9.2.1.2 Destruction of river bank

| Nature: Constructing the tailrace takes place on the edge of the river and requires the altering of shape and composition of the riverbank. This can lead to erosion of the riverbank. |
|---|---|
| **Without mitigation** | **With mitigation** |
| **Extent** | Local (3) | Local (1) |
| **Duration** | Short-term (2) | Short-term (2) |
| **Magnitude** | Moderate (6) | Low (4) |
### Probability

<table>
<thead>
<tr>
<th>Probability</th>
<th>Probable (3)</th>
<th>Probable (3)</th>
</tr>
</thead>
</table>

### Significance

<table>
<thead>
<tr>
<th>Status (positive or negative)</th>
<th>Medium (33)</th>
<th>Low (21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reversibility</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Irreplaceable loss of resources?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Can impacts be mitigated?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Mitigation:** Provide appropriate structures to break flow speed.

It is recommended that the riverbanks surrounding the tailrace canal outlet be protected with riprap. All the areas disturbed during the construction work need to be landscaped to a standard similar or better than previously, on completion of the works.

**Cumulative impacts:**  
Yes, with each development riverbanks will be altered.

**Residual Risks:**  
Yes, cannot rehabilitate to original state.

### 9.2.1.3 Accumulation of spoil material on unwanted area

**Nature:** The excavation of the canal will produce a large amount of spoil material. When the removal and temporary stockpiling is not regulated efficiently, the accumulation of spoil material will interfere with the construction and agricultural activities.

<table>
<thead>
<tr>
<th>Extent</th>
<th>Without mitigation</th>
<th>With mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>Short term (2)</td>
<td>Short term (2)</td>
</tr>
<tr>
<td>Magnitude</td>
<td>Low (4)</td>
<td>Minor (2)</td>
</tr>
<tr>
<td>Probability</td>
<td>Probable (3)</td>
<td>Probable (3)</td>
</tr>
<tr>
<td>Significance</td>
<td>Low (24)</td>
<td>Low (15)</td>
</tr>
<tr>
<td>Status (positive or negative)</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Irreplaceable loss of resources?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Can impacts be mitigated?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Mitigation: Schedule operations not to be in peak season of agricultural activities. Identify designated dumping sites (Filling or removal from site) with uninterrupted cycle of movement of construction vehicles. Use rubble as filling where possible. Transport excess rubble to licenced landfill facility.

Cumulative impacts: No, site bounded

Residual Risks: No, if the spoil material will not been used, would be transported from the site.

9.2.1.4 Soil pollution by construction vehicles and building materials

Nature: Construction machinery and building materials used in the development of the hydro electrical plant will pollute the soil during the construction phase with contaminants such as spillages of hydrocarbon (fuel oil) and cement leaving an unproductive growing medium.

<table>
<thead>
<tr>
<th>Without mitigation</th>
<th>With mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent</td>
<td>Local (1)</td>
</tr>
<tr>
<td></td>
<td>Local (1)</td>
</tr>
<tr>
<td>Duration</td>
<td>Short duration (2)</td>
</tr>
<tr>
<td></td>
<td>Short duration (2)</td>
</tr>
<tr>
<td>Magnitude</td>
<td>Low (4)</td>
</tr>
<tr>
<td></td>
<td>Minor (2)</td>
</tr>
<tr>
<td>Probability</td>
<td>Probable (3)</td>
</tr>
<tr>
<td></td>
<td>Probable (3)</td>
</tr>
<tr>
<td>Significance</td>
<td>Low (21)</td>
</tr>
<tr>
<td></td>
<td>Low (15)</td>
</tr>
<tr>
<td>Status (positive or negative)</td>
<td>Negative</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Irreplaceable loss of resources?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Can impacts be mitigated? Yes Yes

Mitigation: Refuelling normally takes place in the laydown area. Proactive measures must be taken which include constructing of a designated area where refuelling can take place. This area must have an impervious floor with low wall that will keep the spillage inside. This area should be cleaned with absorbent material on a regular basis. The use of cut-off drains must be incorporated to divert upslope clean stormwater around the site into a natural drainage system. On the downslope, polluted water must be collected via a cut-off drain into a leachate collection and recovery system. When spillage accidently takes place, it should be removed and replaced with unpolluted soil. The clean soil can be sourced from excavations nearby. The polluted soil must be piled at a temporary storage facility with a firm waterproof base and is protected from inflow of stormwater. It must have an effective drainage system to a waterproof spillage collection area. Contaminated soil must be disposed of at a hazardous waste storage facility.

Cumulative impacts: No site bounded.

Residual Risks: Yes, it is impossible to clear the affected area totally.
9.2.1.5 Loss of top soil

**Nature:** The excavation of canal, construction of access roads and clearing of laydown area will remove the top soil, leaving an unproductive subsoil prone to be eroded.

<table>
<thead>
<tr>
<th></th>
<th>Without mitigation</th>
<th>With mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extent</strong></td>
<td>Local (2)</td>
<td>Local (1)</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Short term (2)</td>
<td>Short-term (2)</td>
</tr>
<tr>
<td><strong>Magnitude</strong></td>
<td>Minor (2)</td>
<td>Minor (2)</td>
</tr>
<tr>
<td><strong>Probability</strong></td>
<td>Probable (3)</td>
<td>Probable (3)</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td>Low(18)</td>
<td>Low (15)</td>
</tr>
<tr>
<td><strong>Status (positive or negative)</strong></td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td><strong>Reversibility</strong></td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Irreplaceable loss of resources?</strong></td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Can impacts be mitigated?</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Mitigation:**
Topsoil that has been excavated for the clearing of laydown area, footprint of canal and service roads must be stockpiled. This soil must be reused with the rehabilitation at the end of the construction process. Roads will be constructed with specifications including roadway preparation stormwater controls and placing gravel where needed. Where possible, gravel from areas of excavated (cut) will be used to provide material where it is required (fill) and to surface the road.

**Cumulative impacts:**
No, site bounded

**Residual Risks:**
No. Effected areas will be rehabilitated to its previous state once construction has ceased.

9.2.1.6 Obstruction of runoff with new access road and headrace canal

**Nature** .The road and canal will obstruct runoff to the river, which will result in a concentration of water on the road surface. This will prevent traffic to pass due to excessive wetness and stickiness of the surface.

<table>
<thead>
<tr>
<th></th>
<th>Without mitigation</th>
<th>With mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extent</strong></td>
<td>Local (3)</td>
<td>Local (1)</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Short term (2)</td>
<td>Short-term (2)</td>
</tr>
<tr>
<td><strong>Magnitude</strong></td>
<td>Moderate (6)</td>
<td>Minor (2)</td>
</tr>
<tr>
<td><strong>Probability</strong></td>
<td>Probable (3)</td>
<td>Probable (3)</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td>Moderate(33)</td>
<td>Low (15)</td>
</tr>
<tr>
<td><strong>Status (positive or negative)</strong></td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td><strong>Reversibility</strong></td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Irreplaceable loss of resources?</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Can impacts be mitigated? | Yes | Yes
--- | --- | ---
**Mitigation:**
Construct the access road with an inslope towards the cultivated land

![Diagram of land, ditch, new access road, and canal with road slope and land slope](image)

The ditch, the same size as the existing contour banks, can convey runoff to discharge in the wetland. The ditch must be extended (where new access road turns) to convey runoff towards the tailrace, preventing water to accumulate at the canal.
The crossing of contour banks with access road must be shaped to form rolling dips.

This will prevent breakage of contour banks and concentration of runoff on the road.

**Cumulative impacts:**
No, site bounded

**Residual Risks:**
No. Effected areas will be rehabilitated once construction has ceased or maintained as service roads.

### 9.2.2. Possible impacts during operation

#### 9.2.2.1 Loss of agricultural land

**Nature:** The operation of the Hydro electrical plant (specifically the operation of the power line) will be done at the expense of agricultural land. Area lost would be for the footprint of the powerhouse structure and internal service roads.

<table>
<thead>
<tr>
<th></th>
<th>Without mitigation</th>
<th>With mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extent</strong></td>
<td>Local (2)</td>
<td>Local (1)</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Long term (4)</td>
<td>Long term (4)</td>
</tr>
<tr>
<td><strong>Magnitude</strong></td>
<td>Low (4)</td>
<td>Low (4)</td>
</tr>
<tr>
<td><strong>Probability</strong></td>
<td>Probable (3)</td>
<td>Probable (3)</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td>Medium (30)</td>
<td>Low (27)</td>
</tr>
<tr>
<td><strong>Status (positive or negative)</strong></td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td><strong>Reversibility</strong></td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Irreplaceable loss of resources?</strong></td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Can impacts be mitigated?  Yes  Yes

Mitigation: Respect all existing conservation and agricultural practices. Maintain all structures and prevent interference with normal farming activities as far as possible.

Cumulative impacts: No, all impacts will be site bounded.

Residual Risks: No. Effected areas will be rehabilitated when operation has ceased.

### 9.2.2.2 Soil pollution by maintenance vehicles and building materials

**Nature:** Maintenance to service roads and hydro plant will cause a soil pollution impact on agricultural land by means of spillages of fuel and cement.

<table>
<thead>
<tr>
<th></th>
<th>Without mitigation</th>
<th>With mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extent</strong></td>
<td>Local (2)</td>
<td>Local (1)</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Long term (4)</td>
<td>Long term (4)</td>
</tr>
<tr>
<td><strong>Magnitude</strong></td>
<td>Low (4)</td>
<td>Minor (2)</td>
</tr>
<tr>
<td><strong>Probability</strong></td>
<td>Probable (3)</td>
<td>Probable (3)</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td>Medium (30)</td>
<td>Low (21)</td>
</tr>
<tr>
<td><strong>Status (positive or negative)</strong></td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td><strong>Reversibility</strong></td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Irreplaceable loss of resources?</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Can impacts be mitigated?</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Mitigation: Refuelling must take place in a designated area. This area must have an impervious floor with low wall that will keep the spillage inside. This area should be cleaned with absorbent material on a regular basis. When spillage accidently takes place, it should be removed and replaced with unpolluted soil.

Cumulative impacts: No, site bounded

Residual Risks: Yes. It is impossible to clear the affected area.

### 9.2.2.3 Destruction of river bank

**Nature:** Discharge through the tailrace act continuously on the riverbank and if not monitored and maintained will cause erosion to river bank and migrate to agricultural land.

<table>
<thead>
<tr>
<th></th>
<th>Without mitigation</th>
<th>With mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extent</strong></td>
<td>Local (3)</td>
<td>Local (1)</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Short-term (2)</td>
<td>Short-term (2)</td>
</tr>
<tr>
<td><strong>Magnitude</strong></td>
<td>Moderate (6)</td>
<td>Low (4)</td>
</tr>
<tr>
<td><strong>Probability</strong></td>
<td>Probable (3)</td>
<td>Probable (3)</td>
</tr>
</tbody>
</table>
### Significance

<table>
<thead>
<tr>
<th></th>
<th>Medium (33)</th>
<th>Low (21)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Status (positive or negative)</strong></td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td><strong>Reversibility</strong></td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Irreplaceable loss of resources?</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Can impacts be mitigated?</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Mitigation:** Monitor status of riverbank regular and rehabilitate continuously.

**Cumulative impacts:**
Yes, with each development riverbanks will be altered.

**Residual Risks:**
Yes, cannot rehabilitate to original state.

### 9.3. Impacts during Refurbishment

The aim of the developer is to refurbish the plant after twenty years and not to remove structures.

#### 9.3.1. Loss of agricultural land.

**Nature:** The upgrade and maintenance of the Hydro electrical plant will be done at the expense of agricultural land. Area to be lost would be for the footprint of the powerhouse and internal service roads.

<table>
<thead>
<tr>
<th></th>
<th>Without mitigation</th>
<th>With mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extent</strong></td>
<td>Local (2)</td>
<td>Local (1)</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Long term (4)</td>
<td>Long term (4)</td>
</tr>
<tr>
<td><strong>Magnitude</strong></td>
<td>Low (4)</td>
<td>Low (4)</td>
</tr>
<tr>
<td><strong>Probability</strong></td>
<td>Probable (3)</td>
<td>Probable (3)</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td>Medium (30)</td>
<td>Low (27)</td>
</tr>
<tr>
<td><strong>Status (positive or negative)</strong></td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td><strong>Reversibility</strong></td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Irreplaceable loss of resources?</strong></td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Can impacts be mitigated?</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Mitigation:** Respect all existing conservation and agricultural practices. Maintain all structures and prevent interference with normal farming activities as far as possible.

**Cumulative impacts:**
No, all impacts will be site bounded.

**Residual Risks:**
No. Effected areas will be rehabilitated when operation has ceased.
9.3.2. Soil pollution by maintenance vehicles and building materials

| Nature: Upgrading and maintenance to service roads and hydro plant may cause a soil pollution impact on agricultural land by means of spillages of fuel and cement. |
|---|---|---|
| Without mitigation | With mitigation |
| **Extent** | Local (2) | Local (1) |
| **Duration** | Long term (4) | Long term (4) |
| **Magnitude** | Low (4) | Minor (2) |
| **Probability** | Probable (3) | Probable (3) |
| **Significance** | Medium (30) | Low (21) |
| **Status (positive or negative)** | Negative | Negative |
| **Reversibility** | Low | Low |
| **Irreplaceable loss of resources?** | Yes | No |
| **Can impacts be mitigated?** | Yes | Yes |

**Mitigation:** Refuelling must take place in a designated area. This area must have an impervious floor with low wall that will keep the spillage inside. This area should be cleaned with absorbent material on a regular basis. When spillage accidently takes place, it should be removed and replaced with unpolluted soil.

**Cumulative impacts:**
No, site bounded

**Residual Risks:**
Yes. It is impossible to clear the affected area completely.

9.4. Impacts during decommissioning

Should the plant no be refurbished and upgraded, the plant will be decommissioned. The aim of decommissioning (the closure plan) is to restore the site to a similar condition as before construction. All components of the facility should be dissembled and roads demolished. Rehabilitation should focus on:

- Demolish and removal of structures
- Demolish related roads
- Establish cultivation environment
- Stabilisation of erosion

Rehabilitation is an ongoing process, starting at construction.

All areas disturbed by construction related activities such as access roads, construction platforms, workshop area should be rehabilitated.

9.4.1. Disturbance of cultivating practices;

| Nature: The placement of spoil material accumulated from destruction of the powerhouse and filling material required for rehabilitation of canal will interfere with the agricultural activities if rubble and filling material is stockpiled randomly. |
### Without mitigation | With mitigation
---|---
**Extent** | Local (2) | Local (1)
**Duration** | Short term (2) | Short term (2)
**Magnitude** | Low (4) | Minor (2)
**Probability** | Probable (3) | Probable (3)
**Significance** | Low (24) | Low (15)
**Status (positive or negative)** | Negative | Negative
**Reversibility** | Low | Low
**Irreplaceable loss of resources?** | No | No
**Can impacts be mitigated?** | Yes | Yes

**Mitigation:** Schedule procedure of demolition. Start with powerhouse and end with service road. Demolish and relocate rubble to temporary stockpile area, from where licenced contractors can haul to dump on licenced landfill area. Rehabilitate foundation site used for infrastructure, landscape and revegetate riverbank where tailrace operated. Buy filling to rehabilitate canal, demolish and rehabilitate service roads and stockpile area.

**Cumulative impacts:**
No, site bounded

**Residual Risks:**
Yes, cannot rehabilitate to original cultivated state.

### 9.4.2. Soil pollution by construction vehicles and building materials

**Nature:** Soil pollution by contaminant spillages during the decommissioning phase may take place. This is possible during the deconstruction of all facets of the facility: concrete foundations and canal linings, main access and internal service roads.

| Without mitigation | With mitigation |
---|---|
**Extent** | Local (1) | Local (1)
**Duration** | Short duration (2) | Short duration (2)
**Magnitude** | Low (4) | Minor (2)
**Probability** | Probable (3) | Probable (3)
**Significance** | Low (21) | Low (15)
**Status (positive or negative)** | Negative | Negative
**Reversibility** | Low | Low
**Irreplaceable loss of resources?** | Yes | No
**Can impacts be mitigated?** | Yes | Yes

**Mitigation:** Refuelling must take place in a designated area. This area must have an impervious floor with low wall that will keep the spillage inside. This area should be cleaned with absorbent material on a regular basis. When spillage accidentally takes place, it should be removed and replaced with unpolluted soil.

**Cumulative impacts:**
10. CUMULATIVE IMPACT ASSESSMENT

The Ash River is fed by the Trans Caledon Transfer Tunnel, which transfers water from the Katse Dam high up in the Maluti Mountains in Lesotho. Being very predictable, this is one of the greatest small hydro resources in the country, allowing for conditions perfectly suited to electricity production. In addition (also a result of the flow regulation), comprehensive information on current and future flow is available, making the potential highly predictable. For the purpose of the cumulative impact assessment, the LK and Mk will be considered as one project as both facilities form part of the Kruisvallei Hydroelectric Power Generation Scheme.

This made the construction of Hydro electrical generating plants possible and in a 30 km radius from the Kruisvallei Hydroelectric Power Generation Scheme; the following developments were established between Bethlehem and Clarens:

- Sol Plaatjies Hydro Powerplant, operational since 2009;
- Merino Hydro Powerplant, operational since 2010;
- Stortemelk Hydro Powerplant, operational since 2016;
- Boston Hydro Powerplant, authorised, not in operation yet.

Figure 27 shows the distances between these developments.

By comparing photo images of this whole area between 2001 and 2017, there were very few differences in agricultural development. The most substantial was near the northern outlet of the tunnel, where irrigation developments took place.
10.1. Decrease in quantity and quality of soils

The hydro plants will be constructed in the dam wall as in the case of Sol Plaatjies and Stortemelk or as a run of river such as Merino, Boston and the Kruisvallei Hydroelectric Power Generation Scheme. For the purpose of cumulative impacts, the Kruisvallei Hydroelectric
Power Generation Scheme has been considered as a whole as the LK Scheme and MK Scheme form one project.

The area loss will be incorporated within the footprint of the dam wall or at the valley bottom of the land.

Soils at the valley bottom will be restricted with a wetness hazard, disqualifying them as high potential soils.

The locality of the structure will always be at the bottom of the land with low influence on the existing cultivation practices.

10.2. Changes in hydrological regimes

The change in Hydrological regime will be low, because all water used will be returned to the river. An impact that may develop is the decrease in quality of the water.

Construction phase will always be at the cost of riverbanks and operating phase at the cost of the riverbed.

Construction and operational phases will also have the possibilities of pollution from fuel and cement effecting the river system.

10.3. Summary of possible cumulative impacts

10.3.1. Nature: Decrease in quantity and quality of soils

<table>
<thead>
<tr>
<th>Overall impact of proposed project considered in isolation</th>
<th>Cumulative impact of the projects in the area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent</td>
<td>Local (3)</td>
</tr>
<tr>
<td>Duration</td>
<td>Long Term (4)</td>
</tr>
<tr>
<td>Magnitude</td>
<td>Moderate (6)</td>
</tr>
<tr>
<td>Probability</td>
<td>Probable (3)</td>
</tr>
<tr>
<td>Significance</td>
<td>Medium (39)</td>
</tr>
<tr>
<td>Status (Positive or negative)</td>
<td>Negative</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Low</td>
</tr>
<tr>
<td>Irreplaceable loss of Resources?</td>
<td>No</td>
</tr>
<tr>
<td>Confidence in findings</td>
<td>High</td>
</tr>
<tr>
<td>Can impacts be mitigated?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Mitigation:** Find transformed or non-arable land for the development. Implement stormwater management as integral part of planning and as guideline for positioning of structures. Use existing roads and conservation structures to the maximum in the planning and operation phases. Rehabilitate disturbed areas as soon as possible after construction.
**Residual**: Not possible to rehabilitate completely to the original cultivated state, because construction altered the soil profile

### 10.3.2. Nature: Changes in hydrological regimes

Potential impacts that would change rate and quality of run off:
- Scouring of riverbeds and loss of riverbanks due to the erroneous release of water back in the river.
- Clearing of vegetation: increase flow speed, lower infiltration tempo increase silt transport
- Pollution by chemicals and hazardous substances and waste

<table>
<thead>
<tr>
<th></th>
<th>Overall impact of proposed project considered in isolation</th>
<th>Cumulative impact of the projects in the area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent</td>
<td>Local (1)</td>
<td>Regional(3)</td>
</tr>
<tr>
<td>Duration</td>
<td>Long Term (4)</td>
<td>Long Term (4)</td>
</tr>
<tr>
<td>Magnitude</td>
<td>Low (4)</td>
<td>Low (4)</td>
</tr>
<tr>
<td>Probability</td>
<td>Probable (3)</td>
<td>Probable (3)</td>
</tr>
<tr>
<td>Significance</td>
<td><strong>Low (27)</strong></td>
<td><strong>Medium (33)</strong></td>
</tr>
<tr>
<td>Status (Positive or negative)</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Irreplaceable loss of Resources?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Can impacts be mitigated?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Mitigation**: The integrity of riparian vegetation must be protected at all times to prevent or minimise riverbank erosion.

It is recommended that the riverbanks surrounding the headrace canal inlet be protected with riprap.

Appropriately designed riprap protection of the canal invert and walls, or a concrete lined canal, at the tailrace canal would prevent erosion occurring in this reach.

It is recommended that the riverbanks surrounding the tailrace canal outlet be protected with riprap, except where erosion-resistant bedrock is exposed.

The riverbanks immediately downstream of the weir should be provided with significant protection, in the form of either concrete training walls or heavy riprap.

All the areas disturbed during the construction work need to be landscaped to a standard similar or better than previously, on completion of the works.

Erosion and sediment control with proper water run-off control planning.

Appropriate handling and storage of chemicals and hazardous substances and waste.

**Residual Risk**: Yes, not possible to rehabilitate original status completely.

### 11. ENVIRONMENTAL MANAGEMENT PROGRAMME

The following should be included in the Environmental Management Programme:

**11.1. Objective**: Placement of spoil material generated from construction related excavations.

<table>
<thead>
<tr>
<th>Project components</th>
<th>Construction: Excavation of canal and foundation of powerhouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential impact</td>
<td>Unplanned placement of spoil material will disrupt construction processes and occupy agricultural land.</td>
</tr>
<tr>
<td>Activity/risk source</td>
<td>Spoil material will end up in inappropriate places.</td>
</tr>
</tbody>
</table>
11.2. Objective: Prevent and clean up soil pollution

Project components
- Headrace and tailrace;
- Powerhouse;
- Access roads;
- Power line;
- Watercourse crossing, i.e. access roads and culverts;
- All other infrastructure.

Potential impact
Pollution of soil by fuel, cement and other toxic materials. Negative impacts on wetlands.

Activity/risk source
Soil will become contaminated

Mitigation:
Target/Objective
No contamination of soil.

Mitigation:
Action/control
All solid waste must be collected at a central location at each construction site and stored temporary until it can be removed to an appropriate landfill site in the vicinity. The target should be to minimise spillages and soil contamination.

Responsibility
EPC Contractor
Maintenance team

Timeframe
Lifespan of facility

Performance Indicator
No spillages

Monitoring
Regular inspections of terrain and various infrastructure units.
**Mitigation:**
- **Target/Objective:** To minimise erosion of cultivated land.
  To minimise soil degradation.

<table>
<thead>
<tr>
<th>Mitigation:</th>
<th>Responsibility</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action/control</strong></td>
<td>EPC Contractor</td>
<td>Lifespan of facility</td>
</tr>
<tr>
<td>Respect and maintain existing conservation structures on cultivated land. Maintain access roads. Establish vegetation between canal and river. Monitor riverbanks and riverbed for erosion and act to protect.</td>
<td>Maintenance team</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environmental manager</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance Indicator</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>No water run-off problems / erosion</td>
<td>Regular inspections of terrain by ECO.</td>
</tr>
<tr>
<td>Minimal level of soil erosion around site.</td>
<td></td>
</tr>
</tbody>
</table>

### 12. CONCLUSION AND RECOMMENDATION

When studying possible agricultural impacts on Middle Kruisvallei as a proposed site for constructing a Hydroelectric Power Station, the following also had to be kept in mind:

- A hydro plant requires a sustainable and predictable water source to operate efficiently and a terrain where the water head is economically viable.
- The Lesotho Highlands Water Project provided the predictable water source and Middle Kruisvallei’s existing weir provides a perfect re-entering into the river.

The aim of this study was to establish what impacts this facility would have on the existing agricultural milieu and natural resources.

The study identified two utilization units. The one unit represents a cultivated environment with obvious good conservation practices, while the other indicates a wetland utilized as a grazing camp. The field survey confirmed the need for separate use.

The soils in Unit 1 are suitable for cash crop production. The texture and structure are compatible and root depth limitation between 600 and 700mm. The soil does not have any cultivation restrictions and water management is sufficient. The unit has a medium agricultural potential.

The laydown area will be located on this unit. The water run off management is efficient. If the contour banks are not disturbed during the operational phase, erosion should not be a problem. When the area is rehabilitated after the construction phase, it could be established with cultivated pasture to ensure low maintenance and low erodibility.

The position of the power plant at the bottom of the land and service road outlay fit in with the agricultural activities and will not effect on the daily activities.

The soil in Unit 2 dominantly has a vertic character. This soil type has an extremely strong structure and tends to shrink and swell with changes in water content. This is very demanding for crop production and cultivating practices are restricted to a small climate window when implements can operate without difficulty.
The bulk of the power plant will be constructed on this unit. Because of the terrain position, it is very vulnerable to pollution and riverbank erosion. Mitigation measures to prevent this are recommended.

The soil characteristics of this unit will influence engineering projects such as construction of canals. The design of foundations should take into account the shrink and swell properties in the soil.

The powerline is aligned across the wetland. The distance is 170 m, so one pylon would be placed in the wetland. Special care to prevent pollution must be taken.

From an environmental and land use perspective, no fatal flaws are associated with the project.

If mitigation measures are applied as recommended, the hydroelectric power plant will have a low impact on the environment of the site identified and may therefore be authorised in my opinion.

C R LUBBE
AGRICULTURAL SPECIALIST

26 February 2018
LIMITATIONS

This Document has been provided subject to the following limitations:

(i) This Document has been prepared for the particular purpose outlined in the proposal and no responsibility is accepted for the use of this Document in other contexts or for any other purpose.

(ii) CR Lubbe did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document.

(iii) Conditions may exist which were undetectable given the limited nature of the enquiry CR Lubbe was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

(iv) It is recognised that the passage of time affects the information and assessment provided in this Document. CR Lubbe’s opinions are based upon information that existed at the time of the production of the Document. CR Lubbe’s opinion rests on the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site.

(v) Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

(vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted for incomplete or inaccurate data supplied by others.

(viii) This Document is provided for sole use by the Client and is confidential to it and its professional advisers. No responsibility whatsoever for the contents of this Document will be accepted to any person other than the Client. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. CR Lubbe accepts no responsibility for damages, if any, suffered by any third party because of decisions made or actions based on this Document.
REFERENCES


Appendix A

Declaration of Independence

CR Lubbe was appointed by Building Energy South Africa (Pty) Ltd, on behalf of Zevobuzz (Pty) Ltd, who is the owner of Middle Kruisvallei Hydro Project, to conduct an independent agricultural impact study for the proposed project.

He is not a subsidiary or in any way affiliated to Building Energy South Africa (Pty) Ltd or Zevobuzz (Pty) Ltd. CR Lubbe also does not have any interest in secondary developments that may arise from the authorisation of the proposed project.

CR Lubbe

26 February 2018
Specialist Curriculum Vitae – C R Lubbe

KEY QUALIFICATIONS:
National Higher Diploma in Agriculture (Irrigation), Technikon Pretoria, 1982
Certificate in Stereoscopic Interpretation, Geology and Resource Classification and Utilisation, Department of Agriculture, 1979
National Diploma in Agriculture, Technikon Pretoria, 1976

OTHER EDUCATION:
Certificate in Landscape Management, Technikon Pretoria, 1990
Cultivated pastures (Mod 320), University of Pretoria, 1995
FSC Auditors Course (Woodmark, UK), Sappi Ltd, 2003
NOSA Health and Safety Certificate, 1993
Certificate of Competence: Civil Designer - Design Centre and Survey and Design (Knowledge Base, August 2005)

EMPLOYMENT RECORD:
July 2006 to date
CR LUBBE
Self employed
Involved in various projects (see project related experience)

June 2004 - June 2006
Geuteng Department of Agriculture Conservation and Environment
(Component: Technology Development and Support)  
Acting Assistant Director: Resource Planning and Utilization  
Johannesburg, SA

Jan 1997 – May 2004
CR LUBBE
Self employed
Pretoria, SA

1980 to 1996
Technikon Pretoria
Lecturer
Teaching Agricultural Engineering and Land Use Planning subjects. Teaching included practical courses, examination and moderation

1974 – 1976
Department of Agriculture (Transvaal Region)
Senior Extension Technician
Carolina and Emnako, SA

SUMMARY OF EXPERIENCE
Has 42 years of experience in planning and managing natural resources to ensure optimal utilisation, without exploiting such resources to the detriment of future generations.

Fourteen years experience as a soil consultant, doing mainly soil surveys, terrain classification and agricultural potential studies. Reports include a variety of maps and GIS aspects thus play a large role in these surveys and studies.

Seventeen years of lecturing agricultural engineering subjects: Soil Conservation Techniques I, II and III, which dealt with the surveying, design and drawing of soil conservation structures; Farm Planning, which dealt with optimal resource utilization and Agricultural Mechanization, which dealt with the implements and machinery used to mechanize farming.

Ten years experience in the survey, design and supervising the construction of soil conservation structures in the agricultural field, mainly for farm planning.

PROJECT RELATED EXPERIENCE
PROJECTS UNDERTAKEN IN INDIVIDUAL CAPACITY
Cape EA
Agricultural Impact Assessment : EIA for the Construction and Operation of two Photovoltaic Power Stations at Kathu in the Northern Cape.  

Savannah Environmental
Agricultural Impact Assessment : EIA for the Construction and Operation of a Wind Farm near Mooreesburg, Western Cape.

Department of Agriculture, Forestry and Fisheries
Eastern Cape Land Capability Verification Survey  

Department of Agriculture, Forestry and Fisheries
Western Cape Land Capability Verification Survey  

Apr 2015
Mar 2015
Mar 2015
Dec 2014
**Agricultural Impact Assessment on Kruisvallei 190**

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**Cape EA**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station at Postmasburg (RE Cap 5) in the Northern Cape.

Aug 2014

**Cape EA**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station at Upington (Joram) in the Northern Cape.

Aug 2014

**Cape EA**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station at Copperton (RE Cap 5) in the Northern Cape.

Aug 2014

**Cape EA**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station at Upington in the Northern Cape.

Aug 2014

**Cape EA**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station at Upington in the Northern Cape.

Aug 2014

**Agricultural Impact Assessment : EIA for the Establishment of a Cemetery at Zoar, near Ladismith in the Western Cape.**

Aug 2014

**Cape EA**

Agricultural Impact Assessment: EIA for the Establishment of a Cemetery at Zoar, near Ladismith in the Western Cape.

Aug 2014

**Macroplan**

Agricultural Impact Assessment: Application for rezoning of Agricultural land at Upington (Sweet Sensation), Northern Cape.  

Jun 2014

**Macroplan**

Agricultural Potential Study: Application for change of land use at Upington (McTaggarts), Northern Cape.

Mar 2014

**Agricultural Development Corporation**

Design of Feedlot infrastructure and stock watering systems for Kenana Sugar in Sudan.

Jan to March 2014

**Cape EA**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station in the Richtersveld, Western Cape.

Nov 2013

**Cape EA**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station at Upington in the Northern Cape.

Jul 2013

**Cape EA**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station near Danielskuil in the Northern Cape.

Oct 2012

**Senter360**

Agricultural Potential Study for a Food Security Development Units in the Democratic Republic of the Congo.

Oct 2012

**Africa Livestock Project Development Consortium**

Agricultural Impact Assessment for the Construction and Operation of a Beef Cattle Handlings Facility for a Sugar Company in Northern Sudan.

Aug 2012

**Van Zyl Environmental Consultants**

Agricultural Impact Assessment: EIA for the Construction and Operation of a Photovoltaic Power Station in the Northern Cape.

Mar 2012

**Bushveld Eco Services**

Design and cost estimate of a stock watering system in the Lephalale district.

Nov 2011

**WSM Leshika**

Soil suitability survey for two new upcoming farmers at Vhuawela & Tshoga in the Limpopo Province.

Sep 2011

**National Department of Agriculture**

Soil survey investigating soil potential for change of land use at the Levendal Development in the Paarl district, Western Cape.

Aug 2011

**Van Zyl Environmental Consultants**

Agricultural Impact Assessment: EIA for the Construction and Operation of four Photovoltaic Power Stations in the Northern Cape.

Mar 2011

**WSM Leshika**

Potential assessments and land use plans for four new upcoming farmers in the Limpopo Province.

Nov 2010

**FP Botha**

Potential assessments and land use plans for various new Limpopo agricultural development hubs.

Apr 2010
Golder Associates Africa (Pty) Ltd

Potential assessments and Landuse plans for the resettlement of land tenants at Mafube Coal Mine in the Belfast district of the Mpumalanga Province

Sappi

Undertook reconnaissance soil surveys on various plantations and farms in the Vryheid and Piet Retief districts to establish forestation potential and evaluation for species choice (covering a total area of 5173 ha).

Environmmentek, CSIR

Undertook soil and terrain classification surveys on the Jessievale (8313 ha) and New Agatha (1700 ha) plantations.

Safcol (Komatieoland)

Undertook environmental, soil and terrain classification surveys on the Thatevondo (4500 ha), Mafela (920 ha) and Mmamatola (1263 ha) plantations.

Measured Farming

Undertook soil and terrain classification surveys on Ranch Lope and Ranch Suba in Gabon, Kubuta Farm in Swaziland and on the farms Madikwe in the Limpopo Province and Stoffelsrus in the Free State, South Africa.

Loxton Venn and Associates

Assess comparative soils and area for relocating Village Ga-Sekhaolelo on Overysel 815LR to Rooibokfontein 812LR and Village Ga-Puka on Swartfontein 818 LR to Armoed on Potgietersrus Platinum Mine.

Department of Water Affairs and Forestry

GPS survey and alien identification for mapping of Jukskei and Swartspruit areas, as part of the Working for Water Program.

Sustainable Forestry Management Ltd

Participated in a due diligence audit on various SAFCOL plantations in the Limpopo and Mpumalanga Provinces as part of the preparation of a British company’s tender to purchase these plantations.

Mustek Engineering

Survey to provide a detailed inventory of the forest resources in 17 specified Forest Reserves in Ghana to develop a practical and operationally sound methodology for monitoring the natural forest resources in Ghana, based on satellite imagery for the Ghana Forestry Commission.

Afrigis Environmental Solutions, Pretoria

Various Soil Surveys and Landuse Plannings – Domestic and Neighbouring Countries

Rural Integrated Engineering, Pretoria

Various Soil Surveys and Landuse Plannings

Africa Land-Use Training, Modimole

Lectures at Basic Farm Planning Course (Limpopo and Gauteng)