Chapter 8: Soil Specialist Assessment: Land Capability Study

Scoping and Environmental Impact Assessment: Sontule Citrus – Agricultural Expansion on Remainder of Farm 632, Sunland, Sundays River Valley Municipality

Draft EIA Report

September 2022

Prepared by:

Soil Specialist
Bruno Herrmann
Agrimotion Consulting
Private Bag X15
Somerset West
7129

Public Process Consultants
Environmental Impact Assessment and Public Participation Management

SUMMARY

The soil specialist study for this assessment was undertaken in two parts. An initial report surveyed a western portion of the farm, measuring approximately 128ha, in September 2018. This study identified an area of ~90ha that would be suitable for the commercial production of citrus. A second survey was subsequently undertaken on the central and eastern portion of the farm, measuring ~77ha in November 2019. The second study identified an additional 59ha that could potentially be planted with citrus. Therefore, based on the results of the two studies, a total area of ~149ha on RE/632 would be suitable for the cultivation of perennial crops. Due to the steep topography of some areas on the farm, slopes which have a percentage rise of 20% or higher have been deemed unplantable and were not investigated as part of the soil studies.

The key recommendations / amelioration measures from both reports are summarised as follows:

- Deep soil tillage to:
  - **a.** Loosen the soil with a **rip action** (only one direction) to improve root penetration and water infiltration and drainage
  - **b.** Shallow **mixing action** using a tine implement, which will loosen the topsoil to a depth of 30 cm and mix ameliorants into this layer.
  - **c. Ridge construction** using an excavator or grader to increase the root able volume of soil.
- Amelioration through addition of fertilizers as determined from the soil analysis.

During the reconnaissance survey conducted in September 2018 on the western portion of the farm, the northern tip of the gradual sloping area was not accessible due to dense vegetation. Although this area, measuring approximately 15 hectares, wasn’t surveyed, the soil specialist is of the opinion that the soils in this portion of the farm will be similar to the majority of the soils identified across the rest of the site. Similarly, it is anticipated that these soils will have low - medium potential for citrus and will also require the use of the above recommended amelioration methods. Please refer to the specialist opinion provided by Agrimotion, attached as Annexure 1 to this Chapter.

AGRIMOTION

SCIENTIFIC | INDEPENDENT | PRECISE

LAND CAPABILITY STUDY

Sonthule-Sun Citrus, Addo

September 2018

TABLE OF CONTENTS

1. Introduction..8.1
2. Terms of Reference..8.1
3. Methodology..8.1
4. Soil Suitability..8.2
4.1 Soil forms classified at Sonthule..8.2
4.2 Soil Suitability & Potential Rating..8.3
4.3 General description of the classified soils..8.6
4.4 Soil Limitations..8.7
4.5 Amelioration and Soil Preparation..8.8
5 Topography..8.8
6. Summary & Conclusion..8.8
Appendix A – Area Map..8.9
Appendix B - Description of soil forms observed at Sonthule, Addo..8.9
Appendix C - Soil Distribution and Suitability Map..8.12
Appendix D - Description and interpretation of soil code..8.16
Appendix E – Topography maps..8.18
Appendix F - Effective profile depth..8.20
Appendix G - Areas..8.21

1. INTRODUCTION

A land capability study comprising of a soil investigation was conducted in September 2018 at Sonthule, in the Addo area (**Appendix A**) by Bruno Herrmann from Agrimotion Consulting. The purpose of the study was to establish the suitability of the soil for commercial agriculture (citrus production). This reportdiscusses the terms of reference for the study, the soils observed, as well as the suitability of the soilsfor the cultivation of citrus. This report forms part of the Environmental Impact Assessment.

2. TERMS OF REFERENCE

The terms of reference (ToR) for a land capability study as requested by the applicant are stated below. The ToR for soil assessment for the application for clearing of natural vegetation for agricultural purposes are as follows:

- A reconnaissance soil survey of the uncultivated land in order to establish the soil distributionand limitations in terms of the soil's physical and morphological properties.
- Compilation of a soil map on a suitable scale to describe the natural distribution of the soils.
- Description of the different soil types in terms of their physical and morphological properties.
- To identify the more important soil physical and/or morphological limitations of the soil types.
- Evaluation of the relative suitability of the different soil types for cultivation of irrigated citrus.
- Assessment of chemical soil parameters determined from two (2) collected samples.

3. METHODOLOGY

<u>Soil potential investigation</u>

Predetermined positions for profile pits were sent through to the client to ensure that the total area wascovered, and that the observations are representative of the entire area under question. Due to very dense vegetation and steep topography, not all the locations could be reached by the TLB. The profilepit method is preferred to the soil auger method as the layering and structure can be observed in an undisturbed profile and the exact depth of limitations can be observed.

A total of 36 profile holes were investigated and classified according to the South African soil classification system (Published 1991, revised 2006) and the position of each profile hole was recordedby means of a GPS.

Profile classification entails identifying and distinguishing a specific sequence of **diagnostic soil horizons**. Horizons are horizontal layers which develop as a result of natural soil forming processes either from underlying rock or transported material. Within the South African soil classification system, 30 different diagnostic horizons are distinguished. Each diagnostic horizon is the result of a combination of soil forming factors that individually or collectively determine the characteristics of the horizon. In a broad sense, the major soil forming factors can be summarised as climate, topography, parent material and living organisms. The influence of these factors cause variation in soil structure, chemistry, wetness and the degree of weathering. It must also be noted that the same type of diagnostic horizon can vary quite considerably in terms of its clay content, sand grade, wetness, coarse fragments, depth, structure, colour, etc.

A specific sequence of diagnostic soil horizons determines the **soil form**. A total of 73 soil forms are defined in the South African soil classification system, each comprised of a unique horizon sequence. With the variation that can occur in each soil form, it is necessary to report all the profile characteristics in a soil code. The soil code is explained in **Appendix D** and the soil forms that were recorded in the surveyed area are described in **Appendix B**.

The soil description for each profile is given in a code format on the soil distribution map. The complete code is given in a table in **Appendix C**. The map indicates profile positions, soil distribution, soil potential and suitability. Soils of the same form were grouped and colour-coded based on their potentialfor the establishment of perennial crops.

Additional information regarding the soil's chemical attributes will also be supplied and evaluated oncelab analyses are complete and results obtained. This is to assess the influence of soil chemistry on thefeasibility of crop production in the area. Two soil samples were collected at specific sites and the following analyses will be completed: pH (KCl), resistance (Ohm), exchangeable cations, phosphorousand potassium content (mg/kg) and exchangeable acidity.

The soil properties, physical and chemical limitations and recommended soil management practices are discussed in the report and should be read with the map.

4. SOIL SUITABILITY

4.1 SOIL FORMS CLASSIFIED AT SONTHULE

Six (6) different soil forms were observed during the survey. The specific horizon sequence of each soiltype is as follows:

Brandvlei (Br)
Orthic A horizon (ot)
Soft carbonate (sk)

Coega (Cg)
Orthic A horizon (ot)
Hardpan carbonate (hk)

Gamoep (Gm)
Orthic A horizon (ot)
Neocutanic (ne)
Hardpan carbonate (hk)

Katspruit (Ka)
Orthic A horizon (ot)
Gleyed horizon (gc/gs)

Prieska (Pr)
Orthic A horizon (ot)
Neocarbonate (nc)
Hardpan carbonate (hk)

Shortlands (Sd)
Orthic A horizon (ot)
Red structured (vr)

See **Appendix B** for a detailed description of these soils according to South African Soil Taxonomy (Soil Classification Working Group, 1991).

See **Appendix C** for a map indicating the distribution of these soils. In addition, Appendix C also comprises of Table C1 indicating the soil codes as recorded in the field as well as a description of howto interpret the provided soil code.

Feel free to contact Agrimotion if further guidance regarding the interpretation of the soil code is required.

4.2 SOIL SUITABILITY INDEX

A soil suitability rating is awarded to each classified soil profile **according to the observations made in the field**. The index ranges between 1 (very poor) to 10 (exceptional) and it serves as an indication of the soil's capacity to sustain fruit production in its current natural state. Different soils are more or less suitable for different crop or cultivar types, depending on the plant's natural capacity to cope with different soil conditions. What should be kept in mind is that various cultivation practices can be appliedto the soil (e.g. soil preparation, ridging, drainage) to improve the soil's suitability for the cultivation of a specific crop.

The soil suitability distributions for Sonthule is shown in **Appendix C.** All of the observed soils fall within the medium to low suitability class and comprise of similar limitations to crop production. One deep profile with a medium high suitability was observed. The soil's suitability is briefly described in Table 1below.

Table 1. Soil potential description and suitability classes for Sonthule, Addo.

Soil Suitability Index & Class	General description of soils	Soil types & Area distribution (%)
6-7 Medium High	Bleached topsoil with a fine sand grade, 18% clay and no coarse fragments. The subsoil comprises of a non-luvic red structured horizon with 20% clay and no coarse fragments. A soft carbonate horizon is present underneath at a depth of 60 cm. The soft carbonate horizon contains 20% clay and no coarse fragments. Free lime and a high soil pH are the major limitations in these soils.	Shortlands (100%)
5-6 Medium	Bleached topsoil with a fine sand grade, 16-18% clay and between 10-20% coarse fragments. In the Gamoep soil form the subsoil comprises of a neocutanic horizon without any structure. The clay content is between 16-20% and 0-10% coarse fragments are present. At a depth of 40 cm a limiting layer consisting of coarse fragments cemented by carbonate occur. This layer contains 80% coarse fragments and 10-12% clay. In the Shortlands soil form the subsoil comprises of a red structured horizon. Even though there is a clay increase of 6-8% between the topsoil and this red structured layer, the soil structure is still favourable and does not present any limitations. At a depth of 40 cm a limiting layer consisting of coarse fragments cemented by carbonate occur. This layer contains 80% coarse fragments and 10-12% clay. The biggest limitation in this area are the hard carbonate layers, which should be broken up but not brought to the surface. The high pH and carbonate content present chemical limitations for root nutrient uptake.	Gamoep (43%) Shortlands (57%)
4-5 Medium Low	Bleached topsoil with a fine sand grade, 12-16% clay and between 10-20% coarse fragments. In the Brandvlei soil form the subsoil comprises of a soft carbonate horizon, which starts at a depth of 20 cm below the soil surface. This layer contains 12-14% clay and 20-60% coarse fragments, mostly comprising of larger rocks.	Brandvlei (42%) Coega (33%) Gamoep

	Limitations exist in this layer due to high pH and carbonate content. At a depth of 50 cm a hard carbonate layer occurs, consisting of coarse fragments cemented by carbonates. This layer contains 60-80% coarse fragments and 12-14% clay. In the Coega soil form the subsoil comprises of a hard carbonate layer which occurs at a depth of 30cm. This limiting layer contains 10-20% clay and 80% coarse fragments, mostly comprising of larger rocks. In the Gamoep soil form the subsoil comprises of a neocutanic horizon without any structure. The clay content is 18% and contains 10% coarse fragments. At a depth of 40 cm a limiting layer occurs, consisting of coarse fragments cemented by carbonates. This layer contains 80% coarse fragments and 10-12% clay. In the Prieska soil form the subsoil comprises of a neocarbonate horizon which contains 16% clay and 50% coarse fragments. This horizon has the same favourable soil structure as a neocutanic horizon, however free lime is present. At a depth of 40 cm a limiting layer occurs, consisting of coarse fragments cemented by carbonates. This layer contains 30% coarse fragments and 10% clay. In the Shortlands soil form the subsoil comprises of a red structured horizon. Even though there is a clay increase between the topsoil and this red structured layer, the soil structure is still favourable and does not present any limitations. At a depth of 40 cm a limiting layer occurs, consisting of coarse fragments cemented by carbonates. This layer contains 50-80% coarse fragments and 14-16% clay. Free lime represents the biggest limitation in this area. In the case of the hardened carbonate layers, a physical and chemical limitation is present.	(8%) Prieska (8%) Shortlands (8%)
3-4 **Low**	Bleached topsoil with a fine sand grade, 12-18% clay and 20-60% coarse fragments. In localized areas carbonates are also present in the topsoil. These are indicated on the soil map. In the Coega soil form the subsoil comprises of a hard carbonate layer which occurs at a depth of 30cm. Thislimiting layer contains 10-14% clay and 80% coarse fragments, mostly comprising of larger rocks. In the Shortlands soil form the subsoil comprises of a red structured horizon. There is a clay increase of 8% between the topsoil and the subsoil, which results in a denser subsoil horizon. This horizon also contains carbonates and therefore limits the usable soil to the top 10 cm. The most significant limitations in this area are the carbonates, present in both the soft and hard variants. The hard carbonates however present the biggest limitation due to the physical limitations. Areas where the topsoil is calcareous should also be avoided.	Coega (57%) Brandvlei (36%) Shortlands (7%)

1-2 Not suitable	Bleached topsoil with a fine sand grade, 20% clay and 30% coarse fragments. The subsoil is comprised of a gleyed horizon, containing 35% clay and no coarse fragments. Weathered parent material with signs of wetness occur at depth. The soils in this area is not suitable for perennial crop production.	Katspruit (100%)

Table 2. Summary per suitability class for Sonthule, Addo.

Suitability Class	Limitation	% of observations	Approx. Area (ha)
6-7 Medium High	• Steep topography • Free lime in subsoil	0.23	0.3
5-6 Medium	• Free lime in subsoil. • Physical limitation at 40cm, caused by the hard carbonate layer. • Localized areas with high amounts of coarse fragments.	14.62	18.78
4-5 Medium Low	• Free lime in subsoil. • Physical limitation at 40cm, caused by the hard carbonate layer. • Localized areas with a high amount of coarse fragments.	27.16	34.87
3-4 Low	• Free lime in subsoil. • Physical limitation at 30-40cm, caused by the hard carbonate layer. • Localized areas with free lime in the topsoil.	57.20	73.45
1-2 Not suitable	• Periodic waterlogged conditions. • Dense clay layer. • Free lime in topsoil	0.79	1.02*

*According to the applied interpolation model only 1.02 Ha are not suitable. This calculation however has not considered any steep topography or areas where profiles have not been dug. The unsuitable areas are indicated in **Appendix G**, on the Soil Form & Soil Suitability Map. Unsuitable areas have been identified while surveying the area and are made up of the following:

- 1.74 Ha (small area, valley north of the surveyed area, steep topography)
- 15.45 Ha (larger area, all the valleys across the surveyed area, steep topography)
- 7.51 Ha (Katspruit, lowest lying areas, calcareous A, includes 1.02 Ha Ka)

  24.7 Ha Total (Not suitable)

4.3 GENERAL DESCRIPTION OF THE CLASSIFIED SOILS

Although similar soil forms were recorded across the classified area, variations in the depth and consistency of the subsoil horizons dictate the suitability of the soil for crop production. Calcareous horizons were also observed in all of the profiles and represent one of the major limitations to crop production in the area.

The topsoil across the classified area is fairly uniform and extends to depths of between 20-30 cm. These soil horizons exhibit a red-brown (slightly bleached) colour and comprise of a fine sand fraction. In addition, the topsoil also contains 14-20% clay. Coarse fragments were observed at a few profiles and are mainly in the form of rocks with diameter 2.5 -7.5 cm and larger. Crop production will mostly take place in this top 20-30 cm of soil. In localized areas carbonates are present in the topsoil.

Where the profiles are deeper and not limited by a hardpan carbonate layer, the subsoil comprises primarily of neocutanic, neocarbonate, soft carbonate or red structured horizons (Gamoep, Prieska, Brandvlei and Shortlannds). The soils will be discussed in further detail as per horizon.

Per definition, the neocutanic horizons are young and develop on transported materials. Physically, thishorizon presents the ideal structure for root growth. Physical and chemical limitations only occur in thehorizon below (hardpan carbonate). On the surveyed area the Gamoep soil form is mainly found towards the northern side, in the lower parts of the upper slope.

Where carbonates are present, but do not dominate the morphology, the subsoil horizon is described as a neocarbonate. This horizon has the same physical properties as a neocutanic horizon, but free-lime carbonates have accumulated in this layer. The Prieska soil form is found towards the northern side, in the lower parts of the upper slope.

In the soft carbonate horizon, free-lime carbonates dominate the morphology of the subsoil. Even though these soils do not present any physical limitations, they are highly limiting with regards to soil chemistry. Free lime creates a chemical limitation to roots by increasing the soil pH and making it difficult for roots to take up nutrients. The soft carbonate horizon is widely spread over the area and forms partof the Brandvlei soil form, which is found in the mid part of the upper slope.

A higher clay content in the subsoil has led to the formation of moderate structure. In most cases the transition would be a neocutanic horizon. The moderate structure however puts it in the red structured category. The red structured horizons of the Shortlands soil form are mostly found in lower parts of theupper slope. An accumulation of clay is caused due to the topographically lower lying position. The moderate soil structure in this case does not present any limitations to root development, but the carbonate layers underneath physically and chemically limit root and crop growth.

The soils at Sonthule will need to be prepared (loosening action, ridging) correctly, ensuring no subsoil material is brought to the surface, in order to make crop production viable in this area.

Figure 1. The typical Branvlei (Left) and Coega soils (Right) observed at Sonthule, Addo.

4.4 SOIL LIMITATIONS

The soils described above have been grouped into suitability classes specifically for the cultivation of perennial crops, based on the limitations present within each observation. The limitations are described below.

4.4.1 Free lime

Free lime present in all the soils, at varying depths, which leads to an increase in the soil pH. This increase may lead to lowered nutrient availability to pH sensitive crops. Elemental deficiencies such asphosphorous, zinc, copper and iron may occur in these crops, which will greatly hamper crop performance. In some cases, the free lime conditions may also be associated with salinity problems. For this reason, these soils need to be analysed chemically and ameliorated accordingly.

4.4.2 Impermeable calcareous layer

Dense layers, cemented by calcium carbonates, are present over the whole area, at varying depths. These layers need to be broken without bringing the carbonate rich material to the surface.

4.4.3 Wetness

Waterlogging within the plant root zone is extremely detrimental to crop production. When soils become saturated with water, oxygen is displaced from the soil pores resulting in a decrease in the rate of diffusion at the root-soil interface. Soil wetness is evident in the valley bottom and lower lying areas (Ka). Drainage will be required and deep soil preparation to break any limitations and create preferential drainage paths.

4.5 AMELIORATION AND SOIL PREPARATION

To be able to transform the existing soil body at Sonthule into an economically productive agriculturalunit, the following amelioration practices would be required:

- Deep soil tillage to:
  - **a.** Loosen the soil with a **rip action** (only one direction) to improve root penetration andwater infiltration and drainage
  - **b.** Shallow **mixing action** using a tine implement, which will loosen the topsoil to a depthof 30 cm and mix ameliorants into this layer.
  - **c.** **Ridge construction** using an excavator or grader to increase the root able volume ofsoil.
- Amelioration through addition of fertilizers as determined from the soil analysis.

These recommendations are not final and will be refined according to the results of a detailed soil survey.

5. TOPOGRAPHY

Due to the steep topography some areas were not reachable by the TLB to dig profile pits. These areashave been identified and are indicated on the **Slope Percentage Rise map (Appendix E) and Soil Form & Suitability Map (Appendix G).**

Five (5) meter contours have been used to analyse the area. Two areas have been identified which have a gradual topography and a slope below 5%. The steepest slopes have been removed and do notform part of the potential area. See Appendix G.

Slopes that are greater than 10% are likely to have a higher risk of erosion if cleared of vegetation anddeveloped for the commercial production of citrus.

6. SUMMARY & CONCLUSION

Medium to low potential soils are prevalent across Sonthule Farm in Addo. Soil suitability is limited by calcareous subsoil layers across the whole area. The higher lying areas with gradual topography can be further investigated by means of a detailed survey. Areas with steep topography should not be investigated further.

Although the initial investigation indicates that the soils are marginally suited for the cultivation of perennial crops, appropriate soil preparation (e.g. deep soil tillage, ridging, and fertilizer) can serve to significantly improve the soil's ability to sustain perennial crops. The physical and chemical limitations of the calcareous soils will have to be considered as well as the cost involved for amelioration.

Two areas have been identified for further investigation **(Appendix G)** and make up a total of **90 hectares**:

A. 69.57 Ha

B. 20.41 Ha

During the reconnaissance survey the northern tip of the gradual sloping area was not reached due todense vegetation. Even though this area wasn't surveyed, the boundary of area A can be moved further north to compile a detailed survey thereof.

Bruno Herrmann
B. Sc. Agric Soil Science (US)
Cand. Sci. Nat (No: 118999)
0846196841
bruno@agrimotion.net

APPENDIX A – AREA MAP

Figure 2: The location of Sonthule relative to Addo in the Eastern Cape Province of South Africa.

APPENDIX B - DESCRIPTION OF SOIL FORMS OBSERVEDAT SONTHULE, ADDO

Brandvlei (Br)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Soft carbonate horizon (sk):

The soft carbonate horizon is characterised by a build-up of free carbonates but to such an extent that the carbonates dominate the morphology of the horizon. This feature is used to distinguish a soft carbonate horizon from a neocarbonate B. Similarly, free carbonates create a chemical limitation to roots by increasing the soil pH and making it difficult for roots to absorb nutrients.

Coega (Cg)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Hardpan carbonate horizon (hk):

The hardpan carbonate horizon is characterised by a build-up of free carbonates to the extent that the carbonates have cemented the horizon. The hardened nature of these horizons in effect pose a restriction to root growth and water infiltration. Hardpan carbonate horizons usually developed in drier areas where carbonates can accumulate without being leached out of the soil through frequent rainfall events.

Gamoep (Gm)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Neocutanic B horizon (ne):

A neocutanic B horizon is a weakly structured subsoil with cutanic character. Cutanic character refers to a morphological feature where mobile clay and other soil material forms films or skins (cutans) around larger soil aggregates. The presence of cutans are in many instances indicative of a more dispersive clay phase. Neocutanic horizons can vary in colour although the expression of cutans imply that colour will not be uniform as with red and yellow-brown apedal subsoils. Neocutanic horizons are young and by definition develop on transported materials. Physically, this horizon represents the ideal structure for root growth although chemical characteristics can be variable.

Hardpan carbonate horizon (hk):

The hardpan carbonate horizon is characterised by a build-up of free carbonates to the extent that the carbonates have cemented the horizon. The hardened nature of these horizons in effect pose a restriction to root growth and water infiltration. Hardpan carbonate horizons usually developed in drier areas where carbonates can accumulate without being leached out of the soil through frequent rainfall events.

Katspruit (Ka)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

G horizon (gs / gc / gl):

A diagnostic G horizon is a gleyed soil horizon that is, per definition, saturated with water for long periods of the year. These horizons are structurally diverse, exhibit low chroma (grey) colours and has a consistency that is firmer than the overlying A or E horizon. Sesquioxide mottles are often also present but not to the extent that the horizon has a plinthic character. These horizons also do not resemble saprolite. No removal of colloidal material has taken place but rather an accumulation thereof can be observed implying heavier textures. A G horizon usually occurs in lower lying landscape positions and is associated with wetland conditions. They pose a distinct restriction to root growth due to the anoxic and reducing conditions brought about by water saturation.

If a thick A or E horizon is present, crops that are less sensitive to wetness can be cultivated on ridges, with drainage also being an option in some instances.

Prieska (Pr)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Neocarbonate B horizon (nc):

A neocarbonate B is similar in concept to the neocutanic B (weakly structured, non-uniform colour, cutanic character) except that this horizon is characterised by a build-up of free carbonates. These carbonates do not, however, dominate the morphology. Neocarbonate horizons develop in dry climates or in lower lying landscape positions where leaching is restricted. The free carbonates can create a chemical limitation to roots by increasing the soil pH and making it difficult for roots to absorb nutrients.

Hardpan carbonate horizon (hk):

The hardpan carbonate horizon is characterised by a build-up of free carbonates to the extent that the carbonates have cemented the horizon. The hardened nature of these horizons in effect pose a restriction to root growth and water infiltration. Hardpan carbonate horizons usually developed in drier areas where carbonates can accumulate without being leached out of the soil through frequent rainfall events.

Shortlands (Sd)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Red structured B horizon (vr):

A Red structured B horizon has a moderate to strongly developed block structure similar to a pedocutanic B but also exhibits a uniform red soil colour (as for the red apedal B). The red colours are again the result of the presence of hematite (Fe oxide) coatings on the soil mineral particles. In addition, the moderate to strongly developed block structure represents a restriction to root growth although variations in the degree of structural development is often present. Fine blocky structure is more suitable for root development and crop cultivation than a coarser block structure.

APPENDIX C - SOIL DISTRIBUTION AND SUITABILITY MAP

Appendix C. Map indicating the soil type distribution and suitability towards crop production at Sonthule, Addo. The profile positions as well as the soil form abbreviation is indicated on the map andtable. The lighter orange/yellow colour represents soils with a Medium–Low Potential whilst the darkerorange colour represents Low potential soils. In general, the soils observed at Sonthule are marginallysuited for crop production in their current natural state. With the correct soil preparation and rootstock selection the entire area (indicated in Appendix G) can however be considered for cultivation, after conducting a detailed survey. The colours correlate with Table 1 in Section 4 of the report

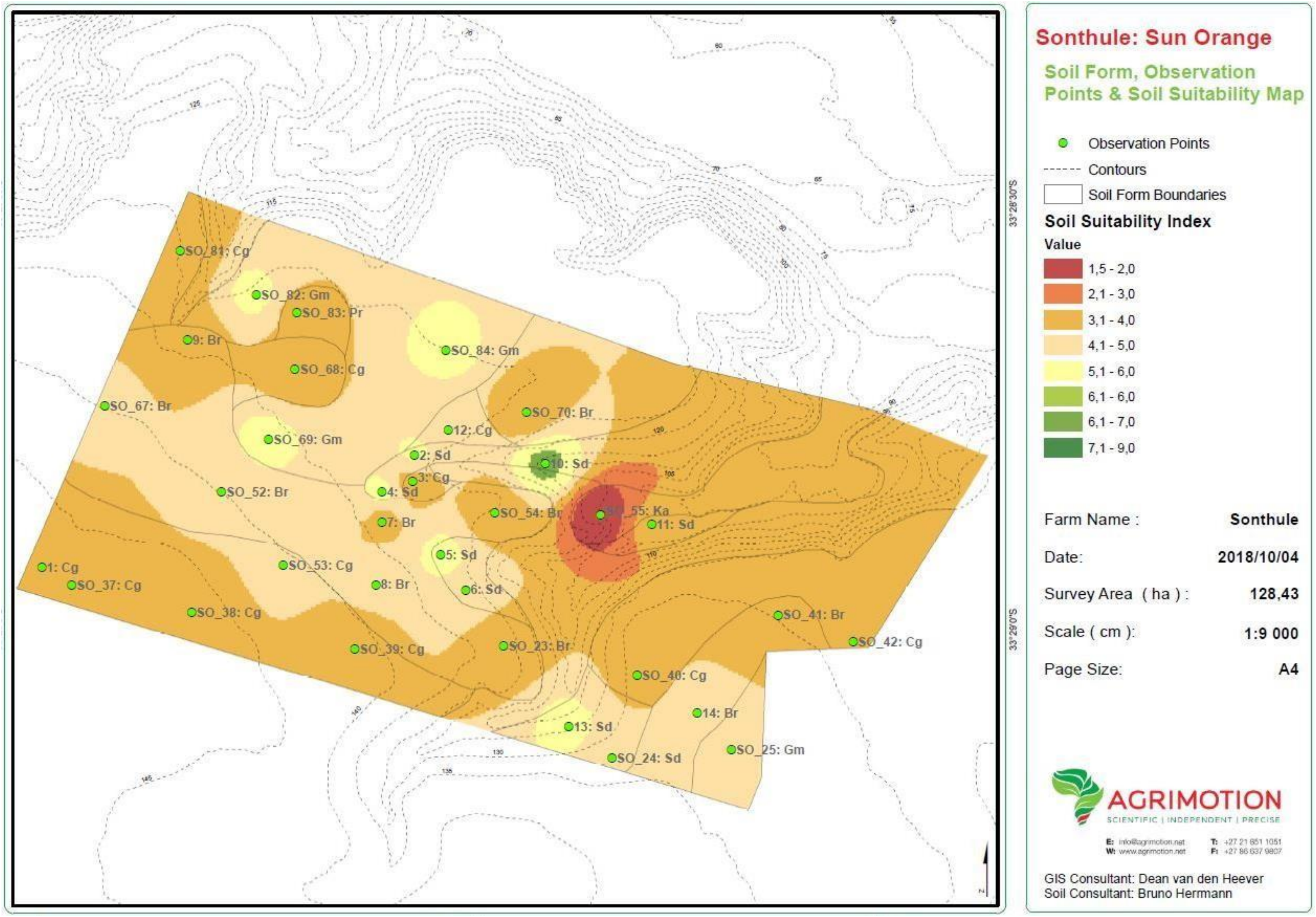


Figure 2 - -Observation point and abbreviated soil code on a soil suitability map.

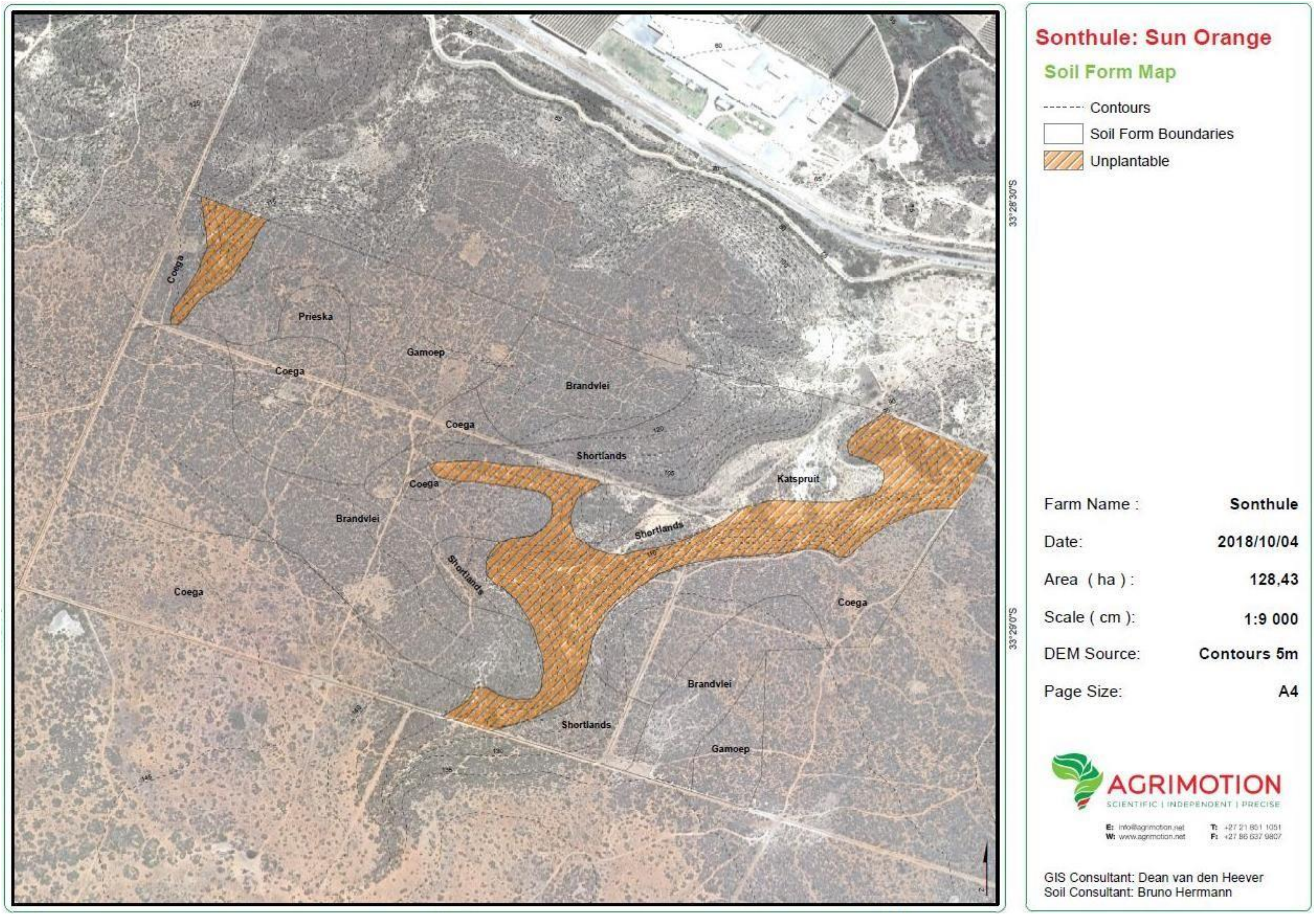


Figure 4 – Soil Form and non-suitable areas

Table C1. Soil codes as described in the field**.**

Profile number	Code above line	Code below line
SO_23	2 Br 1000 sk(12)+f2g3k1 (60/20) (3.5)	f3 fi 3(12) 2
SO_24	24 Sd 1220 hk(14)+g3k5 vr(14) (60/40) (4.5)	fi 1(14) 2
SO_25	14 Gm 2210/Sd hk(-)+g2k4 ne/vr(18)+g1 (60/40) (5.0)	fi f1g1 4(16) 3/4
SO_37	3 Cg 1000 hk(5) (60/30) (3.5)	fi 4(18) 2
SO_38	3 Cg 1000 hk(5) (60/30) (3.5)	fi 4(18) 2
SO_39	3 Cg 1000 hk(5) (60/30) (3.5)	fi 4(18) 2
SO_40	3 Cg 1000 hk(10)+g5k3 (60/30) (3.5)	f1g5 fi 4(18) 2
SO_41	13 Br 1000 hk(-)+g3k5 (60/20) (3.5)	g2 fi 3(12) 2
SO_42	3 Cg 1000 hk(10)+g3k5 (60/30) (4.5)	f1 fi 4(18) 2
SO_52	25 Br 1000 hk(14)+g3k5 sk(14)+g2k4 (60/30) (4.5)	g2 fi 3(14) 2
SO_53	3 Cg 10000 hk(12)+g3k5 (60/30) (4.5)	g3 fi 4(16) 2
SO_54	25 Br 1000 hk(12)+g3k5 sk(12)+g3k3 (60/20) (3.5)	g2 fi 3(14) 2
SO_55	15 Ka 1000 sw(35)+f3g5 gc(35) (60/20) (1.5)	f3 fi 4/5(20) 6
SO_67	3 Br 1000/Cg sk/hk(14)+g3k3 (80/30) (4.5)	g1 fi 4(16) 2
SO_68	3 Cg 1000 hk(5) (60/30) (3.5)	f1g3 fi 4(18) 2
SO_69	14 Gm 2210 hk(12)+g3k5 ne(16)+g1 (60/40) (5.5)	g1 fi 3(14) 2
SO_70	25 Br 1000 hk(12)+g3k5 sk(12)+g3k3 (60/20) (3.5)	g2 fi 3(14) 2
SO_81	3 Cg 2000 hk(14)+g3k5 (60/30) (3.5)	f1 fi 4(16) 2
SO_82	14 Gm 2210 hk(10)+g3k5 ne(18) (60/40) (5.5)	g2 fi 4(16) 2
SO_83	14 Pr 2210/Cg hk(10)+g3 nc/sk(16)+f1g2k2 (60/20) (4.0)	f2g1 fi 4(16) 2
SO_84	14 Gm 2210 hk(-)+g3k5 ne(20)+f1 (60/40) (5.5)	f1 fi 4(16) 2
1	3 Cg 1000 hk(5) (60/30) (3.5)	fi 4(18) 2
2	25 Sd 1110 hk(10)+f2g4 vr(24) (80/40) (5.5)	f1g1 fi 4(16) 2
3	3 Cg 1000 hk(5) (60/30) (3.5)	fi 4(18) 2
4	24 Sd 1110 sk(12)+f2g2k3 vr(24)+f3 (80/40) (5.5)	fi 4(18) 2
5	24 Sd 1110 sk(12)+f2g2k3 vr(24)+f3 (80/40) (5.5)	fi 4(18) 2
6	24 Sd 1110/Gm hk(16)+k5 vr/ne(26)+g1k2 (80/40) (5.0)	f1g1k1 fi 4(16) 2
7	1 Br 1000/Cg sk/hk(10)+f3g3k2 (80/20) (4.0)	f1 fi 2/3(10) 2
8	25 Br 1000 hk(14)+g3k3 sk(14) (80/20) (4.5)	fi 3(14) 2
9	24 Br 1000/Cg sk/hk(14)+f2g3k3 (80/20) (3.5)	fi 3(14) 2
10	36 Sd 1110/Et sk(20) vr/ne(20) (80/60) (6.5)	fi 4(18) 2
11	15 Sd 3110 sk/vr(26) vr/sk(26) (80/30) (3.5)	fi 4(18) 3/4
12	4 Cg 1000 hk(20)+g2k6 (60/40) (4.5)	fi 4/5(20) 2
13	3 Cg 1000 hk(18)+g3k5 (60/30) (4.5)	g1k2 fi 4(18) 2
13	14 Sd 1110/Gm hk(-) vr/ne(24)+f2 (60/40) (5.5)	f1g2k3 fi 4(18) 3/6
14	25 Br 1000 hk(12)+g3k5 sk(12)+g2 (60/20) (4.5)	g2 fi 3(12) 2

APPENDIX D - DESCRIPTION AND INTERPRETATION OF SOIL CODE

363 Oa 1210/Tu lo/lw(45)+f2g3 ne/yp(20)+f3 (80/30)

(6)f2 me 2(8) 2/3

The information above the line explains the soil type, family and subsoil horizon characteristics.

363: Horizon depths: The first numbers in the soil code provides an indication of the depth at which horizon transitions occur. In the provided example, the A horizon ranges from 0-30cm (with the transition at 30 cm i.e. depth code 3), the B horizon from 30-60cm and the last horizon begins at 60cm. The repeated 3 at the end is used to indicate that coarse fragments start at a depth of 30cm.

Oa: Soil form: The symbol for the soil form. Each of the 73 soil forms have a unique 2-letter symbol. These symbols, together with the soil form descriptions, are given in appendix B.

1210: Soil family: The next four numbers indicate the soil family. It provides additional diagnostic characteristics that are common in a given soil form. This can include the presence of carbonates, soil colour, structure etc.

/Tu: Transitional form: In many instances a soil profile can possess characteristics similar to that of a variety of soil forms. The dominant horizon characteristics then need to be used to differentiate between the potential soil form options. An alternative soil form can be reported in the soil code using a / after the dominant soil form and family have been established.

lo/lw: Subsoil horizons: The properties for the subsoil horizons are always provided directly after the soil family code. Each of the diagnostic horizons have a unique 2-letter symbol as indicated in appendix B. If the material foundat the bottom of the classified profile cannot be inferred from the soil form, this 2-letter symbol is used to provide further description. In this example, the last horizon is a transition, as indicated with the '/lw'. Thehorizon abbreviations are provided in appendix B.

( ): Subsoil clay percentage The clay percentages of the observed subsoil horizons are indicated in brackets after the specific horizon description.

+f2g3: Coarse fragments: There are 20% fine coarse fragments (i.e. letter 2) and 30% medium coarse fragments (i.e. letter 3) noted in the last horizon. Symbols & diameter: 'f' for fine (0.2 – 2.5cm), 'g' for medium (2.5 - 7.5cm), 'k' for stone (7.5 – 25cm) and 'r' for rock (25+cm).

(yp): Additional horizon properties:

Additional properties for each subsoil horizon can be indicated after the specific subsoil horizon description. In the example above the B horizon is hard setting when dry (yp).

(80/30): Rip and delve depth: The pair of numbers in brackets indicate the *depth in cm* to which 1) a rip-action can be completed and 2) to which depth the soil can be mixed.

(6.5):	Soil Potential:	The second number in brackets is the soil's potential which is given out of a total of 10. This concept is discussed further in section 4.

The information below the line characterises the topsoil horizon and profile wetness.

f2:	Coarse Fragments:	There are 20% fine coarse fragments in the A horizon.
me:	Sand grade:	The A horizon has a medium sand grade. 'me' for medium sand grade, 'fi' for fine sand grade and 'co' for coarse sand grade.
2(8):	Clay percentage:	This indicates that there is an estimated 8% clay in the A horizon.
2/3:	Soil wetness:	The 2/3 class is a soil wetness estimation dependent on the depth at which the signs of wetness were observed, and the period of time that the soil will remain wet for. A wetness class of 1 indicates that the soil in the profile is dry throughout the year. A soil with a wetness class of 9 is saturated with water from a depth of 30cm for the whole year.

APPENDIX E – TOPOGRAPHY MAPS

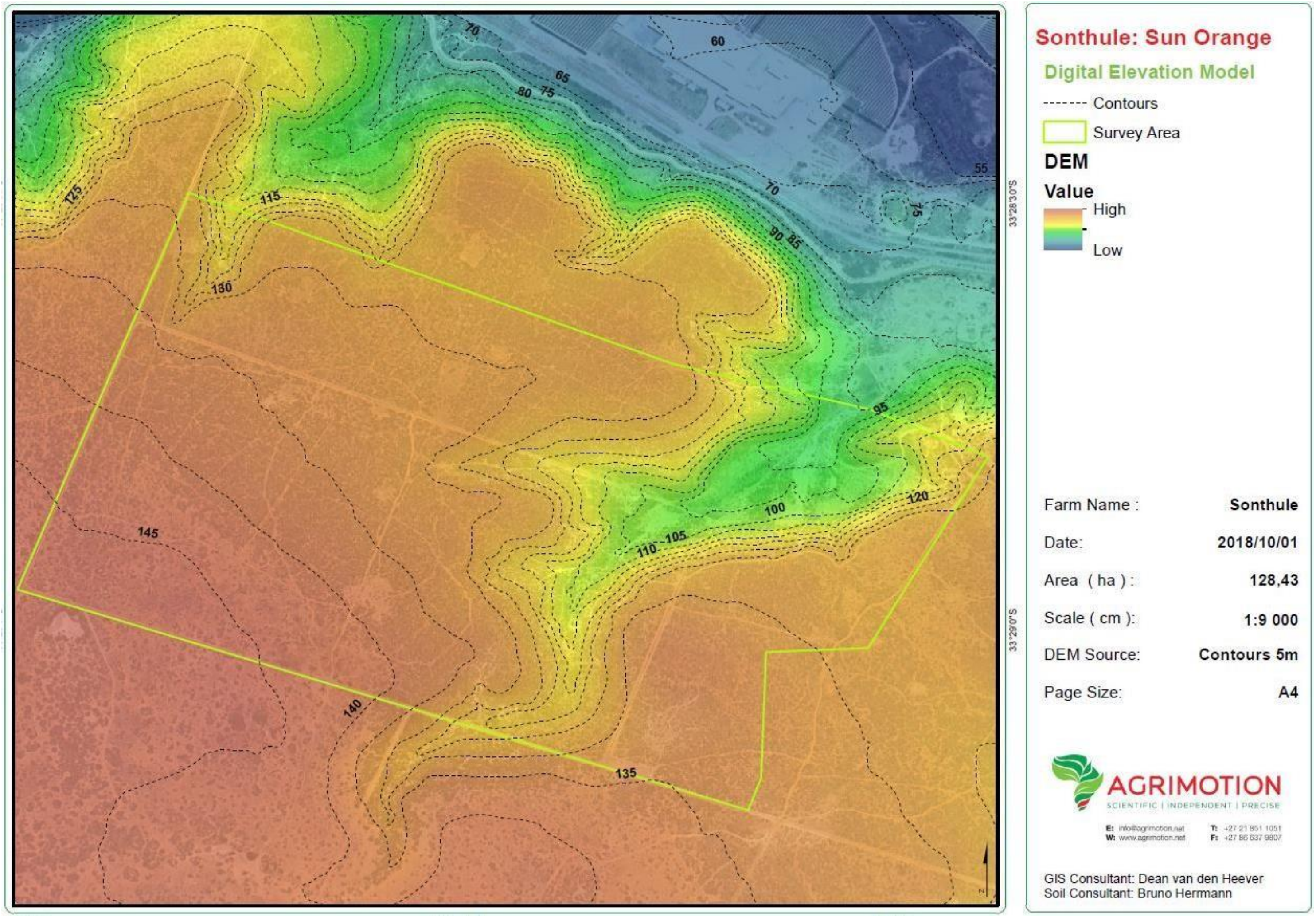


Figure 5 - Digital Elevation Model

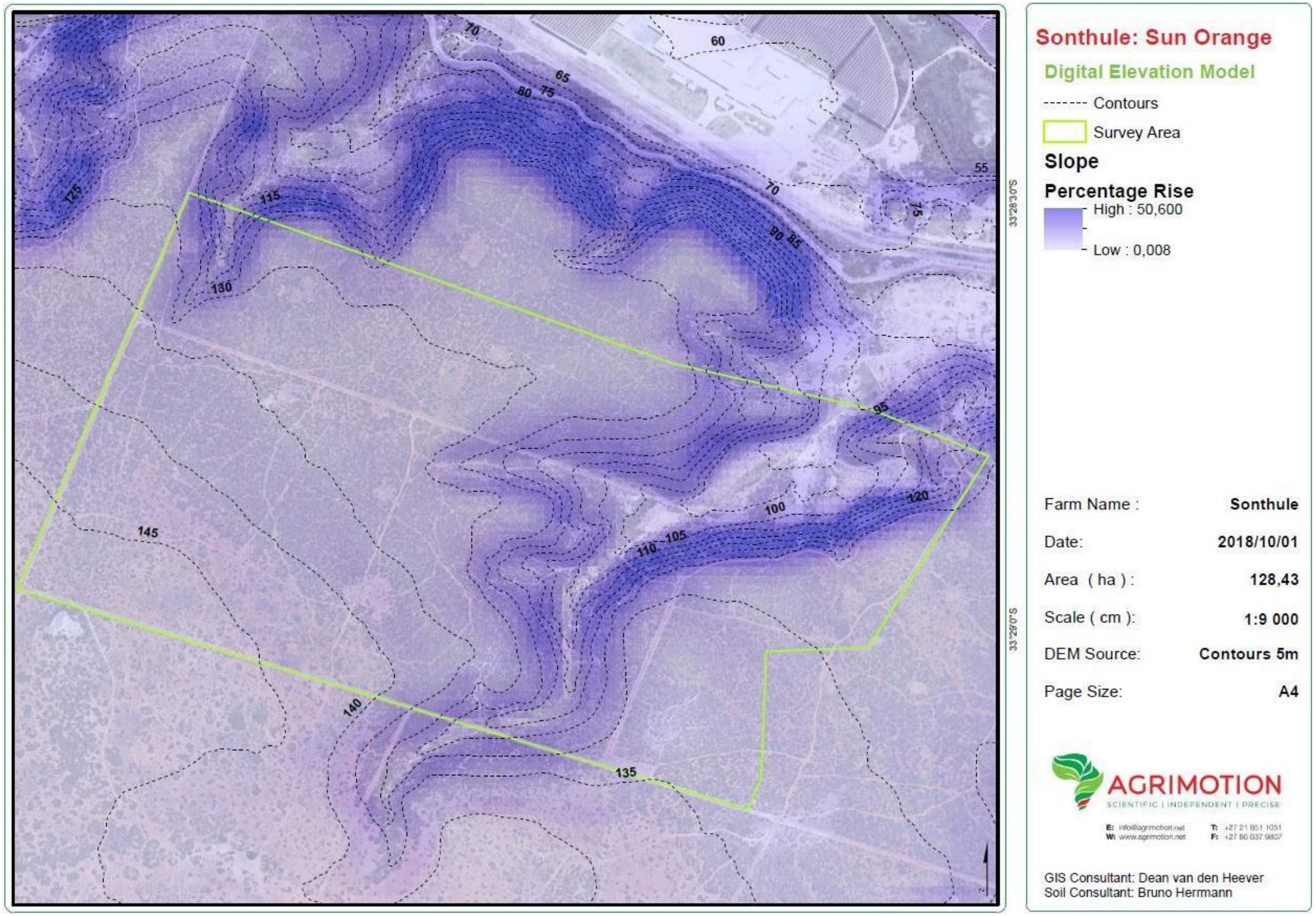


Figure 6 - Slope Percentage Rise

APPENDIX F - EFFECTIVE PROFILE DEPTH

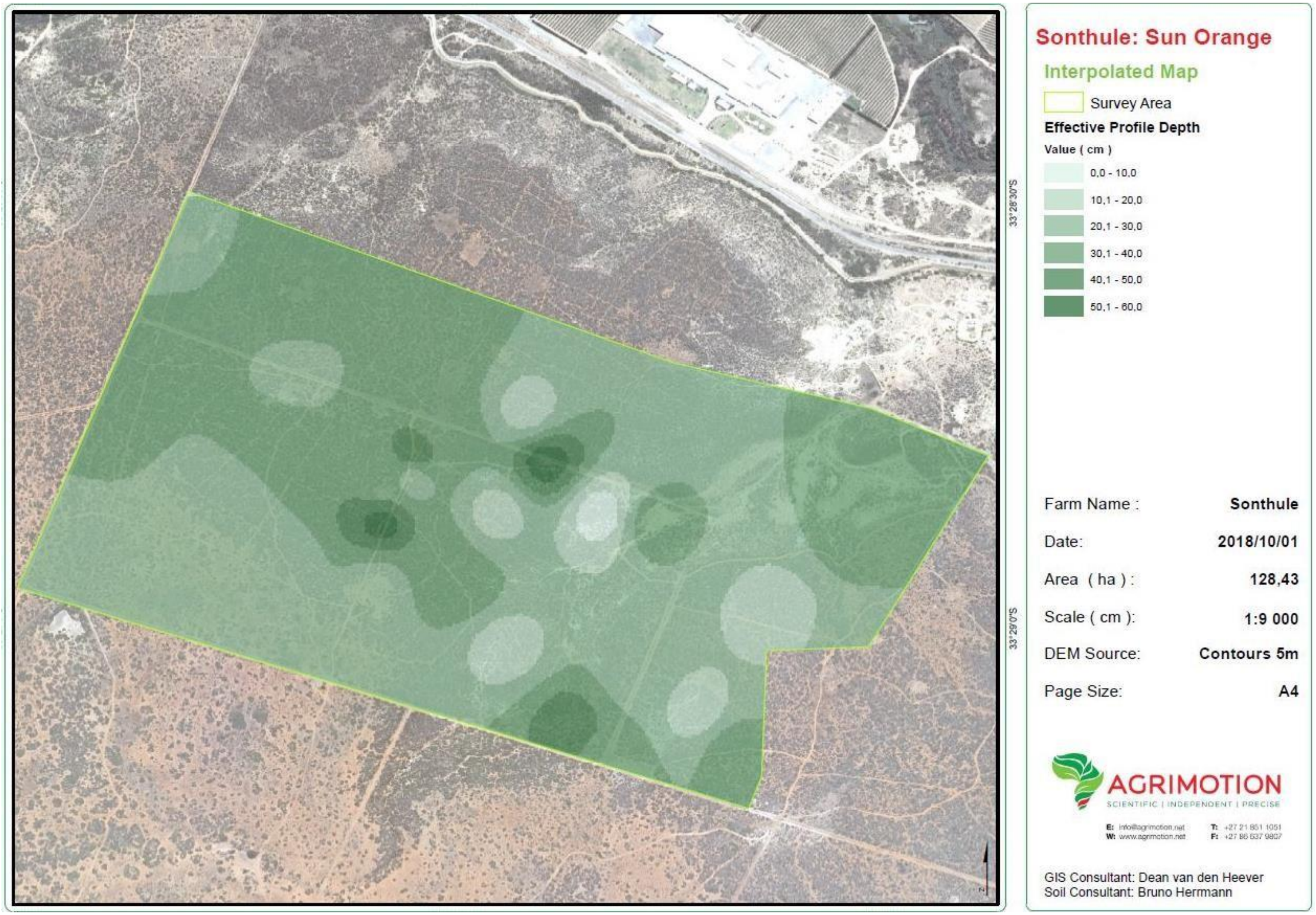


Figure 7 - Effective Profile depth determined by calcareous layer.

APPENDIX G - AREAS

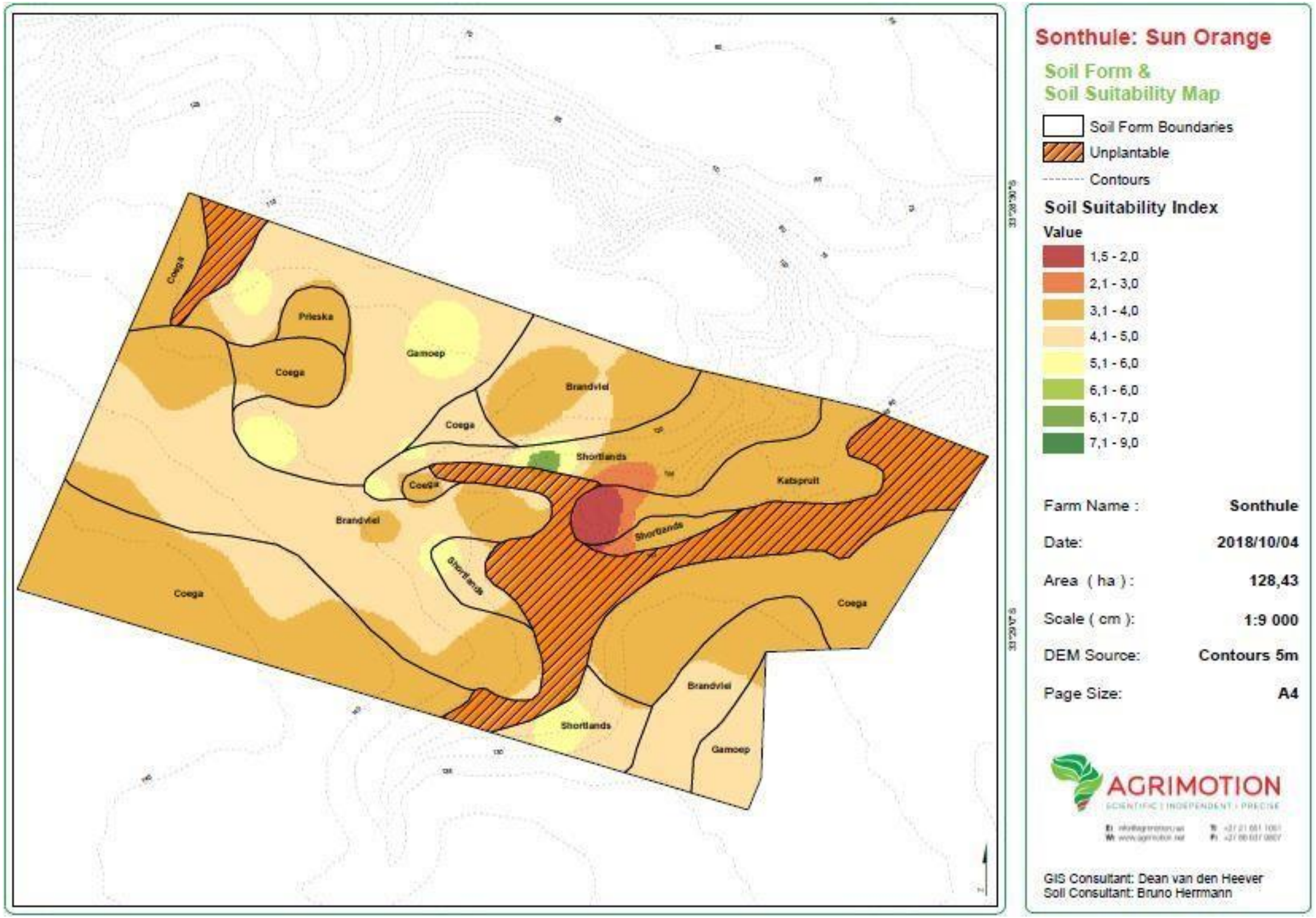


Figure 8 - Map indicating non-suitable areas as determined by slope percentage.

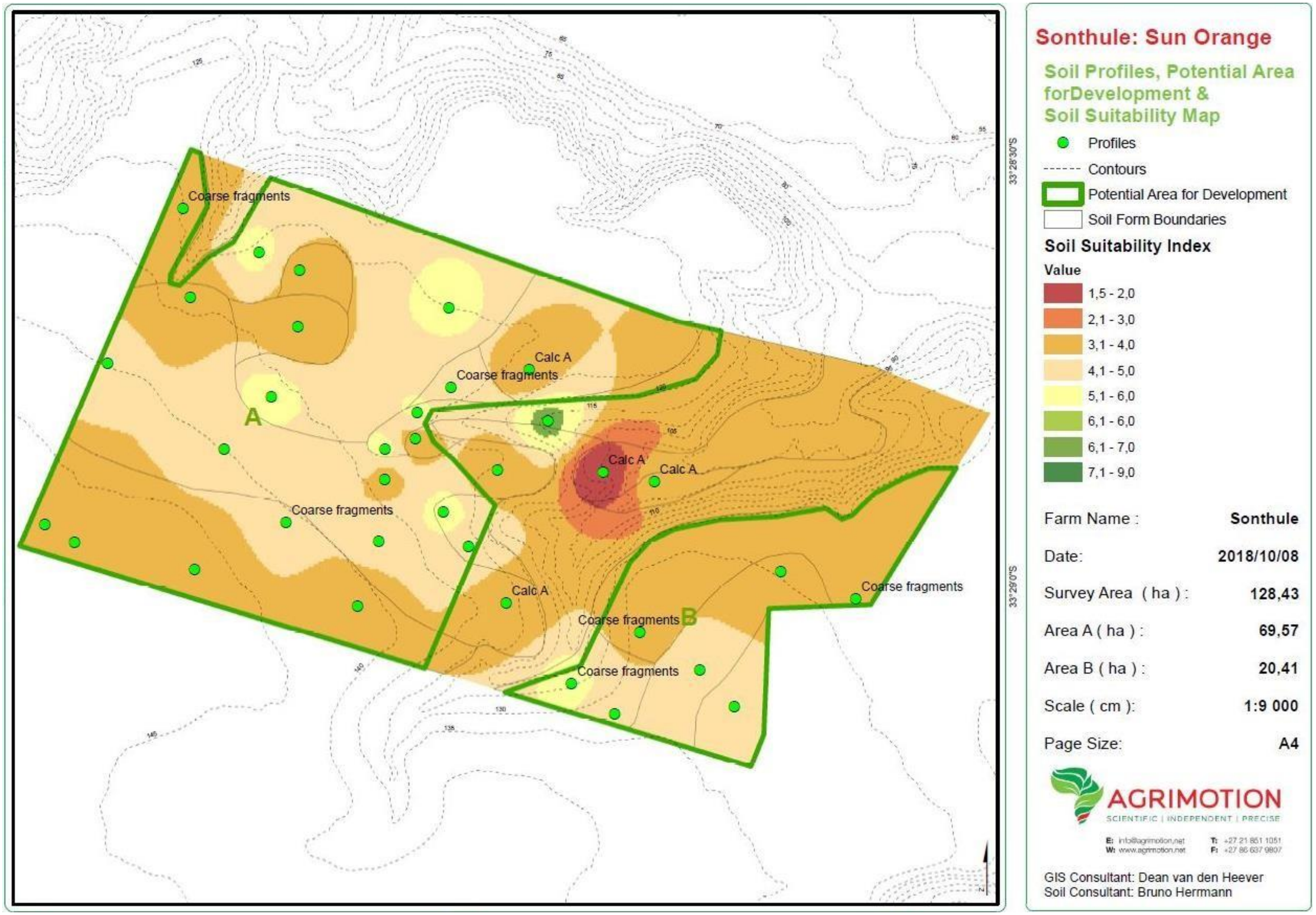


Figure 9 – Map with two potential areas (A & B) for further investigation

AGRIMOTION

SCIENTIFIC | INDEPENDENT | PRECISE

LAND CAPABILITY STUDY

Sonthule-Sun Citrus, Addo
(EIA extended)

November 2019

info@agrimotion.net
+27 21 851 1051
+27 86 637 9807

Eenheid 20, Kingfisher Park
Ou Paardevleiweg
Somerset-Wes, 7130

Postnet Suite #704
Privaatsak X15
Somerset-Wes, 7129

www.agrimotion.net
@Agrimotion2013

TABLE OF CONTENTS

1. Introduction 8.25
2. Terms of Reference 8.25
3. Methodology 8.25
4. Soil Suitability 8.26
4.1 Soil forms classified at Sonthule 8.26
4.2 Soil Suitability & Potential Rating 8.27
4.3 General description of the classified soils 8.29
4.4 Soil Limitations 8.30
4.5 Amelioration and Soil Preparation 8.31
5 Topography 8.31
6. Summary & Conclusion 8.31
Appendix A – Area Map 8.32
Appendix B - Description of soil forms observed at Sonthule, Addo 8.33
Appendix C - Soil Distribution and Suitability Map 8.36
Appendix D - Description and interpretation of soil code 8.40
Appendix E – Topography 8.42
Appendix F - Areas 8.44
Annexure 1 - Comments on suitability of soils not yet investigated 8.45

info@agrimotion.net | +27 21 851 1051 | www.agrimotion.net

1. INTRODUCTION

A land capability study comprising of a soil investigation was conducted in November 2019 at Sonthule, in the Addo area (**Appendix A**) by Bruno Herrmann from Agrimotion Consulting. This survey is an extension of the area surveyed in September 2018. The purpose of the study was to establish the suitability of the soil for commercial agriculture (citrus production). This report discusses the terms of reference for the study, the soils observed, as well as the suitability of the soils for the cultivation of citrus. This report forms part of the Environmental Impact Assessment.

2. TERMS OF REFERENCE

The terms of reference (ToR) for a land capability study as requested by the applicant are stated below. The ToR for soil assessment for the application for clearing of natural vegetation for agricultural purposes are as follows:

- A reconnaissance soil survey of the uncultivated land in order to establish the soil distributionand limitations in terms of the soil's physical and morphological properties.
- Compilation of a soil map on a suitable scale to describe the natural distribution of the soils.
- Description of the different soil types in terms of their physical and morphological properties.
- To identify the more important soil physical and/or morphological limitations of the soil types.
- Evaluation of the relative suitability of the different soil types for cultivation of irrigated citrus.

3. METHODOLOGY

<u>**Soil potential investigation**</u>

Predetermined positions for profile pits were sent through to the client to ensure that the total area wascovered and that the observations are representative of the entire area under question. Due to very dense vegetation and steep topography, three locations could be reached by the TLB. The profile pit method is preferred to the soil auger method as the layering and structure can be observed in an undisturbed profile and the exact depth of limitations can be observed.

A total of 21 profile holes were investigated and classified according to the South African soil classification system (Published 1991, revised 2006) and the position of each profile hole was recordedby means of a GPS.

Profile classification entails identifying and distinguishing a specific sequence of **diagnostic soil horizons**. Horizons are horizontal layers which develop as a result of natural soil forming processes either from underlying rock or transported material. Within the South African soil classification system, 30 different diagnostic horizons are distinguished. Each diagnostic horizon is the result of a combinationof soil forming factors that individually or collectively determine the characteristics of the horizon. In a broad sense, the major soil forming factors can be summarised as climate, topography, parent material and living organisms. The influence of these factors cause variation in soil structure, chemistry, wetness and the degree of weathering. It must also be noted that the same type of diagnostic horizon can vary quite considerably in terms of its clay content, sand grade, wetness, coarse fragments, depth, structure, colour, etc.

A specific sequence of diagnostic soil horizons determines the **soil form**. A total of 73 soil forms are defined in the South African soil classification system, each comprised of a unique horizon sequence. With the variation that can occur in each soil form, it is necessary to report all the profile characteristics in a soil code. The soil code is explained in **Appendix D** and the soil forms that were recorded in the surveyed area are described in **Appendix B**.

The soil description for each profile is given in a code format on the soil distribution map. The complete code is given in a table in **Appendix C**. The map indicates profile positions, soil distribution, soil potential and suitability. Soils of the same form were grouped and colour-coded based on their potentialfor the establishment of perennial crops.

The soil properties, physical and chemical limitations and recommended soil management practices are discussed in the report and should be read with the map.

4. SOIL SUITABILITY

4.1 SOIL FORMS CLASSIFIED AT SONTHULE

Eight (8) different soil forms were observed during the survey. The specific horizon sequence of each soil type is as follows:

Augrabies (Ag)
Orthic A horizon (ot)
Neocarbonate (nc)
Unspecified material

Brandvlei (Br)
Orthic A horizon (ot)
Soft carbonate (sk)

Coega (Cg)
Orthic A horizon (ot)
Hardpan carbonate (hk)

Glenrosa (Gs)
Orthic A horizon (ot)
Lithocutanic (lo/lw/so/sw)

Montagu (Mu)
Orthic A horizon (ot)
Neocarbonate (nc)
Unspecified material with signs of wetness

Oakleaf (Oa)
Orthic A horizon (ot)
Neocutanic (ne)

Prieska (Pr)
Orthic A horizon (ot)
Neocarbonate (nc)
Hardpan carbonate (hk)

Shortlands (Sd)
Orthic A horizon (ot)
Red structured (vr)

See **Appendix B** for a detailed description of these soils according to South African Soil Taxonomy (Soil Classification Working Group, 1991).

See **Appendix C** for a map indicating the distribution of these soils. In addition, Appendix C also comprises of Table C1 indicating the soil codes as recorded in the field as well as a description of how to interpret the provided soil code.

Feel free to contact Agrimotion if further guidance regarding the interpretation of the soil code is required.

4.2 SOIL SUITABILITY INDEX

A soil suitability rating is awarded to each classified soil profile **according to the observations made in the field**. The index ranges between 1 (very poor) to 10 (exceptional) and it serves as an indication of the soil's capacity to sustain fruit production in its current natural state. Different soils are more or less suitable for different crop or cultivar types, depending on the plant's natural capacity to cope with different soil conditions. What should be kept in mind is that various cultivation practices can be applied to the soil (e.g. soil preparation, ridging, drainage) to improve the soil's suitability for the cultivation of aspecific crop.

The soil suitability distributions for Sonthule is shown in **Appendix C.** All of the observed soils fall within the medium to low suitability class and comprise of similar limitations to crop production. One deep profile with a medium high suitability was observed. The soil's suitability is briefly described in Table 1 below.

Table 1. Soil potential description and suitability classes for Sonthule, Addo.

Soil Suitability Index & Class	General description of soils	Soil types & Area distribution (%)
4-5 **Medium Low**	Bleached topsoil with a fine sand grade, 12-16% clay and between 10-20% coarse fragments. In the Brandvlei soil form the subsoil comprises of a soft carbonate horizon, which starts at a depth of 30cm below the soil surface. This layer contains 18% clay and 60% coarse fragments, mostly comprising of larger rocks. Limitations exist in this layer due to high pH and carbonate content. At a depth of 50cm a hard carbonate layer occurs, consisting of coarse fragments cemented by carbonates. This layer contains 60-80% coarse fragments and 12-14% clay. In the Prieska soil form the subsoil comprises of a neocarbonate horizon which contains 18% clay and 20% coarse fragments. This horizon has the same favourable soil structure as a neocutanic horizon, however free lime is present. At a depth of 40cm a limiting layer occurs, consisting of coarse fragments cemented by carbonates. In the Shortlands soil form the subsoil comprises of a red structured horizon. Even though there is a clay increase between the topsoil and this red structured layer, the soil structure is still favourable and does not present any limitations. At a depth of 50cm a limiting layer occurs. Free lime represents the biggest limitation in this area. In the case of the hardened carbonate layers, a physical and chemical limitation is present.	Brandvlei (37.5%) Glenrosa (12.5%) Oakleaf (12.5%) Prieska (12.5%) Shortlands (25%)
3-4 **Low**	Bleached topsoil with a fine sand grade, 10-16% clay and 20-60% coarse fragments. In the Coega soil form the subsoil comprises of a hard carbonate layer which occurs at a depth of 30cm. This limiting layer contains 16-20% clay and 50-90% coarse fragments, mostly comprising of larger rocks. The most significant limitations in this area are the carbonates, present in both the soft and hard variants.	Augrabies (9.0%) Coega (45.5%) Brandvlei (27.3%)

	The hard carbonates however present the biggest limitation due to the physical limitations. Areas where the topsoil is calcareous should also be avoided.	Glenrosa (9.0%) Montagu (9.0%)
2- 3 Very Low	Bleached topsoil with a fine sand grade, 14-16% clay and 20-30% coarse fragments. The subsoil is comprised of a gleyed horizon, containing 35% clay and no coarse fragments. Weathered parent material with signs of wetness occur at depth. The soils in this area is not suitable for perennial crop production.	Coega (100%)

Table 2. Summary per suitability class for Sonthule, Addo.

Suitability Class	Limitation	% of observations	Approx. Area (ha)
4-5 Medium Low	• Free lime in subsoil. • Physical limitation at 40cm & 60cm, caused by the hard carbonate layer. • High amount of coarse fragments in topsoil.	38.10	29.5
3-4 Low	• Free lime in subsoil. • Physical limitation at 30-50cm, caused by the hard carbonate layer. • Localized areas with free lime in the topsoil. • High amount of coarse fragments throughout the profile.	52.38	40.5
2-3 Very Low	• Free lime in topsoil • Physical limitation at 20-30cm, caused by the hard carbonate layer. • High amount of coarse fragments throughout the profile.	9.52	7.4

*According to the applied interpolation model only two spots are not suitable. This calculation however has not considered any steep topography. The unsuitable areas are indicated in **Appendix F,** on the Soil Form & Soil Suitability Map. Unsuitable areas have been identified and the **projected area not to be planted amounts to 18.56ha** from 77.4ha.

4.3 GENERAL DESCRIPTION OF THE CLASSIFIED SOILS

The classified soils are fairly uniform across the whole area. Soil variation occurs in higher lying landscape positions as well as depressions. The depth and consistency of the subsoil horizons dictate the suitability of the soil for crop production. Calcareous horizons were also observed in all of the profiles and represent one of the major limitations to crop production in the area.

The topsoil across the classified area is fairly uniform and extends to depths of between 20-30cm. These soil horizons exhibit a red-brown (slightly bleached) colour and comprise of a fine sand fraction. In addition, the topsoil also contains 14-20% clay. Large amounts of coarse fragments were observed at most profiles and are mainly in the form of rocks with diameter 2.5 -7.5cm and larger. Crop production will mostly take place in this top 20-30cm of soil. In localized areas carbonates are present in the topsoil.

Where the profiles are deeper and not limited by a hardpan carbonate layer, the subsoil comprises primarily of neocutanic, neocarbonate, soft carbonate or red structured horizons (Montagu, Oakleaf, Prieska, Brandvlei and Shortlands). The soils will be discussed in further detail as per horizon.

Per definition, the neocutanic horizons are young and develop on transported materials. Physically, this horizon presents the ideal structure for root growth. Physical and chemical limitations only occur in the horizon below (hardpan carbonate). On the surveyed area the Oakleaf soil form is mainly found towards the eastern side, in the higher lying landscape position.

Where carbonates are present, but do not dominate the morphology, the subsoil horizon is described as a neocarbonate. This horizon has the same physical properties as a neocutanic horizon, but free-lime carbonates have accumulated in this layer. The Prieska soil form is found towards the western side, in the higher lying landscape position.

In the soft carbonate horizon, free-lime carbonates dominate the morphology of the subsoil. Even though these soils do not present any physical limitations, they are highly limiting with regards to soil chemistry. Free lime creates a chemical limitation to roots by increasing the soil pH and making it difficult for roots to take up nutrients. The soft carbonate horizon is widely spread over the area and forms part of the Brandvlei soil form, which is found in the mid part of the upper slope.

A higher clay content in the subsoil has led to the formation of moderate structure. In most cases the transition would be a neocutanic horizon. The moderate structure however puts it in the red structured category. The red structured horizons of the Shortlands soil form are mostly found in lower parts of the upper slope. An accumulation of clay is caused due to the topographically lower lying position. The moderate soil structure in this case does not present any limitations to root development, but the carbonate layers underneath physically and chemically limit root and crop growth.

The soils at Sonthule will need to be prepared (loosening action, ridging) correctly, ensuring no subsoil material is brought to the surface, in order to make crop production viable in this area.

Figure 1 The typical Branvlei (Left) and Coega soils (Right) observed at Sonthule, Addo

4.4 Soil Limitations

The soils described above have been grouped into suitability classes specifically for the cultivation of perennial crops, based on the limitations present within each observation. The limitations are described below.

4.4.1 Free lime

Free lime present in all the soils, at varying depths, which leads to an increase in the soil pH. This increase may lead to lowered nutrient availability to pH sensitive crops. Elemental deficiencies such asphosphorous, zinc, copper and iron may occur in these crops, which will greatly hamper crop performance. In some cases, the free lime conditions may also be associated with salinity problems. For this reason, these soils need to be analysed chemically and ameliorated accordingly.

4.4.2 Impermeable calcareous layer

Dense layers, cemented by calcium carbonates, are present over the whole area, at varying depths. These layers need to be broken without bringing the carbonate rich material to the surface.

4.4.3 Wetness

Waterlogging within the plant root zone is extremely detrimental to crop production. When soils become saturated with water, oxygen is displaced from the soil pores resulting in a decrease in the rate of diffusion at the root-soil interface.

4.5 AMELIORATION AND SOIL PREPARATION

To be able to transform the existing soil bodies at Sonthule into an economically productive agricultural unit, the following amelioration practices would be required:

- Deep soil tillage to:
    - **a.** Loosen the soil with a **rip action** (only one direction) to improve root penetration and water infiltration and drainage
    - **b.** Shallow **mixing action** using a tine implement, which will loosen the topsoil to a depthof 30 cm and mix ameliorants into this layer.
    - **c.** **Ridge construction** using an excavator or grader to increase the root able volume of soil.
- Amelioration through addition of fertilizers as determined from the soil analysis.

These recommendations are not final and will be refined according to the results of a detailed soil survey.

5. TOPOGRAPHY

Due to the steep topography some areas were not reachable by the TLB to dig profile pits. These areas have been identified and are indicated on the **Slope Percentage Rise map (Appendix E) and Soil Form & Suitability Map (Appendix F).**

Five (5) meter contours have been used to analyse the area. Two areas have been identified which have a gradual topography and a slope below 5%. The steepest slopes have been removed and do notform part of the potential area. See Appendix G.

Slopes that are greater than 10% are likely to have a higher risk of erosion if cleared of vegetation and developed for the commercial production of citrus.

6. SUMMARY & CONCLUSION

Medium-low to low potential soils are prevalent across Sonthule Farm in Addo. Soil suitability is limited by calcareous subsoil layers across the whole area. The higher lying areas with gradual topography can be further investigated by means of a detailed survey. Areas with steep topography should not be investigated further.

Although the initial investigation indicates that the soils are marginally suited for the cultivation of perennial crops, appropriate soil preparation (e.g. deep soil tillage, ridging, and fertilizer) can serve to significantly improve the soil's ability to sustain perennial crops. The physical and chemical limitations of the calcareous soils will have to be considered as well as the cost involved for amelioration.

The soils of the extended survey area are less suitable for perennial crop production in comparison to the soils which were surveyed in 2018.

The area which has been identified for further investigation **(Appendix F)** makes up a total of **58.84 hectares**.

Bruno Herrmann

B. Sc. Agric Soil Science (US)
Cand. Sci. Nat (No: 118999)
0846196841
bruno@agrimotion.net

APPENDIX A – AREA MAP

Figure 2: The location of Sonthule relative to Addo in the Eastern Cape Province of South Africa

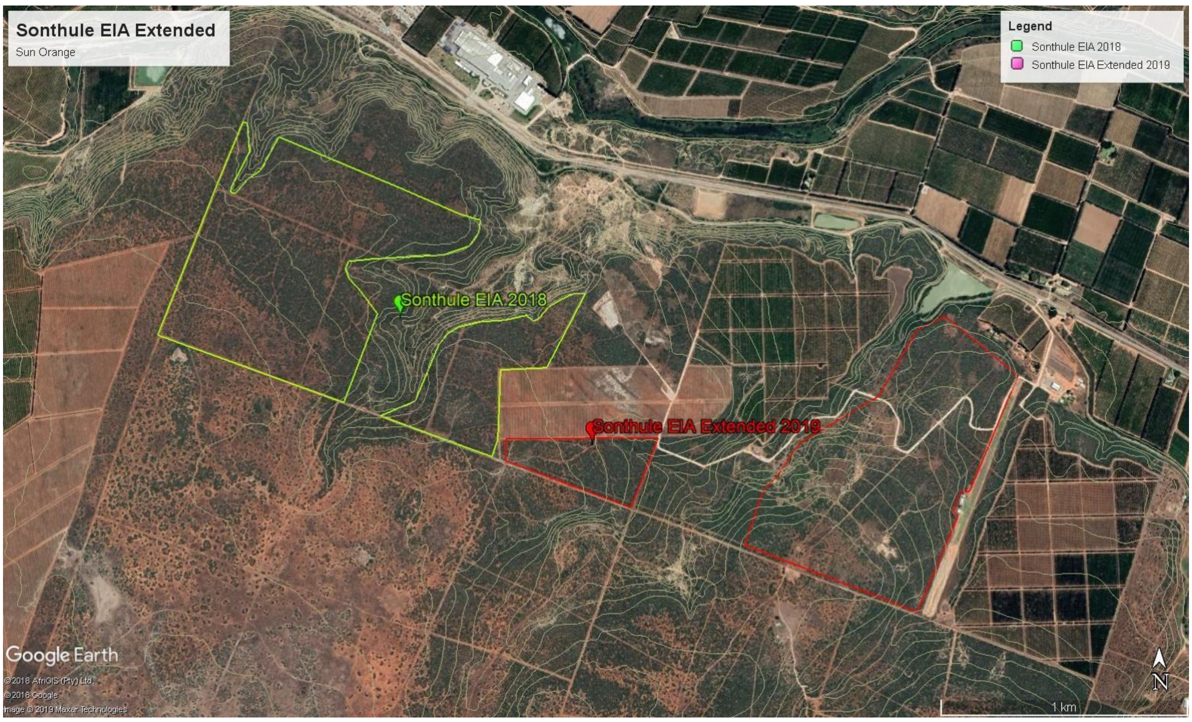


Figure 3: Sonthule EIA Survey 2018 and 2019 (extended)

APPENDIX B - DESCRIPTION OF SOIL FORMS OBSERVED AT SONTHULE, ADDO

Augrabies (Ag)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Neocarbonate B horizon (nc):

A neocarbonate B is similar in concept to the neocutanic B (weakly structured, non-uniform colour, cutanic character) except that this horizon is characterised by a build-up of free carbonates. These carbonates do not, however, dominate the morphology. Neocarbonate horizons develop in dry climates or in lower lying landscape positions where leaching is restricted. The free carbonates can create a chemical limitation to roots by increasing the soil pH and making it difficult for roots to absorb nutrients.

Unspecified material:

This is not a defined horizon but it encapsulates different soil types, which occur at depth and exhibit a wide variety of characteristics.

Brandvlei (Br)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Soft carbonate horizon (sk):

The soft carbonate horizon is characterised by a build-up of free carbonates but to such an extent that the carbonates dominate the morphology of the horizon. This feature is used to distinguish a soft carbonate horizon from a neocarbonate B. Similarly, free carbonates create a chemical limitation to roots by increasing the soil pH and making it difficult for roots to absorb nutrients.

Coega (Cg)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Hardpan carbonate horizon (hk):

The hardpan carbonate horizon is characterised by a build-up of free carbonates to the extent that the carbonates have cemented the horizon. The hardened nature of these horizons in effect pose a restriction to root growth and water infiltration. Hardpan carbonate horizons usually developed in drier areas where carbonates can accumulate without being leached out of the soil through frequent rainfall events.

Glenrosa (Gs)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Lithocutanic B horizon (lo/lw/so/sw):

A lithocutanic horizon is a youthful soil horizon that is still in its early stages of development and which consequently possess characteristics of both soil and the underlying rock that the soil is weathering from. With depth this horizon gradually changes to unweathered rock. These horizons exhibit cutanic characteristics (mobile clay and other soil material which form a film or skin around larger soil aggregates) and is not always horizontally continuous within the profile. Lithocutanic B horizons can also vary based on the percentage of rock present in the horizons (hard vs not-hard) and their tendency to become saturated with water. These horizons can impose a physical restriction to root growth.

Montagu (Mu)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Neocarbonate B horizon (nc):

A neocarbonate B is similar in concept to the neocutanic B (weakly structured, non-uniform colour, cutanic character) except that this horizon is characterised by a build-up of free carbonates. These carbonates do not, however, dominate the morphology. Neocarbonate horizons develop in dry climates or in lower lying landscape positions where leaching is restricted. The free carbonates can create a chemical limitation to roots by increasing the soil pH and making it difficult for roots to absorb nutrients.

Unspecified material with signs of wetness:

This horizon distinguishes subsoils that have suffered the effects (e.g. iron reduction) of intermittent or prolonged water saturation. Although such horizons can exhibit a wide variety of other characteristics, only the signs of wetness is recognised and pertinently mentioned due to its significance towards land-use.

Oakleaf (Oa)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Neocutanic B horizon (ne):

A neocutanic B horizon is a weakly structured subsoil with cutanic character. Cutanic character refers to a morphological feature where mobile clay and other soil material forms films or skins (cutans) around larger soil aggregates. The presence of cutans are in many instances indicative of a more dispersive clay phase. Neocutanic horizons can vary in colour although the expression of cutans imply that colour will not be uniform as with red and yellow-brown apedal subsoils. Neocutanic horizons are young and by definition develop on transported materials. Physically, this horizon represents the ideal structure for root growth although chemical characteristics can be variable.

Unspecified material:

Unspecified soil material is not a defined horizon but it encapsulates different soil types which occur at depth and exhibit a wide variety of characteristics.

Prieska (Pr)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Neocarbonate B horizon (nc):

A neocarbonate B is similar in concept to the neocutanic B (weakly structured, non-uniform colour, cutanic character) except that this horizon is characterised by a build-up of free carbonates. These carbonates do not, however, dominate the morphology. Neocarbonate horizons develop in dry climates or in lower lying landscape positions where leaching is restricted. The free carbonates can create a chemical limitation to roots by increasing the soil pH and making it difficult for roots to absorb nutrients.

Hardpan carbonate horizon (hk):

The hardpan carbonate horizon is characterised by a build-up of free carbonates to the extent that the carbonates have cemented the horizon. The hardened nature of these horizons in effect pose a restriction to root growth and water infiltration. Hardpan carbonate horizons usually developed in drier areas where carbonates can accumulate without being leached out of the soil through frequent rainfall events.

Shortlands (Sd)

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Red structured B horizon (vr):

A Red structured B horizon has a moderate to strongly developed block structure similar to a pedocutanic B but also exhibits a uniform red soil colour (as for the red apedal B). The red colours are again the result of the presence of hematite (Fe oxide) coatings on the soil mineral particles. In addition, the moderate to strongly developed block structure represents a restriction to root growth although variations in the degree of structural development is often present. Fine blocky structure is more suitable for root development and crop cultivation than a coarser block structure.

APPENDIX C - SOIL DISTRIBUTION AND SUITABILITY MAP

Appendix C. Map indicating the soil type distribution and suitability towards crop production at Sonthule, Addo. The profile positions as well as the soil form abbreviation is indicated on the map and table. The lighter orange/yellow colour represents soils with a Medium–Low Potential whilst the darker orange colour represents Low potential soils. In general, the soils observed at Sonthule are marginally suited for crop production in their current natural state. With the correct soil preparation and rootstock selection the area indicated in Appendix F can be considered for cultivation, after conducting a detailed survey. The colours correlate with Table 1 in Section 4 of the report.

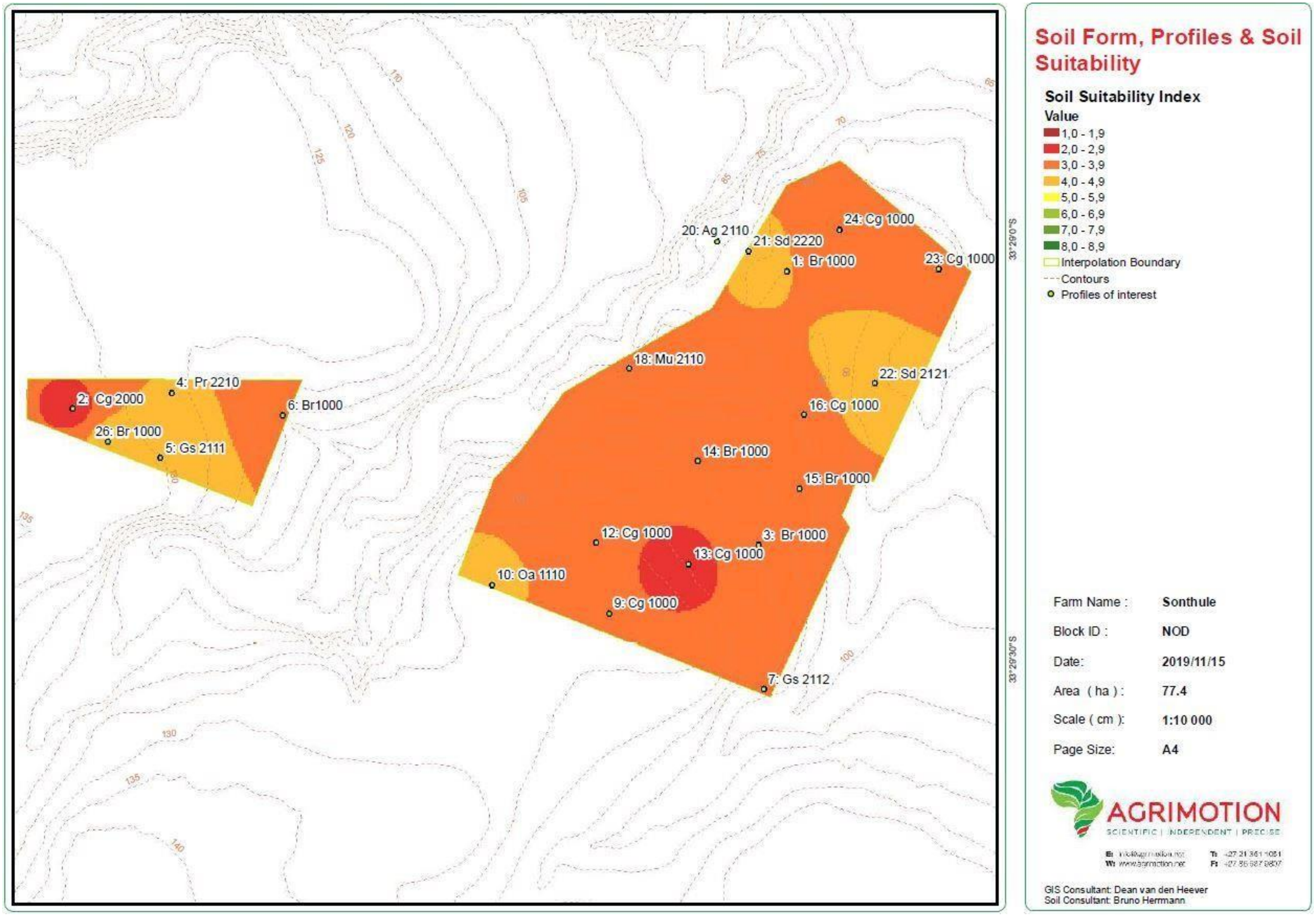


Figure 4 - -Observation point and abbreviated soil code on a soil suitability map.

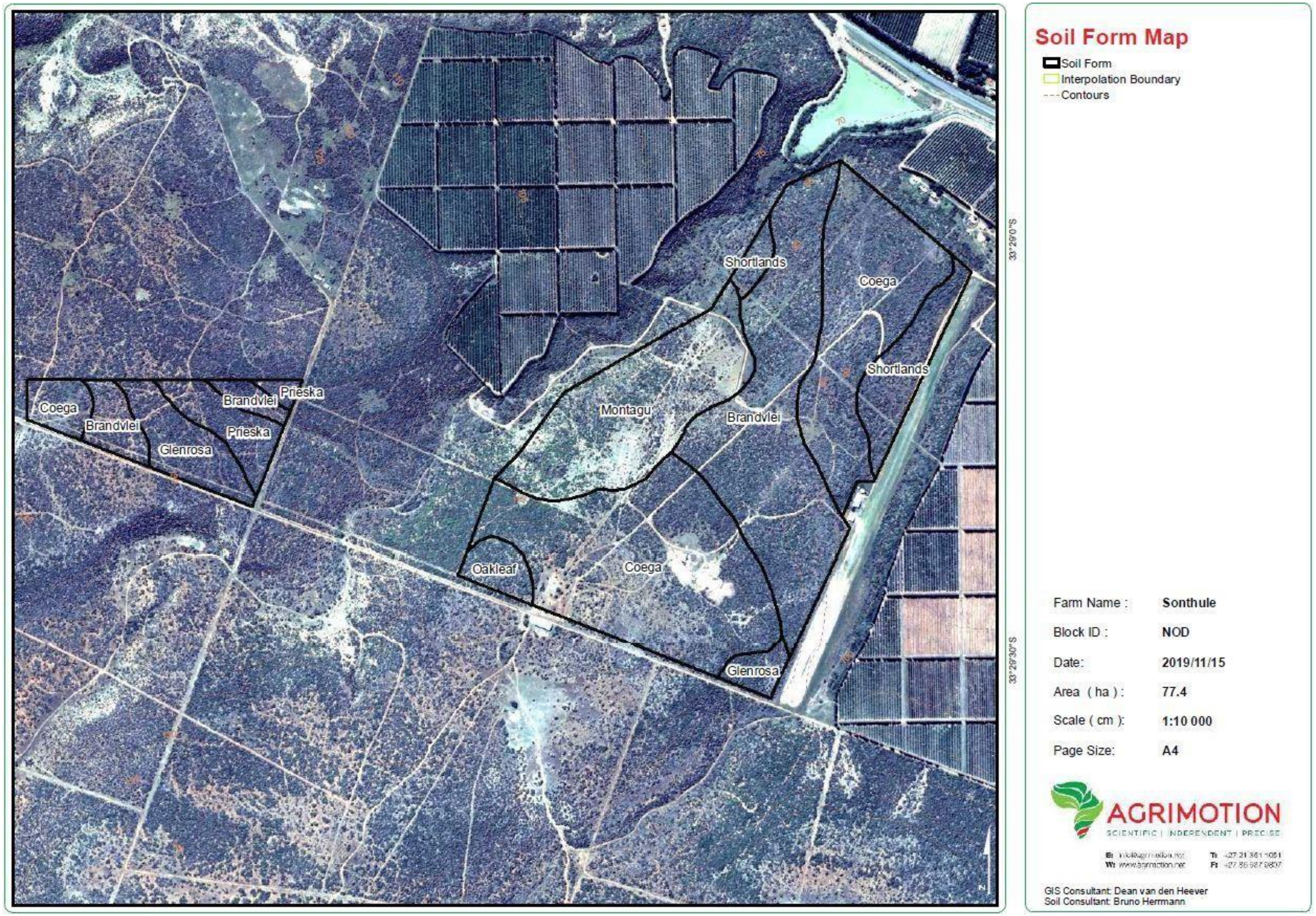


Figure 5 – Soil Form and non-suitable areas

Table C1. Soil codes as described in the field**.**

Profile number	Code above line	Code below line
1	33 Br 1000 sk(18)+f2g4 (60/30) (4)	f2 3(12) Fi 1
2	33 Cg 2000 hk(14)+f2g4k2 (60/30) (2.5)	f2g1 3(14) Fi 1
3	353 Br 1000 hk(20)+g3k3 sk(20)+f3g2 (60/30) (4)	f3g1 2(10) Fi 1
4	242 Pr 2210 hk() nc(18)+f2 (60/20) (4)	f2g1 3(14) Fi 1
5	33 Gs 2111 so/ne(18)+f2g4k2 (80/40) (5)	f2g3k1 3(14) Fi 1
6	33 Br 2000 sk(26)+f2g3k1 (80/20) (3.5)	f3g1 4(16) Fi 2
7	33 Gs 2112 so/sk(24)+f2g5k1 (60/30) (3.5)	f2g1 3(14) Fi 1
9	33 Cg 1000 hk(16)+g4k4 (60/30) (3)	g2 4(16) Fi 1
10	242 Oa 1110/Pr hk(16)+g8 ne/nc(16)+f2g3k2 (60/40) (4.5)	f1g2k2 4(16) Fi 1
12	33 Cg 1000 hk(16)+f1g3k1 (60/30) (3)	g2 4(16) Fi 1
13	23 Cg 1000 hk(16)+g4k4 (60/30) (2.5)	g2 4(16) Fi 1
14	22 Br 1000 sk(16)+f2g6k1 (60/30) (3.5)	f2 4(16) Fi 1
15	22 Br 1000 sk(16)+f2g6k1 (60/30) (3.5)	f2 4(16) Fi 1
16	33 Cg 1000 hk(20)+g2k6 (60/30) (3.5)	f2g2k1 3(14) Fi 1
18	37 Mu 2110 nc/sp(24) nc(20) (80/30) (3.5)	f1g1 4(16) Fi 2
20	22 Ag 2110 nc(26)+f2g4 (80/30) (3.5)	f2g1 4(20) Fi 2
21	35 Sd 2220 lo(18) vr(18) (80/30) (4.5)	f2 2(10) Fi 2
22	262 Sd 2121 sk(28)+f3g3 vr/ne(22)+f3 (80/60) (5)	f3 3(14) Fi 1
23	44 Cg 1000 hk(16)+g3k4r2 (60/40) (3.5)	f2g2r2 4(16) Fi 1
24	33 Cg 1000 hk/sp(14)+f3g6 (60/30) (3.5)	f2 3(14) Fi 1
26	33 Br 1000 sk(18)+f3g3 (60/30) (4.5)	f3 3(14) Fi 1

APPENDIX D - DESCRIPTION AND INTERPRETATION OF SOIL CODE

363 Oa 1210/Tu lo/lw(45)+f2g3 ne/yp(20)+f3 (80/30) (6)

f2 me 2(8) 2/3

The information above the line explains the soil type, family and subsoil horizon characteristics.

363:	Horizon depths:	The first numbers in the soil code provides an indication of the depth at which horizon transitions occur. In the provided example, the A horizon ranges from 0-30cm (with the transition at 30 cm i.e. depth code 3), the B horizon from 30-60cm and the last horizon begins at 60cm. The repeated 3 at the end is used to indicate that coarse fragments start ata depth of 30cm.
Oa:	Soil form:	The symbol for the soil form. Each of the 73 soil forms have a unique 2-letter symbol. These symbols, together with the soil form descriptions, are given in appendix B.
1210:	Soil family:	The next four numbers indicate the soil family. It provides additional diagnostic characteristics that are common in a given soil form. This can include the presence of carbonates, soil colour, structure etc.
/Tu:	Transitional form:	In many instances a soil profile can possess characteristics similar to that of a variety of soil forms. The dominant horizon characteristics then need to be used to differentiate between the potential soil form options. An alternative soil form can be reported in the soil code using a / after the dominant soil form and family have been established.
lo/lw:	Subsoil horizons:	The properties for the subsoil horizons are always provided directly after the soil family code. Each of the diagnostic horizons have a unique 2-letter symbol as indicated in appendix B. If the material foundat the bottom of the classified profile cannot be inferred from the soil form, this 2-letter symbol is used to provide further description. In thisexample, the last horizon is a transition, as indicated with the '/lw'. The horizon abbreviations are provided in appendix B.
( ):	Subsoil clay percentage	The clay percentages of the observed subsoil horizons are indicated in brackets after the specific horizon description.
+f2g3:	Coarse fragments:	There are 20% fine coarse fragments (i.e. letter 2) and 30% medium coarse fragments (i.e. letter 3) noted in the last horizon. Symbols & diameter: 'f' for fine (0.2 – 2.5cm), 'g' for medium (2.5 - 7.5cm), 'k' for stone (7.5 – 25cm) and 'r' for rock (25+cm).
(yp):	Additional horizon properties:	Additional properties for each subsoil horizon can be indicated after the specific subsoil horizon description. In the example above the B horizon is hard setting when dry (yp).
(80/30):	Rip and delve depth:	The pair of numbers in brackets indicate the *depth in cm* to which 1) a rip-action can be completed and 2) to which depth the soil can be mixed.
(6.5):	Soil Potential:	The second number in brackets is the soil's potential which is given out of a total of 10. This concept is discussed further in section 4.

The information below the line characterises the topsoil horizon and profile wetness.

f2:	Coarse Fragments:	There are 20% fine coarse fragments in the A horizon.

me:	Sand grade:	The A horizon has a medium sand grade. 'me' for medium sand grade, 'fi' for fine sand grade and 'co' for coarse sand grade.
2(8):	Clay percentage:	This indicates that there is an estimated 8% clay in the A horizon.
2/3:	Soil wetness:	The 2/3 class is a soil wetness estimation dependent on the depth at which the signs of wetness were observed, and the period of time that the soil will remain wet for. A wetness class of 1 indicates that the soil in the profile is dry throughout the year. A soil with a wetness class of 9 is saturated with water from a depth of 30cm for the whole year.

APPENDIX E - TOPOGRAPHY

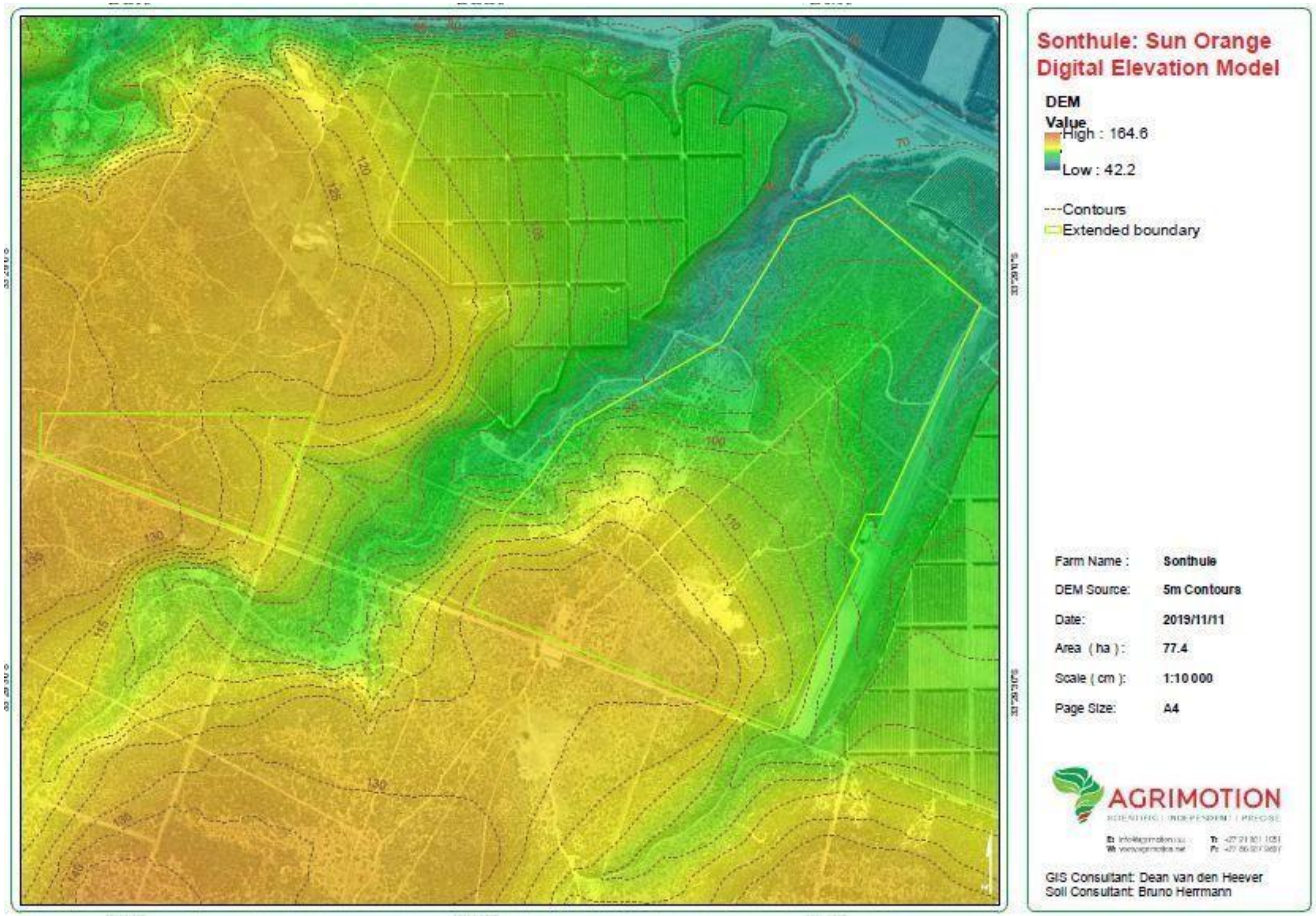


Figure 6 – Digital Elevation Model

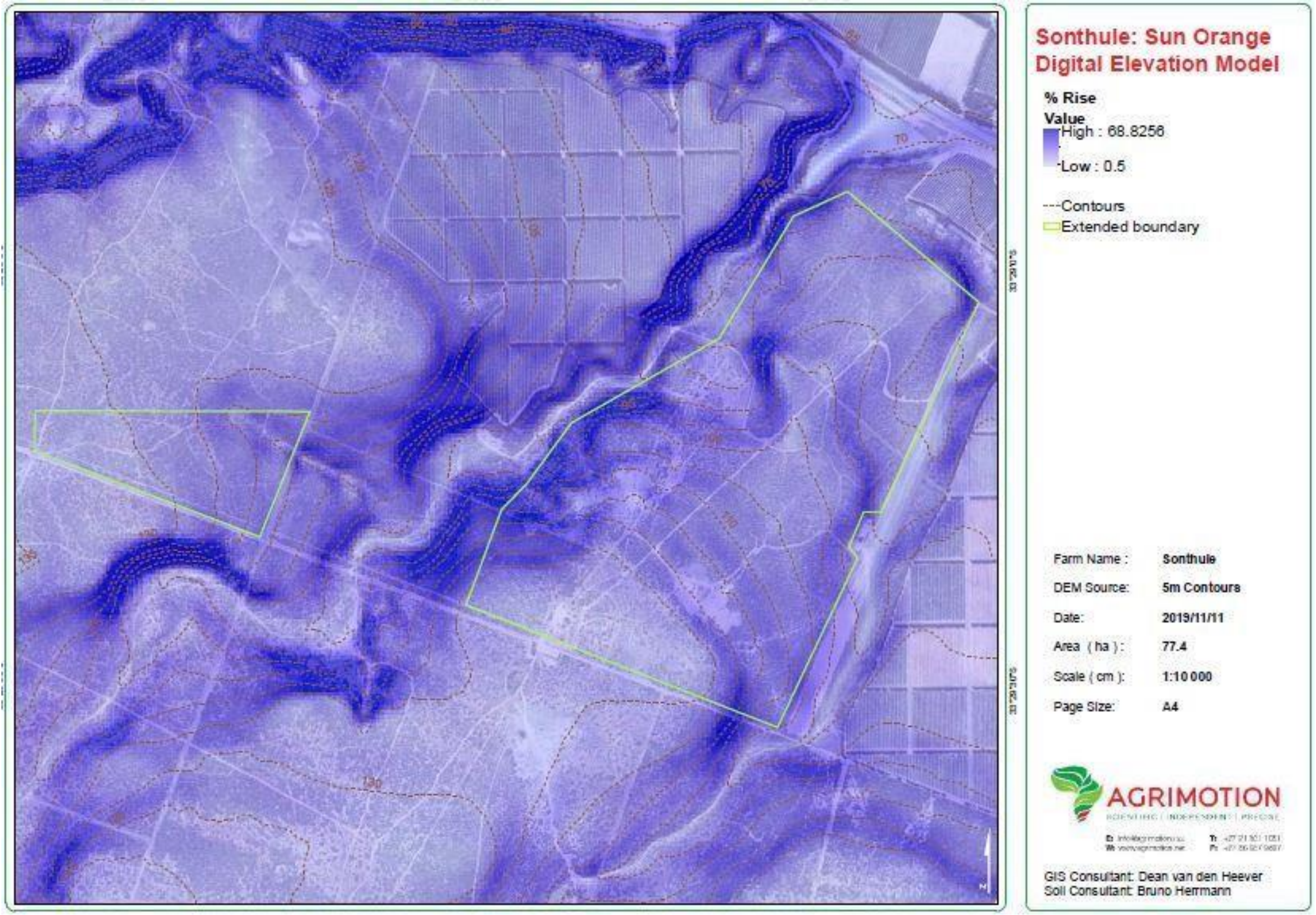


Figure 7 – Slope Percentage Rise

APPENDIX F – AREAS

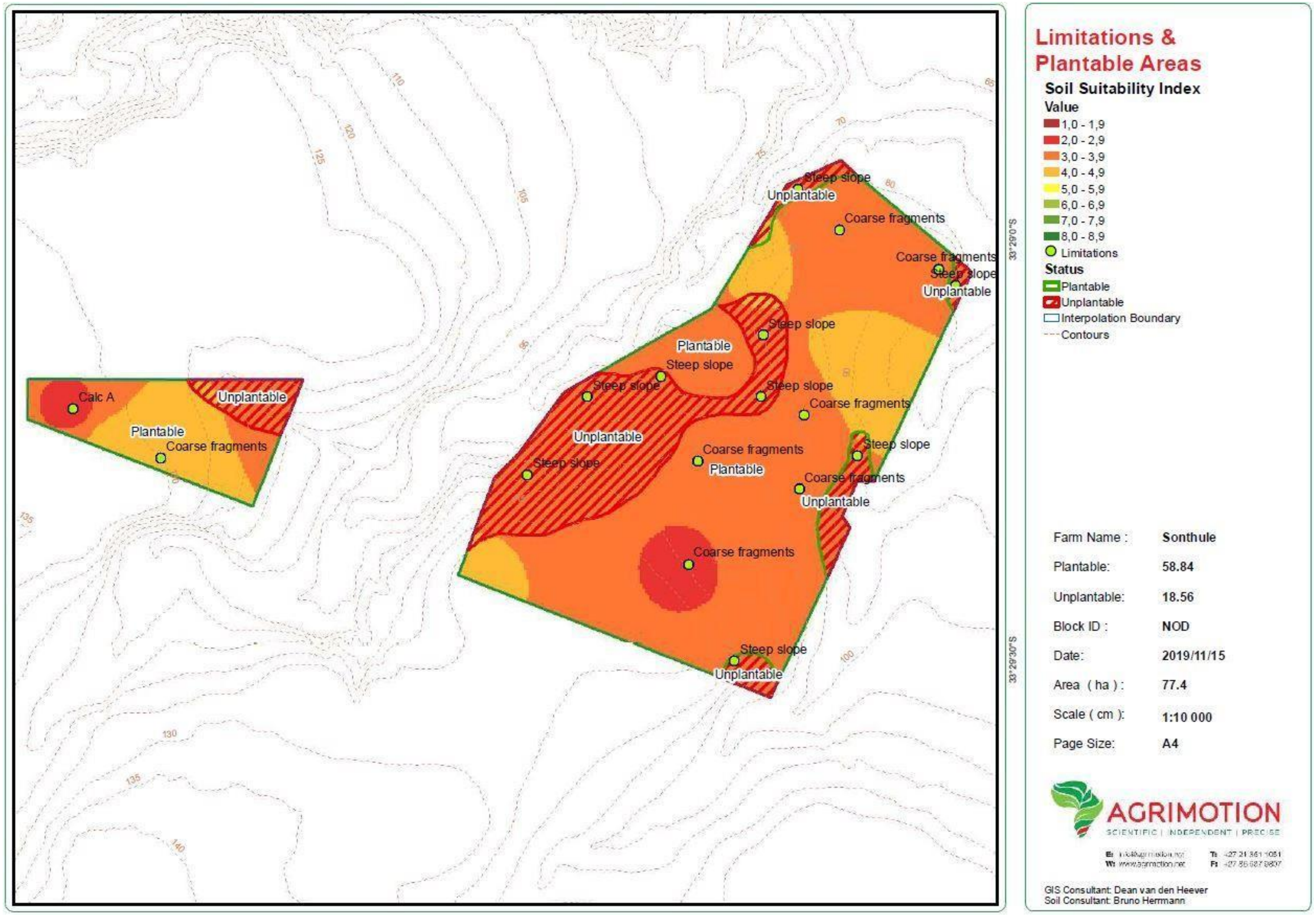


Figure 8 – Limitations and Plantable Areas

ANNEXURE 1: COMMENTS ON SUITABILITY OF SOILS NOT YET INVESTIGATED

AGRIMOTION
SCIENTIFIC | INDEPENDENT | PRECISE

May 2022

San Miguel

Extension Review of Land Capability Study Completed in 2018

(Sonthule)

General Comments

Below an image of the soil suitability of the area surveyed at Sonthule farm in 2018, overlayed onto the EIA demarcations in red.

The blue circle indicates the current area under investigation, as shown in the figure below, *Agrimotion* does not have soil data for this specific area, however, at least 90% of the current surveyed area contains soils specifically from the carbonate family of soil types. Extrapolating from this we can assume that the remaining soils are also calcareous soil-types of low - medium potential (at best). Specific rootstock-selection and soil preparation (amongst other management practices) can be expected to be required for sustainable (perennial) crop production.

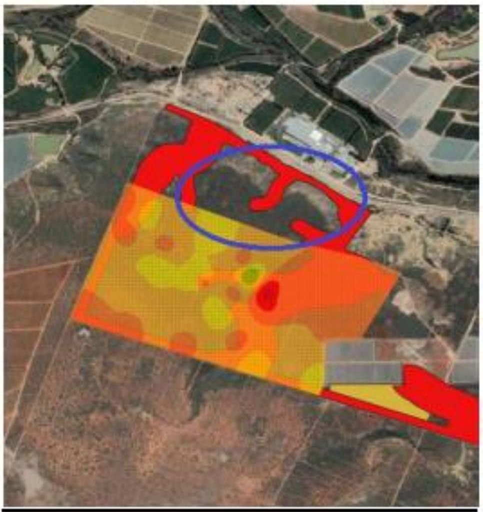


Figure 1: EIA Demarcations and Soil Suitability at Sonthule Farm.

info@agrimotion.net
+27 21 851 1051
+27 86 637 9807
Unit 7, Kingfisher Park
Old Paardevlei Road
Somerset West, 7130
Postnet Suite #704
Private Bag X15
Somerset West, 7129
www.agrimotion.net
@Agrimotion2013
@Agrimotion

Regards,

JP Rheeder

BSc Agric Plant and Soil Sciences

Cand.Sci.Nat. (128217)

074 555 2244

jp@agrimotion.net

info@agrimotion.net
+27 21 851 1051
+27 86 637 9807

Unit 7, Kingfisher Park
Old Paardevlei Road
Somerset West, 7130

Postnet Suite #704
Private Bag X15
Somerset West, 7129

www.agrimotion.net
@Agrimotion2013
@Agrimotion

Chapter 9: Archaeological Impact Assessment

Scoping and Environmental Impact Assessment: Sontule Citrus – Agricultural Expansion on Remainder of Farm 632, Sunland, Sundays River Valley Municipality

Draft EIA Report

September 2022

Prepared by:

Archaeological Specialist
Compiled by: Mr Kobus Reichert
Reviewed by: Dr Johan Binneman
Eastern Cape Heritage Consultants cc
P.O. Box 689
Jeffreys Bay
6330

Public Process Consultants
Environmental Impact Assessment and Public Participation Management

A PHASE 1 ARCHAEOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED DEVELOPMENT OF 144 HA OF CITRUS ORCHARDS AND ASSOCIATED INFRASTRUCTURE AS WELL AS THE CONSTRUCTION OF A DAM ON THE REMAINDER OF FARM 632 NEAR SUNLANDS, SUNDAYS RIVER VALLEY MUNICIPALITY, EASTERN CAPE PROVINCE

Prepared for: Public Process Consultants
P.O. Box 27688
Greenacres, 6057
Tel.: 041-374 8426
Contact person: Ms Sandy Wren
Email: sandy@publicprocess.co.za

Compiled by: Mr Kobus Reichert **Reviewed by:** Dr Johan Binneman

On behalf of: Eastern Cape Heritage Consultants cc
Reg. no: 2006/088345/23
P.O. Box 689
Jeffreys Bay, 6330
Cell: 072 800 6322
Email: kobusreichert@yahoo.com
jnfbinneman@gmail.com

Date: December 2021

CONTENTS

EXECUTIVE SUMMARY 9.i
9.1 PROJECT INFORMATION 9.1
9.1.1 The type of development 9.1
9.1.2 Purpose of the study 9.1
9.3 Site and location 9.2
9.3.1 Relevant impact assessments, databases and collections 9.2
9.4 BRIEF ARCHAEOLOGICAL BACKGROUND 9.4
9.4.1 Literature review 9.4
9.4.2 References 9.4
9.5 ARCHAEOLOGICAL INVESTIGATION 9.4
9.5.1 Methodology 9.5
9.5.2 Limitations and assumptions 9.5
9.5.3 Finds and results 9.5
9.6 ASSESSMENT OF THE IMPACTS 9.5
9.7 DISCUSSION AND MITIGATION 9.10
9.8 GENERAL REMARKS AND CONDITIONS 9.10

APPENDIX A: brief legislative requirements 9.12
APPENDIX B: Guidelines and procedures for developers 9.13

LIST OF TABLES
Table 1. Impacts on the pre-colonial archaeology 9.5

LIST OF FIGURES
Figure 1. General views of the proposed area for the development of citrus orchards 9.8
Figure 2. General views of the proposed area for the development of a storage dam 9.9

LIST OF MAPS
Map 1. 1:50 000 topographic maps indicating the location of the proposed development 9.14
Map 2. Aerial images indicating the location of the proposed development 9.15
Map 3. Map of the proposed area for the development of the citrus orchards and dam 9.16

A PHASE 1 ARCHAEOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED DEVELOPMENT OF 144 HA OF CITRUS ORCHARDS AND ASSOCIATED INFRASTRUCTURE AS WELL AS THE CONSTRUCTION OF A DAM ON THE REMAINDER OF FARM 632 NEAR SUNLAND, SUNDAYS RIVER VALLEY MUNICIPALITY, EASTERN CAPE PROVINCE

Note: This report follows the minimum standard guidelines required by the South African Heritage Resources Agency for compiling Archaeological Heritage Phase 1 Impact Assessment (AHIA) reports.

EXECUTIVE SUMMARY

Public Process Consultants on behalf of Sun Orange Farms (Pty) Ltd appointed Eastern Cape Heritage Consultants cc to conduct a Phase 1 Archaeological Impact Assessment (AIA) for the proposed development of 144 hectares of citrus orchards and associated infrastructure as well the construction of a dam on the Remainder of Farm 632 near Sunland, Sundays River Valley Municipality, Eastern Cape Province. The project will be known as the Sontule Citrus development.

Access to the study area was easy, but dense vegetation and grass in certain areas made it difficult to find *in situ* archaeological sites/materials. Nonetheless, occasional Middle Stone Age (MSA) stone tools were observed in a vehicle track along the southern boundary fence. These stone tools were in secondary context and not associated with any other archaeological material and no further action is needed. There is a dilapidated old building next to a quarry on the property. There are no known graves older than 60 years on the property.

The proposed development will take place near the Sundays River, in an area where one would expect to find freshwater mussel middens. It is recommended that if such features or any other concentrations of archaeological material are exposed, it must be reported to the archaeologist at the Albany Museum in Makhanda (Grahamstown) or to the Eastern Cape Provincial Heritage Resources Authority so that a systematic and professional investigation can be undertaken. Furthermore, all clearing activities must be monitored and managers/foremen should be informed before clearing/construction starts on the possible types of heritage sites and cultural material they may encounter and the procedures to follow when they find sites. The ECO can be trained to monitor the clearing of the vegetation and to report finds. In general, the proposed areas for development appears to be of **low archaeological sensitivity** and the development may proceed as planned.

9.1 PROJECT INFORMATION

9.1.1 Type of development

The farm measures approximately 459 hectares and is currently a working citrus farm with an additional 144 ha of orchards and associated infrastructure proposed. The effective irrigation areas are ~127ha.

The Sontule citrus development will also require the construction of a new dam on site and will be supplied with water from an existing dam on the property, which is supplied with water from the LSRWUA canal system.

- The existing dam has a capacity of 20 000m³
- The proposed new dam will be supplied with water from the existing dam via a 315mm uPVC pipe
- New dam specs:
  - Dam wall height 5 meters
  - Total proposed dam footprint ~31 800 m²
  - Estimated dam capacity ~49 000 m³
- New pumphouse (electrical consumption for pumps ~75kw)
- Relay water to orchards via pipes of varying sizes of either 250mm or 315mm uPVC pipe

The footprint for the new dam will be 3.18 ha and the area proposed for clearing for orchards and associated infrastructure is approximately 144 ha. A total clearance area of 147 ha is therefore proposed.

Applicant

Sun Orange Farms (Pty) Ltd.

Consultant

Public Process Consultants
P.O. Box 27688
Greenacres, 6057
Tel.: 041-374 8426
Contact person: Ms Sandy Wren
Email: sandy@publicprocess.co.za

9.2 Purpose of the study

The purpose of the study was to conduct a Phase 1 Archaeological Impact Assessment (AIA) for the proposed development of ~144 hectares of citrus orchards and associated infrastructure as well as the construction of a dam on the Remainder of Farm 632 near Sunland, Sundays River Valley Municipality, Eastern Cape Province. The survey was conducted to establish:

- the range and importance of possible exposed and *in situ* archaeological sites, features and materials,
- the potential impact of the development on these resources and,
- to make recommendations to minimize possible damage to these resources.

9.3 Site and Location

The site for the proposed developments is located within the 1:50 000 topographic reference maps 3325BC Coerney (Map 1). The proposed areas for the citrus orchard and dam developments are situated approximately 7 kilometres northwest of Sunlands, and it is located close to the Sundays River (Map 2). The property consists of hills with moderate to steep gradients and relatively flat areas in between. The proposed development area comprises of reddish alluvial soils and it is covered by short grass and dense vegetation in places (Figure 1). Some areas have been disturbed by previous agricultural and other activities (Figure 2). There are no known graves or buildings older than 60 years on the property. A general GPS reading was taken at 33.28.906S; 25.32.781E.

9.3.1 Selected relevant impact assessments from the adjacent region, databases and collections

Binneman, J. and Reichert, K. 2021a. A phase 1 archaeological impact assessment for the proposed development of approximately 250 hectares of citrus on Portion 15 of the Farm Oliphants Kop No. 194 (Gates Farm), near Addo within the Nelson Mandela Bay Municipality, Eastern Cape Province. Prepared for I.W. Terblanche & Associates. Humansdorp. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2021b. Phase 1 Archaeological Impact Assessment (AIA) for the proposed development of approximately 250 hectares of citrus orchards and associated infrastructure on Portion 4 of the Farm Klein Rooipoort No. 632 and the development of a storage dam on Portion 2 of Farm 658 near Sunlands within the Sundays River Valley Municipality, Eastern Cape Province. Prepared for I.W. Terblanche & Associates. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2020a. An archaeological assessment of the proposed amendment application for the authorised Instomi citrus farm, that includes the installation of irrigation pipelines, near Addo within the Sundays River Valley Local Municipality, Eastern Cape Province. Prepared for Public Process Consultants Greenacres. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2020b. An archaeological assessment of the proposed amendment application for the establishment of a goat breeding facility on the authorised Instomi citrus farm near Addo within the Sundays River Valley Local Municipality, Eastern Cape Province. Prepared for Public Process Consultants Greenacres. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2020c. A phase 1 archaeological assessment for the proposed cultivation of 67 ha of citrus and associated infrastructure on Portion 11 of Farm 100 (Tango) near Addo in the Sundays River Valley Local Municipality of the Eastern Cape Province. Prepared for Public Process Consultants Greenacres. Eastern Cape Heritage Consultants cc.

Binneman, J. and Reichert, K. 2019. A phase 1 archaeological impact assessment for the proposed establishment of a big 5 game reserve with lodge accommodation and a water pipeline to various dams near Addo in the Sunday's River Valley Municipality of the Eastern Cape Province. Prepared for Habitat Link Consulting. Greenacres. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2018. A phase 1 archaeological impact assessments for the proposed agricultural activities on Portion 525 of the farm Strathsomers Estate No. 42 and associated irrigation infra-structure on Portion 523 of the farm Strathsomers Estate No. 42 in the Sundays River Valley Municipality of the Eastern Cape Province. Prepared for Public Process Consultants Greenacres. Eastern Cape Heritage Consultants cc.

Binneman, J. and Reichert, K. 2016a. A phase 1 archaeological impact assessment for the proposed clearing of natural vegetation to establish citrus orchards and grazing for game on the Remainder of Portion 1 of farm 119 (Wolverton) in the Sundays River Valley Municipality of the Eastern Cape Province. Prepared for Public Process Consultants. Greenacres. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2016b. A phase 1 archaeological impact assessments for the proposed clearing of vegetation in three areas to establish citrus orchards on the farm Boschkraal near Kirkwood, Sunday's River Valley Local Municipality Eastern Cape Province. Prepared for Prime Resources (Pty) Ltd. Parklands. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2016c. A phase 1 archaeological impact assessment for the proposed clearing of natural vegetation to expand the existing agricultural activities on portion 274, Strathsomers Estate No. 42 in the Sundays River Valley Municipality of the Eastern Cape Province. Prepared for Public Process Consultants Greenacres. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2016d. A phase 1 archaeological impact assessment for the proposed clearing of natural vegetation to establish citrus orchards on the Remainder of Portion 14 of the farm Geelhoutboom No. 89 in the Sundays River Valley Municipality of the Eastern Cape Province. Prepared for Public Process Consultants. Greenacres. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. and Reichert, K. 2015. A letter of recommendation (with conditions) for the exemption of a full phase 1 archaeological impact assessment for the proposed clearing of 20 ha of natural vegetation to establish citrus orchards on the farm Hitgeheim, Sunland, Sundays River Valley Municipality, Eastern Cape Province. Prepared for Engineering Advice & Services (Pty) Ltd. Humewood. Eastern Cape Heritage Consultants cc. Jeffreys Bay

Binneman, J. 2014a. A phase 1 archaeological impact assessment for the proposed expansion of agricultural activities on Portion 7 of the Farm Scheepers Vlakte No. 98, Sunland near Kirkwood, Sundays River Valley Municipality, Eastern Cape Province. Prepared for I.W. Terblanche & Associates. Stellenbosch. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. 2014b. A phase 1 archaeological impact assessment for the proposed expansion of agricultural activities on Farm 632, Sunland near Kirkwood, Sundays River Valley Municipality, Eastern Cape Province. Prepared for I.W. Terblanche & Associates. Stellenbosch. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. 2014c. A phase 1 archaeological impact assessment for the proposed expansion of agricultural activities on the remaining extent of Farm 714, Sunland Near Kirkwood, Sundays River Valley Local Municipality, Eastern Cape Province. Prepared for I.W. Terblanche & Associates. Stellenbosch. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. 2014d. Phase 1 archaeological impact assessment for the proposed expansion of agricultural activities on Luthando farm, Portion 320 of Strathsomers Estate No. 42, Kirkwood, Sundays River Valley Municipality, Eastern Cape Province. Prepared for Public Process Consultants. Greenacres. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Binneman, J. 2013. A phase 1 archaeological impact assessment for the proposed expansion of agricultural activities on portion 5 of the Farm Nooitgedacht No. 118, Sunland, Sundays River Valley Municipality, Eastern Cape Province. Prepared for Public Process Consultants Greenacres. Eastern Cape Heritage Consultants cc. Jeffreys Bay.

Gaigher, S. 2013. Heritage Impact Assessment for the Stormwater infrastructure in Valencia, Addo, Sundays River Valley Municipality, Eastern Cape Province.

Rossouw, L. (Paleo Field Service). 2013 a. Phase 1 Heritage Impact Assessment of Disco Chicks Farm 2 (Farm 713), Sundays River Valley Municipality.

Rossouw, L. 2015. Phase 1 Archaeological Impact Assessment of Intsomi Game Farm, Sundays River Valley Municipality, Eastern Cape Province. Prepared for Public Process Consultants Greenacres. National Museum. Bloemfontein.

The Albany Museum in Makhanda (Grahamstown) houses collections and information from the wider region.

9.4 BRIEF ARCHAEOLOGICAL BACKGROUND

9.4.1 Literature review

The oldest evidence of the early inhabitants in the Sundays River region are large stone tools, called hand axes and cleavers, which can be found amongst river gravels and in old spring deposits in the region. These large stone tools are from a time period called the Earlier Stone Age (ESA) and may date between 1,5 million and 250 000 years old. In a series of spring deposits at Amanzi Spring near Addo, a large number of stone tools were found *in situ* to a depth of 3-4 metres. Remarkably, wood and seed material preserved in the spring deposits, possibly dating to between 250 000 to 800 000 years old (Inskeep 1965; Deacon 1970) were also found.

Evidence of MSA sites occur throughout the region and date between 250 000 and 30 000 years old. These stone artefacts, like the Earlier Stone Age tools are also found in the gravels along the banks of the Sundays River and, like hand axes, are mainly in secondary context. Fossil bone may, in rare cases, be associated with MSA occurrences.

The majority of archaeological sites found in the area date from the past 10 000 years (called the Later Stone Age) and are associated with the campsites of San hunter-gatherers and Khoi pastoralists. These sites are difficult to find because they are in the open veld and often covered by vegetation and sand. Sometimes these sites are only represented by a few stone tools and fragments of bone (Deacon & Deacon 1999). The preservation of these sites is poor, and it is not always possible to date them. There are many San hunter-gatherer sites in the nearby Suurberg and adjacent mountains. Here, caves and rock shelters were occupied by the San during the Later Stone Age with well-preserved living deposits and paintings along the walls (Deacon 1976).

Some 2 000 years ago Khoi pastoralists occupied the region and lived mainly in small settlements. They were the first food producers in South Africa and introduced domesticated animals (sheep, goat and cattle) and ceramic vessels to southern Africa. Often archaeological sites are found close to the banks of large streams and rivers. Large piles of freshwater mussel shell (called middens) usually mark these sites. Prehistoric groups collected the freshwater mussel from the muddy banks of the rivers as a source of food. Mixed with the shell and other riverine and terrestrial food waste are also cultural materials. Human remains are often found buried in the middens.

9.4.2 References

Deacon, H.J. 1970. The Acheulian occupation at Amanzi Springs, Uitenhage District, Cape Province. Annals of the Cape Provincial Museums. 8:89-189.

Deacon, H. J., 1976. Where hunters gathered: a study of Holocene Stone Age people in the Eastern Cape. South African Archaeological Society Monograph Series No. 1.

Deacon, H.J. & Deacon, J. 1999.Human beginnings in South Africa. Cape Town: David Phillips Publishers.

Inskeep, R.R. 1965. Earlier Stone Age occupation at Amanzi: preliminary investigations. South African Journal of Science. 61:229-242.

9.5 ARCHAEOLOGICAL INVESTIGATION

9.5.1 Methodology

The farm manager was contacted prior to the investigation to inform him about the visit and to gain access to the property. All previous relevant survey information for the immediate and adjacent areas was reviewed before the survey started. The farm manager pointed out the proposed areas for the development at the start of the survey and he was consulted about possible locations of archaeological remains, graves and historical buildings and features. A Google Earth aerial image study was also conducted of the area, prior to the investigation. The investigation was conducted on foot by an archaeologist and by doing spot checks from a vehicle. To cover as much of the proposed development areas as possible, vehicle tracks and cut lines on the farm were followed. GPS readings were taken with a Garmin and all the important features were digitally recorded.

9.5.2 Limitations and assumptions

It was not possible to do a complete survey of the areas due to the short grass and dense vegetation in places which made it difficult to locate *in-situ* archaeological sites/materials. Some areas on the property have been cleared of vegetation in the past and there are number of vehicle tracks and cut lines where the archaeological visibility was relatively good. The experiences and knowledge gained from several other investigations in the wider surrounding region provided background information to make assumptions and predictions on the incidences and the significance of possible pre-colonial archaeological sites/material which may be located in the areas, or which may be covered by soil and vegetation.

9.5.3 Finds and results

Although it was difficult to locate archaeological sites/materials, occasional Middle Stone Age (older than 30 000 years) stone tools were observed in areas where surface soil was removed in a gravel road along the southern boundary fence (Figure 1, bottom right insert). These Middle Stone Age (MSA) stone tools were manufactured from quartzite river cobbles/pebbles and the flakes displayed typical facetted striking platforms. The stone tools were found randomly without any recognised distribution patterns. They were in secondary context and not associated with any other archaeological remains. Few points and blades were observed and most of the tools were thick, small ‘informal’ flakes. No further action is needed. Apart from the occasional stone tools no other archaeological sites/materials were found.

There is a dilapidated old building on the property next to a quarry. In general, it would appear that the area is of **low archaeological sensitivity** and that it is unlikely that any sensitive archaeological remains will be exposed during the development.

9.6 ASSESSMENT OF THE IMPACTS

<u>**Direct impacts**</u>

Table 1. The potential physical disturbance and destruction of surface and buried pre-colonial archaeology sites/remains during all developments (rating based on the surface visibility of archaeological remains).

Nature of the Impact	**Possible loss of non-renewable heritage resources:** The main impact on archaeological sites/remains (if any) will be the physical disturbance of the material and its context. The clearing of the vegetation may expose, disturb and displace archaeological sites/material. However, from the investigation it would appear that the proposed areas earmarked for development are of low archaeological sensitivity. The Middle Stone Age stone tools observed in the area to be developed are considered to be of low cultural significance, because they are in secondary context and not associated with any other archaeological remains. Notwithstanding, important materials may be

	covered by soil and vegetation. There are no known graves or buildings older than 60 years on the area surveyed.
Extent	**Site specific -** The impact will be limited to the development footprint.
Duration	**Permanent -** Disturbance to archaeological material will be permanent.
Intensity	**Medium**
Probability	**Probable** – the archaeological material within the proposed development footprint will be disturbed, displaced or destroyed.
Reversibility	**Irreversible** – Once the archaeological material has been removed or destroyed this impact cannot be reversed.
Degree of Confidence	**Medium / High**
Status and Significance of Impact (no mitigation)	**Low Negative (-)**
Mitigation	• All construction activities must be monitored or alternatively a person must be specially trained, for example the ECO, to conduct the monitoring. This must include the clearing of vegetation, leveling, excavations for pipelines and other underground/ buried infrastructure and all above ground construction activities such as roads and buildings. • Construction managers/foremen should also be informed before construction starts on the possible types of heritage sites and cultural material they may encounter and the procedures to follow when they find sites. If any human remains (or any other concentrations of archaeological heritage material) are exposed during construction, all work must cease in the immediate area of the finds and must be reported immediately to the archaeologist at the Albany Museum in Makhanda (Tel.: 046 6222312) or to the Eastern Cape Provincial Heritage Resources Authority (Tel.: 043 7450888). Sufficient time should be allowed to investigate and to remove/collect such material. Recommendations will follow from the investigation and may include: • Consultation with the local communities regarding the conditions for the possible removal, storage and reburial (in the case of human remains) of heritage material. • If the local communities agree to the removal of human remains and heritage, an archaeologist must apply for permits from the Eastern Cape Province Heritage Resources Authority to collect and/or excavate sites/materials from archaeological sites impacted by the development. • Consultation with the Albany Museum (repository for archaeological material in the Eastern Cape) regarding permit(s) to remove the heritage material, the storing, curating and costs involved. • A Phase 2 Mitigation process to systematically excavate and to remove the archaeological deposits before construction of the development continues. Note: All costs must be financed by the applicants. This may include: All monitoring and mitigation expenses regarding the excavations/collecting of material, travel, accommodation and subsistence, analysis of the material, radiocarbon date(s) of the site(s) and a once-off

	curation/storage fee payable to the Department of Archaeology at the Albany Museum.
Significance and Status (with mitigation)	**Neutral (0)**
Residual Impact	The cumulative impacts on above and below ground heritage will increase when further developments take place in adjoining areas, such as the proposed development of approximately 250 hectares of citrus orchards and associated infrastructure on Portion 4 of the Farm Klein Rooipoort No. 632 (located to the south and adjacent to the proposed Sontule Citrus development) and the development of a storage dam on Portion 2 of Farm 658 (located to the north and adjacent to the proposed Sontule Citrus development). It is anticipated that archaeological material uncovered or found during the development will be of low cultural significance similar to those observed during this survey. The cumulative impact of the developments therefore does not change the overall impact rating. **Low Negative (-)**

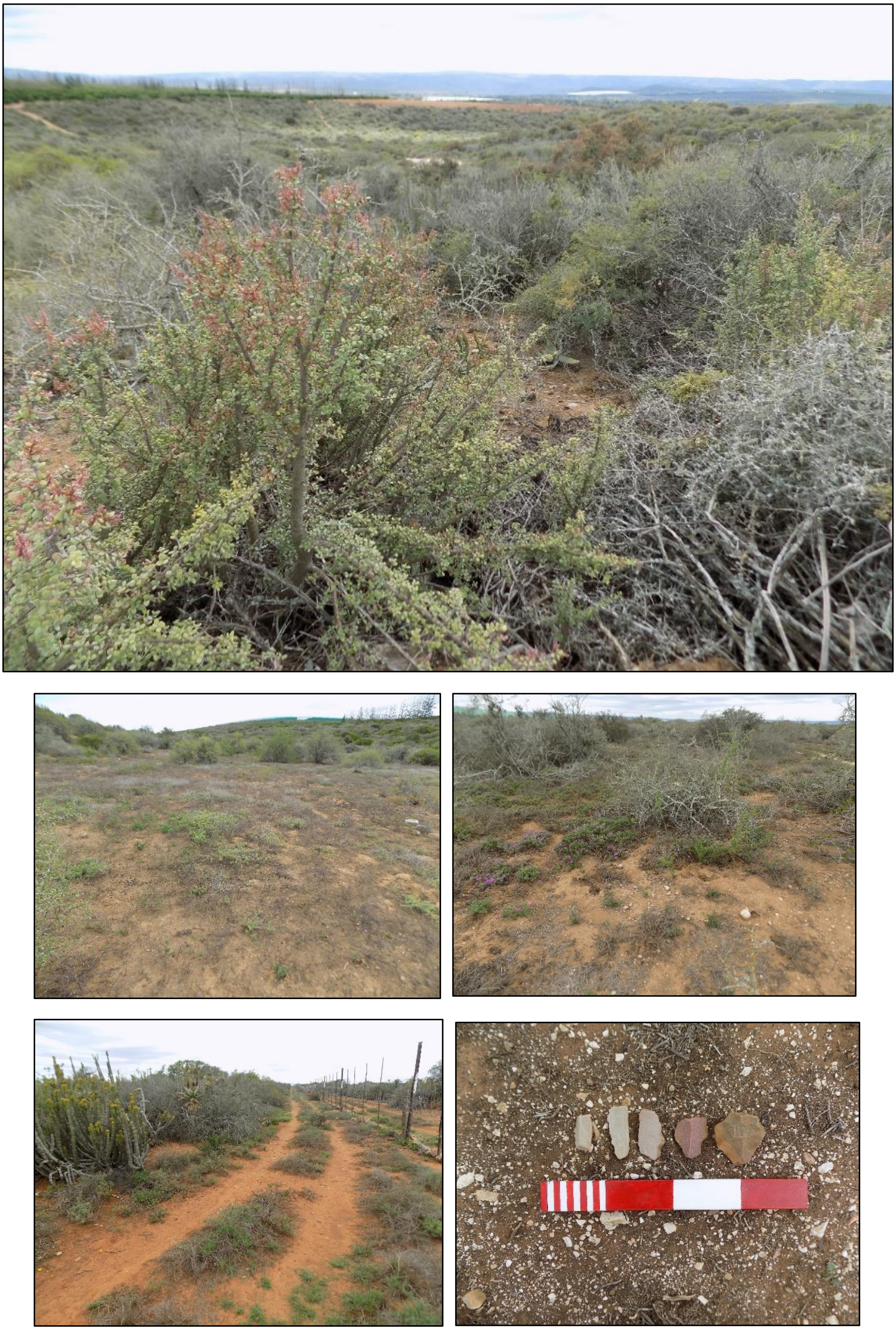


Figure 1. General views of the proposed area for the development of ~144 hectares of citrus orchards and associated infrastructure. A sample of Middle Stone Age stone tools (bottom right image) observed in a gravel road along the southern boundary of the property.

Figure 2. General views of the proposed area for the construction of a dam on the Remainder of Farm 632

9.7 DISCUSSION AND MITIGATION

The areas investigated are mostly covered by reddish alluvial soil and with short grass and dense vegetation in places. The archaeological visibility was relatively good in areas disturbed by agricultural and other activities. The proposed dam area for example has been cleared and levelled recently but no sites or stone artefacts were observed in this area (Figure 2). Middle Stone Age (MSA) tools were found along the southern boundary of the property but no further action is required. The proposed development will take place near the Sundays River in an area where one would expect to find freshwater shell middens. These are important archaeological sites and special care must be taken that these sites are not destroyed during development. The main potential impact on possible archaeological sites/remains will be the physical disturbance of the material and its context. However, from the investigation, it would appear that the proposed areas earmarked for the development are of **low archaeological sensitivity**.

It is recommended that:

1. Although it would seem unlikely that any significant archaeological remains will be exposed during the development, there is always a possibility that human remains and/or other archaeological remains such as freshwater shell middens and historical material may be uncovered during the development. Should such material be exposed during construction, all work must cease in the immediate area (depending on the type of find) and it must be reported to the archaeologist at the Albany Museum in Makhanda (Grahamstown) (Tel: 046 6222 312) or to the Eastern Cape Provincial Heritage Resources Authority (Tel: 043 7450 888), so that a systematic and professional investigation can be undertaken. Sufficient time should be allowed to investigate and to remove/collect such material. Recommendations will follow from the investigation (See appendix B of this Specialist Chapter for a list of possible archaeological sites that maybe found in the area).

2. All clearing activities and other developments must be monitored. Managers/foremen should be informed before clearing/construction starts on the possible types of heritage sites and cultural material they may encounter and the procedures to follow when they find sites. Alternatively, it is suggested that a person must be trained (ECO) as a site monitor to report to the foreman when heritage sites/materials are found.

9.8 GENERAL REMARKS AND CONDITION

Note: This is an Archaeological Impact Assessment (AIA) report compiled for the Eastern Cape Provincial Heritage Resources Authority (ECPHRA) to enable them to make informed decisions regarding the heritage resources assessed in this report and only they have the authority to revise the report. This Report must be reviewed by the ECPHRA where after they will issue their Review Comments to the EAP/developer. The final decision rests with the ECPHRA who must grant permits if there will be any impact on cultural sites/materials as a result of the development.

This report is a Phase 1 Archaeological Impact Assessment and does not exempt the developer from any other relevant heritage impact assessments as specified below:

In terms of the National Heritage Resources Act, No. 25 of 1999 (section 38) ECPHRA may require a full Heritage Impact Assessment (HIA) to assess all heritage resources, that includes *inter alia*, all places or objects of aesthetical, architectural, historic, scientific, social, spiritual, linguistic, or technological significance that may be present on a site earmarked for development. A full Heritage Impact Assessment (HIA) should assess all these heritage components, and the assessment may include archaeology, shipwrecks, battlefields, graves, and structures older than 60 years, living heritage, historical settlements, landscapes, geological sites, palaeontological sites and objects.

It must be emphasized that this Phase 1 AIA is based on the visibility of archaeological sites/material and may not therefore reflect the true state of affairs. Sites and material may be covered by soil and vegetation and will only be located once this has been removed. In the event of such finds being uncovered during construction activities, ECPHRA or an archaeologist must be informed immediately so that they can investigate the importance of the sites and excavate or collect material before it is destroyed (see attached list of possible archaeological sites and material). The developer must finance the costs should additional studies be required as outlined above. The *onus* is on the developer to ensure that the provisions of the National Heritage Resources Act No. 25 of 1999 and any instructions from ECPHRA are followed. The EAP/developer must forward this report to ECPHRA in order to obtain their Review Comments, unless alternative arrangements have been made with the heritage specialist to submit the report.

APPENDIX A: brief legislative requirements

Parts of sections 35(4), 36(3) and 38(1) (8) of the National Heritage Resources Act 25 of 1999 apply:

Archaeology, palaeontology and meteorites

35 (4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

Burial grounds and graves

36. (3) (a) No person may, without a permit issued by SAHRA or a provincial heritage resources authority—
(a) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
(b) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or
(c) bring onto or use at a burial ground or grave referred to in paragraph (a) or (b)any excavation equipment, or any equipment which assists in the detection or recovery of metals.

Heritage resources management

38. (1) Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorized as –

(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;
(b) the construction of a bridge or similar structure exceeding 50m in length;
(c) any development or other activity which will change the character of the site –
(i) exceeding 5000m^2 in extent, or
(ii) involving three or more erven or subdivisions thereof; or
(iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or
(iv) the costs of which will exceed a sum set in terms of regulations by SAHRA, or a provincial resources authority;
(d) the re-zoning of a site exceeding 10 000m^2 in extent; or
(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must as the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

APPENDIX B: IDENTIFICATION OF ARCHAEOLOGICAL FEATURES AND MATERIAL FROM INLAND AREAS: guidelines and procedures for developers

Human Skeletal material

Human remains, whether the complete remains of an individual buried during the past, or scattered human remains resulting from disturbance of the grave, should be reported. In general, human remains are buried in a flexed position on their side but are also found buried in a sitting position with a flat stone capping. Developers are requested to be on alert for the possibility of uncovering such remains.

Freshwater mussel middens

Freshwater mussels are found in the muddy banks of rivers and streams and were collected by people in the past as a food resource. Freshwater mussel shell middens are accumulations of mussel shell and are usually found close to rivers and streams. These shell middens frequently contain stone tools, pottery, bone, and occasionally human remains. Shell middens may be of various sizes and depths, but an accumulation which exceeds 1 m^2 in extent, should be reported to an archaeologist.

Large stone cairns

They come in different forms and sizes but are easy to identify. The most common are roughly circular stone walls (mostly collapsed) and may represent stock enclosures, remains of wind breaks or cooking shelters. Others consist of large piles of stones of different sizes and heights and are known as *isisivane.* They are usually near river and mountain crossings. Their purpose and meaning are not fully understood however some are thought to represent burial cairns while others may have symbolic value.

Stone artefacts

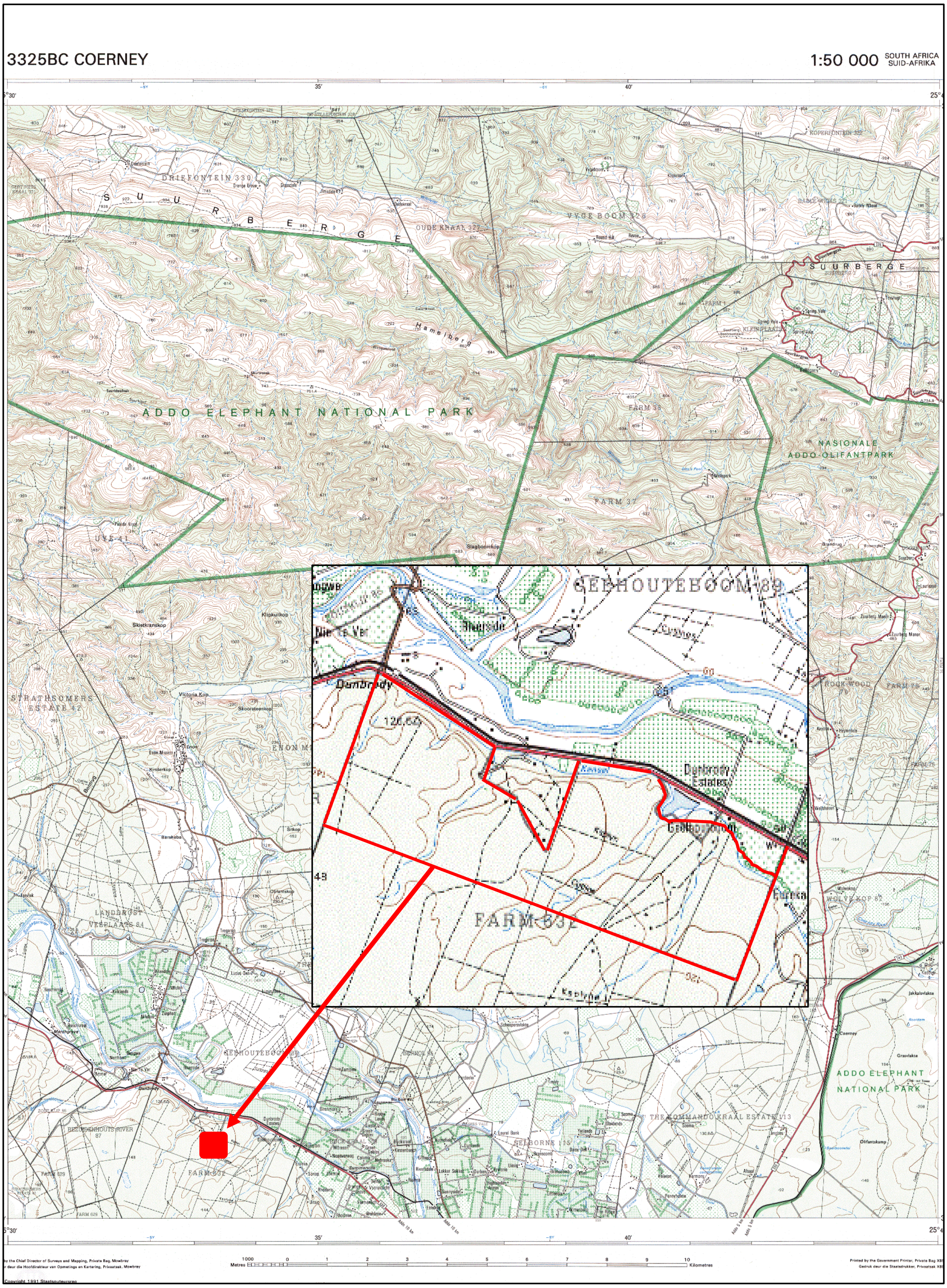
These are difficult for the layman to identify. However, large accumulations of flaked stones which do not appear to have been distributed naturally should be reported. If the stone tools are associated with bone remains, development should be halted immediately, and archaeologists notified.

Fossil bone

Fossil bones may be found embedded in geological deposits. Any concentrations of bones, whether fossilized or not, should be reported.

Historical artefacts or features

These are easy to identify and include foundations of buildings or other construction features and items from domestic and military activities**.**



Map 1. 1:50 000 Topographic maps indicating the approximate location of the Remainder of Farm 632 indicated by the red arrow and red square.

Map 2. Aerial images indicating the location of the Remainder of Farm 632 outlined by the red lines.

Map 3. Map of the area surveyed indicated in green. The proposed clearance of ~144 hectares of vegetation for the cultivation of citrus will be located within the green area. The proposed area for the construction of a dam is indicated by the yellow placemark (Map courtesy of Public Process Consultants).

Chapter 10: Palaeontological Impact Assessment

Scoping and Environmental Impact Assessment: Sontule Citrus – Agricultural Expansion on Remainder of Farm 632, Sunland, Sundays River Valley Municipality

Draft EIA Report

September 2022

Prepared by:

<u>Palaeontological Specialist</u>
Compiled by: John E. Almond PhD (Cantab.)
Natura Viva cc
PO Box 12410 Mill Street
Cape Town
8010
naturaviva@universe.co.za

Public Process Consultants
Environmental Impact Assessment and Public Participation Management

PALAEONTOLOGICAL SPECIALIST STUDY: COMBINED DESKTOP & FIELD-BASED ASSESSMENT

Proposed Sontule Citrus agricultural expansion on the Remainder of Farm 632 near Addo, Sundays River Valley Municipality, Eastern Cape

John E. Almond PhD (Cantab.)

Natura Viva cc, PO Box 12410 Mill Street,

Cape Town 8010, RSA

naturaviva@universe.co.za

March 2022

TABLE OF CONTENTS

EXECUTIVE SUMMARY 10.1
1. INTRODUCTION 10.2
1.1. Legislative context of this palaeontological study 10.4
2. APPROACH TO THE PALAEONTOLOGICAL HERITAGE ASSESSMENT 10.5
2.1. Assumptions & limitations 10.6
2.2. Legislative context 10.7
3. GEOLOGICAL BACKGROUND 10.8
3.1. Sundays River Formation 10.11
3.2. Caenozoic sediments 10.11
4. PALAEONTOLOGICAL HERITAGE 10.20
4.1. Fossils in the Sundays River Formation 10.20
5.2. Fossils in Late Caenozoic alluvial deposits 10.22
5. CONCLUSIONS & RECOMMENDATIONS 10.32
6. ACKNOWLEDGEMENTS 10.33
7. REFERENCES 10.35
8. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR 10.39
APPENDIX 1: FOSSIL SITE DATA – JANUARY 2022 ..... 10.40
APPENDIX 2: CHANCE FOSSIL FINDS PROCEDURE:Remainder of Farm 632 near Addo 10.43

FIGURES:

Figure 1: Approximate location of the Sontule Citrus agricultural project study area (black rectangle) on the Remainder of Farm 632, situated near Dunbrody on the southern side of the Sundays River and the R336 tar road, c. 13 km southeast of Kirkwood and c. 15 km NW of Addo in the Sundays River Valley Municipality, Eastern Cape (Extract from 1: 250 000 topographical sheet 3324 Port Elizabeth, courtesy of The Chief Directorate: National Geo-spatial information, Mowbray). 10.3

Figure 2: Google Earth© satellite image of the Sontule Citrus project area on the Remainder of Farm 632 (orange polygon). 10.4

Figure 3: View northwards across the western sector of the Remainder of Farm 632 showing the flat, very gently N-sloping pediment surface on the skyline, gravelly hillslopes in the foreground and valley slopes clothed in dense subtropical thicket vegetation. 10.9

Figure 4: Most of the outcrop area of the Sundays River Formation along the escarpment slopes is mantled by colluvial gravels – Sundays River Formation sandstones and concretionary material, quartzite cobbles and pebbles from the Kuduskloof Formation – as well as thicket and soils. 10.9

Figure 5: Typical low-relief terrain on the upland plateau where the new citrus groves will be established with pervasive quartzitic eluvial surface gravels and sandy soils exposed in paths and clearings among dense thicket vegetation. 10.10

Figure 6: One of a few areas on the upland plateau that have been disturbed by quarrying for subsurface calcrete. 10.10

Figure 7: Extract from 1: 250 000 geological map 3324 Port Elizabeth (Council for Geoscience, Pretoria). The study area for the proposed Sontule Citrus agricultural project between Kirkwood and Addo in the Sundays River Valley, Eastern Cape (approximately indicated by the green rectangle) is underlain by Early Cretaceous marine sediments of the Sundays River Formation (Uitenhage Group) (Ks, red). A series of fluvial terrace gravel units of the Kudus Kloof Formation ("High Level Gravels") of Late Tertiary / Neogene age are also mapped here (T-Qg, yellow with red stipple) capping a stepped pediment surface incised into the Uitenhage Group bedrocks on the southern flanks of the Sundays River Valley. 10.12

Figure 8: Extract from map of High Level Terrace Gravels of the Sundays River published by Hattingh (2001, Appendix 2) showing the representatives of Terrace 5 (dark green), Terrace 6 (purple), Terrace 7 (mid blue), Terrace 8 (orange) and Terrace 9 (grey) alluvial gravels within the Sontule Citrus study area (black rectangle). These terrace gravels of inferred Middle to Late Pliocene age are now grouped within the Kudus Kloof Formation whose type area on Kudus Kloof 117 lies some 5 km further to the SE (Hattingh 1994). 10.13

Figure 9: Small quarry excavated into gently dipping, purplish-brown and khaki sediments of the Sundays River Formation in the NW sector of the project area. The reddish to purplish hues seen here suggest a nearby continental influence and are more typical of the Kirkwood Formation which crops out just to the west; the two formations may inter-finger here. 10.14

Figure 10: The grey-green to khaki siltstones and thin sandstones within the upper part of the Sundays River Formation succession illustrated above are highly fossiliferous and contain many large-scale ferruginous concretions (hammer = 30 cm) (Locs. 924 to 929). 10.14

Figure 11: Thick unit of pale brown, well-sorted sandstone with darker, brownish, ferruginous carbonate concretions overlain by a several dm-thick shelly coquina (arrowed), Sundays River Formation (hammer = 30 cm) (Loc. 935) (See also Fig. 33). 10.15

Figure 12: Hillslope exposure of in situ and slightly displaced blocks of brownish calcareous sandstone of the Sundays River Formation that contain abundant fossil mollusc assemblages and coquinas (Loc. 946) (See also Figures 31 & 32). 10.15

Figure 13: Well-calcretized, poorly-sorted, quartzitic alluvial gravels capping a pediment surface incised into Uitenhage Group bedrocks at c. 115 m amsl – possibly Terrace 4 of the alluvial Kuduskloof Formation of inferred Early Pliocene age. 10.16

Figure 14: Extension of the same calcretised unit of the Kuduskloof Formation shown in the previous figure, here showing a calcrete hardpan directly overlying thin, tabular sandstones of the Sundays River Formation (hammer = 30 cm). 10.16

Figure 15: Coarse, poorly-sorted, quartzitic terrace gravels of the Kuduskloof Formation at c. 100 m amsl – possibly Terrace 5 of inferred Middle Pliocene age (hammer = 30 cm). 10.17

Figure 16: Thick sandy calcrete hardpan exposed on the margins of a shallow quarry in the central sector of the Remainder of Farm 632 and capped by dark brown soils with abundant calcrete rubble (hammer = 30 cm). 10.17

Figure 17: Well-developed calcrete hardpan beneath gravelly brown soils exposed in a shallow quarry area in the south-eastern sector of the project area (hammer = 30 cm). 10.18

Figure 18: Test pits within the proposed citrus plantation project areas often expose a clacrete hard pan 30 to 50 cm beneath the surface, capped by sparsely gravelly, orange-brown sandy soils (hammer = 30 cm). 10.18

Figure 19: Test pit into coarse alluvial gravels and sands that mantle large portions of the citrus plantation project areas, here at c. 126 m amsl and possibly derived from Terrace 4 of the Kuduskloof Formation. 10.19

Figure 20: Bright orange-brown, only sparsely gravelly sandy soils which cover parts of the plateau area might, at least in part, be derived from modified aeolianites such as the Nanaga Formation which is typically rubified in the coastal interior. 10.19

Figure 21: Readily gullied, khaki to grey-green silty soils on lower hillslopes are derived from the underlying Sundays River Formation mudrocks and grade downwards into saprolite. 10.20

Figure 22: Fossil localities in the Sundays River Formation of the Algoa Basin near Addo (town marked by red triangle), with the present study area on the Remainder of Farm 632 near Dunbrody approximately indicated by a red rectangle. Several groups of marine invertebrates (molluscs, including bivalves, gastropods and ammonites, as well as serpulid worm tubes) are reported from Sundays River Formation beds on the flanks of the Sundays River Valley between Kirkwood and Addo, including the present study area, while various dinosaur and other vertebrate remains are recorded from Barclay Bridge to the south of Addo (Figure modified from McLachlan & Anderson 1976, their Fig. 8). 10.23

Figure 24: Articulated specimen of large, trigoniid bivalve apparently preserved in life position within siltstone facies (Loc. 929) (scale in cm). 10.24

Figure 25: Well-preserved valves of the small, thin-shelled oyster *Amphidonte* weathering out of siltstone facies of the Sundays River Formation. The largest shell seen here is 3.5 cm across (Loc. 929). ... 10.25

Figure 26: Stacks of superimposed *Amphidonte* oyster shells (scale in cm) (Loc. 929). 10.25

Figure 27: Dense cluster (c. 9 cm across) of *Amphidonte* oyster shells encrusting one another (Loc. 929). 10.26

Figure 28: Slab of brownish, gritty to pebbly calcareous sandstone containing comminuted shelly debris as well as probable reworked invertebrate burrow casts (see following figure for detail) (scale = 15 cm) (Loc. 926). 10.26

Figure 29: Close-up of rusty-brown, subcylindrical casts (0.5 cm wide, arrowed) of invertebrate burrows within the pebbly calcareous sandstone illustrated above (Loc. 926). 10.27

Figure 30: Small ferruginised woody stem axes preserved within pebbly calcareous sandstone facies (scale in cm and mm) (Loc. 925). 10.27

Figure 31: Thin pavement of wave-sorted, well-sorted, disarticulated bivalve shells preserved within brown-weathering calcareous sandstone (scale in cm and mm) (Loc. 947). 10.28

Figure 32: Comminuted shelly debris (largely bivalves) forming a shelly hash preserved within a brownish calcareous sandstone (scale in cm) (Loc. 946). 10.28

Figure 33: Thin, prominent weathering shelly bed within siltstone succession, with underlying apron of downwasted shells extending downslope (hammer = 30 cm) (Loc. 935). 10.29

Figure 34: Close-up of weathered-out bivalves from the shell bed illustrated above – mainly the thin-shelled oyster *Amphidonte* but also possible *Isognomon*, among other taxa (largest shell is c. 6 cm wide) (Loc. 935). 10.29

Figure 35a, b: Well-cemented cluster of intact and broken bivalve shells with detail of several shells seen in lower figure (scale in cm and mm) (Loc. 935). 10.30

Figure 36: Angular blocks of pale grey petrified log preserving fibrous woody fabric (scale in cm) (Loc. 930) (scale in cm and mm). These fossils suggest proximity to land and possible inter-tonguing of Kirkwood and Sundays River Formations in the study area. 10.31

Figure 37: Close-up of dense, dark-speckled Late Caenozoic calcrete hardpan from quarry area showing pale vermiform structures that *might* be fine root traces, or perhaps abiogenic (field of view c. 6 cm across) (Loc. 951). 10.31

Figure 38: Road cutting through well-consolidated, orange-brown sandy sediment showing incipient pale calcretisation around subfossil plant roots (hammer = 30 cm) (Loc 957). 10.32

Figure A1.1: Google Earth© satellite image of the Sontule Citrus project area on the Remainder of Farm 632 near Addo showing location of recently recorded fossil and subfossil sites. None of the fossil sites lies within the footprint of the proposed agricultural development and no mitigation is required in their regard. 10.42

EXECUTIVE SUMMARY

Sun Orange Farms (Pty) Ltd. is proposing the Sontule Citrus agricultural development on the Remainder of Farm 632, situated between Kirkwood and Addo in the Sundays River Valley Municipality, Eastern Cape Province. The project involves the establishment of new citrus orchards and associated infrastructure, including a new farm dam, irrigation infrastructure and internal roads on an existing citrus farm.

The Sontule Citrus agricultural project area is underlain at depth by fossiliferous marine sediments of the Sundays River Formation (Uitenhage Group) of Early Cretaceous age. Shelly invertebrate fossils have been previously recorded from the Cretaceous beds here in the scientific literature (e.g. McLachlan & McMillan 1976). During a recent one-day site visit several rich fossil sites yielding well-preserved bivalve molluscs as well as storm-generated coquinas (shell beds) of broken shelly remains and a few blocks of well-preserved petrified wood were recorded from small exposures of marine siltstones and calcareous sandstones along the low escarpment on the northern borders of the project area. However, none of these fossil sites lie within the project footprint and therefore no mitigation measures are recommended in their regard.

The proposed agricultural expansion will be situated in an undulating, gently sloping plateau area which has already been partly disturbed by agriculture, farm tracks and quarrying and is largely vegetated by dense subtropical thicket. The Cretaceous bedrocks here are entirely mantled by deep (several meters) alluvial deposits of the Late Caenozoic Kudus Kloof Formation. These sandy to gravelly sediments of inferred Pliocene age are often calcretised in the subsurface and are generally unfossiliferous. No fossil remains, apart from possible calcretised plant root traces of low scientific interest, were recorded within them.

Given (1) the small (partially disturbed) footprint of the proposed agricultural expansion, (2) the likely deeply weathered condition of the underlying Mesozoic bedrocks near-surface, as well as (3) the low palaeontological sensitivity of the overlying superficial sediments, the palaeontological heritage impact significance of all components of the proposed agricultural expansion (i.e. new blocks of citrus plantation, new dam, internal roads, irrigation pipeline etc) is assessed as LOW (negative) without mitigation. Current impacts on palaeontological heritage within the wider project area involve on-going destruction of newly exposed fossils by natural weathering and erosion processes (Impacts due to farming activities or illegal fossil collection here are likely to be negligible). This assessment applies to the individual project components as well as their anticipated cumulative impact.

There are no objections on palaeontological heritage grounds to authorisation of the proposed Sontule Citrus agricultural development. No further palaeontological heritage studies or specialist mitigation are required for the proposed developments, pending the potential discovery or exposure of any significant fossil remains (e.g. vertebrate bones and teeth, large blocks of petrified wood, shelly fossil horizons) during the construction phase. The ECO responsible for these developments should be alerted to the possibility of important fossil remains being found either on the surface or exposed by fresh excavations during construction.

Should fossil remains such as bones, shells or petrified wood be discovered during construction, these should be safeguarded (preferably in situ) and the ECO should alert the Eastern Cape Provincial Heritage Resources Authority (ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). This is so that appropriate mitigation (e.g. recording, sampling or collection) can be taken by a professional palaeontologist (See tabulated Chance Fossil Finds Procedure in Appendix 2 to this report). The specialist involved would require a collection permit from ECPHRA. Fossil material must be curated in an approved repository (e.g. museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013).

1. INTRODUCTION

The project applicant, Sun Orange Farms (Pty) Ltd., is proposing the Sontule Citrus agricultural development on parts of the Remainder of Farm 632 (c. 459 ha in total area), situated near Dunbrody on the southern side of the Sundays River and the R336 tar road, c. 13 km southeast of Kirkwood and c. 15 km NW of Addo in the Sundays River Valley Municipality, Eastern Cape Province (Figs. 1 & 2). The project involves the establishment of new citrus orchards and associated infrastructure (144 ha) including a new farm dam (~3ha), irrigation infrastructure and internal roads on an existing citrus farm.

The following project details have been provided by Public Process Consultants:

- **Proposed New Dam**

The Sontule citrus development will require the construction of a new dam on site which will be supplied with water from the LSRWUA canal system via an existing dam on the property.

- The existing dam has a capacity of 20 000m³
- The proposed new dam will be supplied with water from the existing dam via a 315mm uPVC pipe
- New dam specs:
  - Dam wall height 5 meters
  - Total proposed dam footprint ~31 800 m²
  - Estimated dam capacity ~49 000 m³
- New pumphouse (electrical consumption for pumps ~75kw)
- Relay water to orchards via pipes of varying sizes of either 250mm or 315mm uPVC pipe

- **Internal Irrigation Infrastructure**

Irrigation water will be supplied to the orchards via uPVC pipes varying in diameter from 250mm to 315mm. Irrigation water will be reticulated within the orchards via a network of underground pvc irrigation pipes and valves, with varying internal diameters (60mm to 160mm). The applicant proposes to utilise drip/ micro irrigation as the preferred method of water delivery to the trees within the orchards.

- **Electrical Infrastructure**

Pumping requirements will be 75kW for the existing dam and 30kW for the new (top) dam. A step-up transformer to be placed at the existing Eskom point with a cable to be placed in the same trench as the pipeline. A step-down transformer will be required at the proposed new dam. Electricity capacity is yet to be confirmed and will require written confirmation from Eskom.

- **Access**

Access to the site and proposed orchards will be from the existing gravel roads on the farm. The internal roads will be ~9m in width, but lengths will be confirmed in the Civil Engineering Services Report. A Traffic Impact Assessment has been undertaken by a traffic specialist to determine the suitability of the existing farm access to accommodate the additional generated traffic and the potential impact of the proposed development on the R336.

- **Footprint**

The footprint for the new dam will be 3.18 ha and the area proposed for clearing is approximately 144 ha and thus, dependent on the outcome of the various specialist assessments, a total clearance area of 147 ha is proposed. Approximately 321ha of natural area is remaining on the farm. However, portions thereof are anticipated to be unsuitable for development due to biophysical constraints such as unsuitable soils, steep slopes, drainage lines and the requirement to conserve a representative portion of the vegetation types identified on site in order to meet conservation targets.

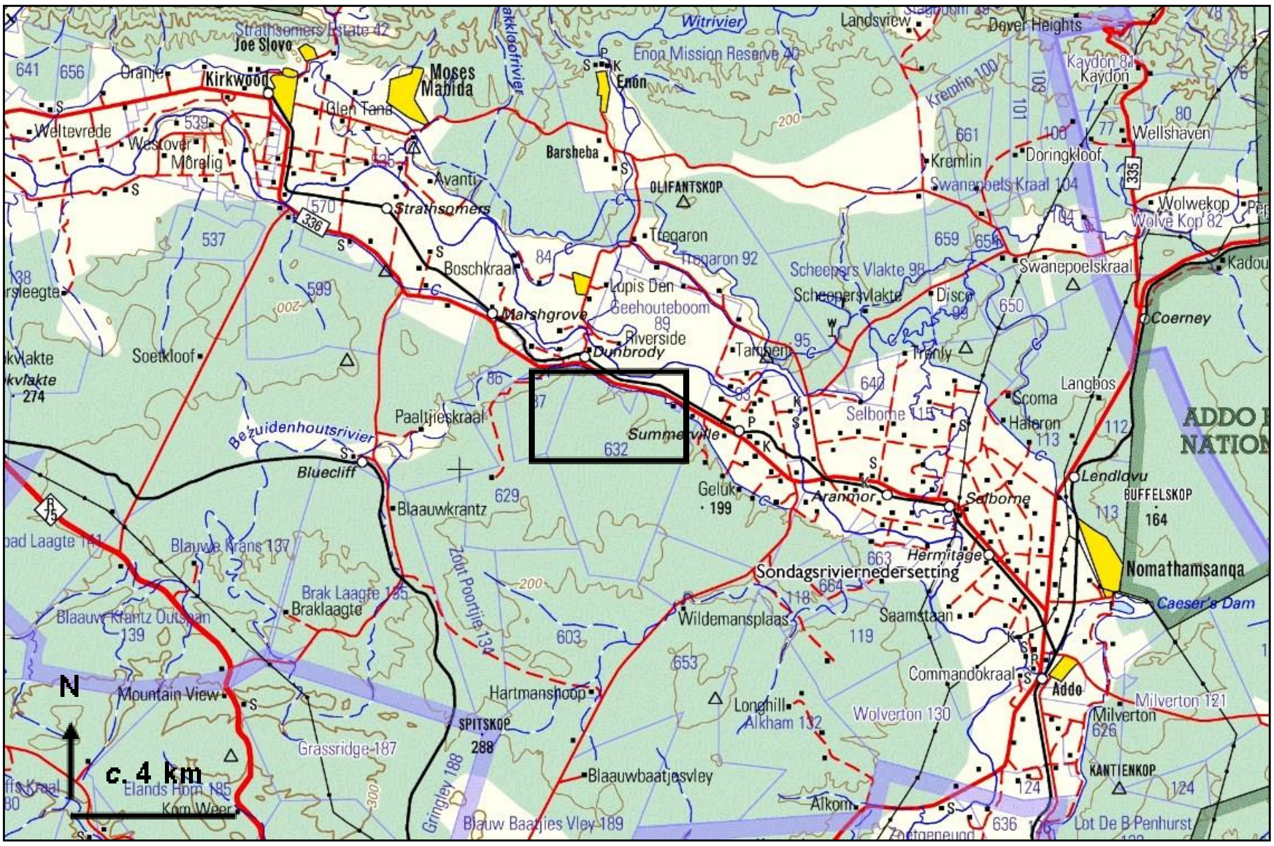


Figure 1: Approximate location of the Sontule Citrus agricultural project study area (black rectangle) on the Remainder of Farm 632, situated near Dunbrody on the southern side of the Sundays River and the R336 tar road, c. 13 km southeast of Kirkwood and c. 15 km NW of Addo in the Sundays River Valley Municipality, Eastern Cape (Extract from 1: 250 000 topographical sheet 3324 Port Elizabeth, courtesy of The Chief Directorate: National Geo-spatial information, Mowbray).

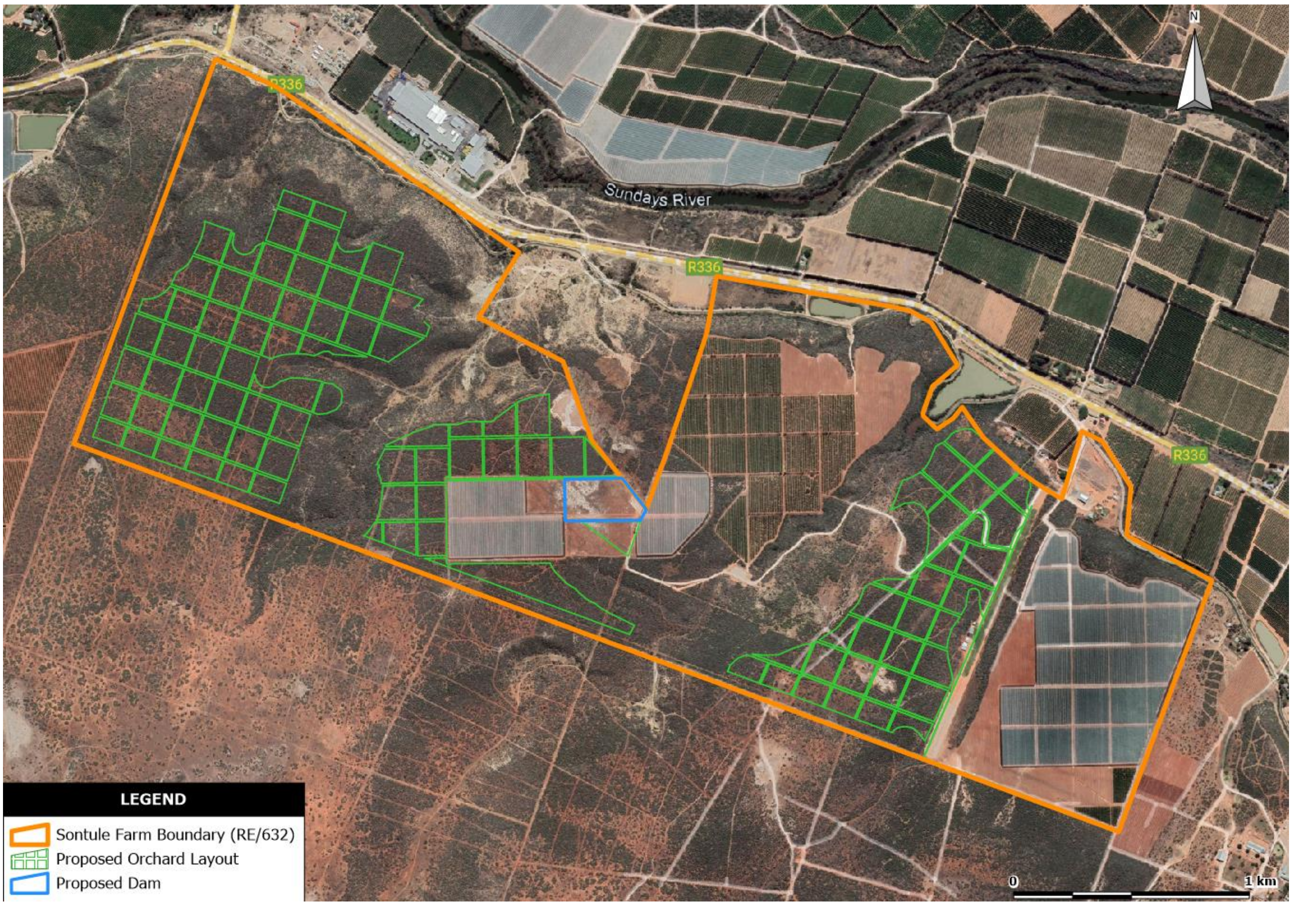


Figure 2: Google Earth© satellite image of the Sontule Citrus project area on the Remainder of Farm 632 (orange polygon).

The Sontule Citrus project area is underlain at depth by potentially fossiliferous sediments of the Sundays River Formation (Uitenhage Group) of Early Cretaceous age. In accordance with the National Heritage Resources Act, 1999, a palaeontological heritage assessment is required as part of a Heritage Impact Assessment for such projects, since important fossil material of scientific and conservation value has previously been recorded from the Kirkwood – Addo region area within this formation (e.g. McLachlan & McMillan 1976).

The present PIA (Palaeontological Impact Assessment) report has accordingly been commissioned as part of the EA Process on behalf of the applicant by the Independent Environmental Assessment Practitioners Public Process Consultants (Contact details: Ms Sandra Wren, Public Process Consultants, 120 Diaz Road, Adcockvale, Port Elizabeth 6001. Phone: 041 374 8426. Cell: 082 4909 828. E-mail: sandy@publicprocess.co.za).

1.1. Legislative context of this palaeontological study

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (1999) include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:

(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
(4) No person may, without a permit issued by the responsible heritage resources authority—
(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and
(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports have been developed by SAHRA (2013).

2. APPROACH TO THE PALAEONTOLOGICAL HERITAGE ASSESSMENT

This combined desktop and field-based PIA study was based on the following information sources:

1. A short project outline, kmz files and maps provided by Public Process Consultants;

2. A review of the relevant scientific literature, including published topographical maps (1: 50 000 scale map 3325BC Bersheba, 1: 250 000 scale map 3324 Port Elizabeth), geological maps (sheet 3324 Port Elizabeth, Council for Geoscience, Pretoria and the associated short sheet explanation by Toerien & Hill 1989), Google Earth© satellite images, and several previous palaeontological heritage assessments in the region (See Almond in References);

3. A one-day site visit by the author and an experienced assistant on 27 January 2022.

4. The author's database on the formations concerned and their palaeontological heritage (cf Almond et al. 2008).

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations etc) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following field assessment during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development. The potential impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (e.g. sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authority, i.e. the Eastern Cape Provincial Heritage Resources Authority, ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). It should be emphasized that, providing appropriate mitigation is carried out, the majority of developments involving bedrock excavation can make a positive contribution to our understanding of local palaeontological heritage.

2.1. Assumptions & limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil etc), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information;

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (e.g. of commercial mining companies) - that is not readily available for desktop studies;

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:

(a) underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

(b) overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium etc).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails inferring the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist.

In the case of the proposed Sontule Citrus agricultural project the major limitation for fossil heritage assessment is the low level of Mesozoic bedrock exposure due to extensive cover by largely unfossiliferous superficial sediments as well as the limited access to many parts of the study area because of the dense thicket vegetation. However, sufficient sedimentary rock exposures were examined during the course of the one-day site visit, supported by several previous field-based palaeontological heritage studies in the wider region, to allow an adequate assessment of the potential impacts of the proposed development.

2.2. Legislative context

The present combined desktop and field-based palaeontological heritage report falls under Sections 35 and 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999), and it will also inform the EMPr for this project.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act include, among others:
- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:
(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
(2) All archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
(4) No person may, without a permit issued by the responsible heritage resources authority—
  (a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
  (b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and
(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have been published by SAHRA (2013) and by Heritage Western Cape (2021).

3. GEOLOGICAL BACKGROUND

The Sontule Citrus agricultural project area on the Remainder of Farm 632 is situated on the southern side of the Sundays River near Dunbrody, midway between Kirkwood and Addo and just east of the tributary valley of the Bezuidenhoutsrivier (Figs. 1 & 2). It largely comprises gently undulating terrain on a broadly north-sloping pediment surface at elevations of c. 100-150 m amsl. (Figs. 3 to 6). This upland area is partly disturbed by farm tracks, existing citrus plantations and a few small quarries; most of the remainder – where the new citrus orchards will be established - is clothed in dense subtropical thicket vegetation with narrow pathways and small clearings. Bedrock exposure in this upland area is almost non-existent. A gently sloping, N-facing escarpment between c. 70 and 100 m amsl. incised by small stream valleys runs along the margins of the pediment plateau. Most of the escarpment slopes are clothed in thicket vegetation and mantled by gravelly soils and scree. Uitenhage Group bedrocks – the main target for the present palaeontological study - are exposed here and there in small footslope quarries and lower-lying areas incised by gully erosion.

The geology of the Kirkwood – Addo region of the Sundays River Valley is shown on 1: 250 000 geological map 3324 Port Elizabeth (Council for Geoscience, Pretoria; Toerien & Hill 1989) (Fig. 7). The present study area lies towards the northern edge of the extensive Algoa Basin which is infilled with a 3.5 km-thick succession of alluvial fan, fluvial and estuarine to marine shelf sediments of Late Jurassic to Early Cretaceous age (c. 150-125 Ma) that are referred to as the Uitenhage Group (McLachlan & Anderson 1976, Shone 2006). The Remainder of Farm 632 is entirely underlain at depth by marine sediments of the Sundays River Formation (Ks, red in map Fig. 7). These marine beds interfinger along the basin margin to the north, west and south, outside the project area, with continental facies of the Kirkwood Formation (J-Kk, orange in Fig. 7). Sandy to gravelly alluvial terrace deposits ("High Level Gravels") of Late Caenozoic (Miocene to Recent) age that are assigned to the Kudus Kloof Formation mantle the Mesozoic Uitenhage Group bedrocks across the higher lying parts of the project area. The type area for this formation is located on the farm Kudus Kloof 117 which lies some 5 km to the SE of the present study area (Hattingh 1994) (Fig. 8).

Figure 3: View northwards across the western sector of the Remainder of Farm 632 showing the flat, very gently N-sloping pediment surface on the skyline, gravelly hillslopes in the foreground and valley slopes clothed in dense subtropical thicket vegetation.

Figure 4: Most of the outcrop area of the Sundays River Formation along the escarpment slopes is mantled by colluvial gravels – Sundays River Formation sandstones and concretionary material, quartzite cobbles and pebbles from the Kuduskloof Formation – as well as thicket and soils.

Figure 5: Typical low-relief terrain on the upland plateau where the new citrus groves will be established with pervasive quartzitic eluvial surface gravels and sandy soils exposed in paths and clearings among dense thicket vegetation.

Figure 6: One of a few areas on the upland plateau that have been disturbed by quarrying for subsurface calcrete.

3.1. Sundays River Formation

The Sundays River Formation is of Early Cretaceous (Valanginian-Hauterivian) age, i.e around 140-130 Ma (million years old). It comprises a thick (up to 2 km) succession of thin-bedded, grey-green sandstones, siltstones and finer-grained mudrocks that are often highly fossiliferous (Shone 2006). Depositional settings range from estuarine through littoral (shoreline) to marine outer shelf (McMillan 2003). These beds are differentiated from the older to contemporaneous Kirkwood Formation of the Uitenhage Group by (a) the absence of reddish-hued mudrocks, (b) the presence of prominent-weathering calcareous sandstones, and (c) the frequent occurrence of fossil marine shells. These last are commonly, but not invariably, associated with the thin, calcareous sandstone beds, many of which are tempestites (i.e. storm deposits). Various members within the Sundays River succession have been identified from borehole data (Cooper 2018). Key geological accounts of the Sundays River Formation include those by Du Toit (1954), Rigassi & Dixon (1972), Winter (1973), McLachlan & McMillan (1976), Tankard et al. (1982), Dingle et al., (1983), McMillan (2003) and Shone (1976, 2006). For the study area the geological sheet explanations by Haughton (1928), Engelbrecht et al. (1962), Toerien and Hill (1989) and Le Roux (2000) are most relevant.

Uitenhage Group bedrocks are only exposed in small quarry and gullied areas in the escarpment zone while stream valley floor outcrops elsewhere are completely covered by gravelly colluvium, soil and vegetation. The best exposures are seen just west of a small cluster of houses towards the northern edge of the study area (Figs. 9 & 10). Here gently dipping, tabular bedded, gullied purple grey, grey-green to khaki massive siltstones with horizons of blocky-weathering, coffee-brown ferruginous diagenetic concretions (some septarian) pass upwards into a zone with thin (up to a few dm), pale brownish-weathering, thinly and flat-laminated sandstone interbeds. The reddish to purplish hues seen lower down in the succession suggest a nearby continental influence and are more typical of the Kirkwood Formation which crops out just to the west, while abundant shelly fossils (Section 4) are mainly associated with more typical Sundays River grey-green beds above. In the same sector of the farm can be seen thick (several m), medium-bedded, well-sorted, pale brown sandstone packages associated with dark brown-patinated ferruginous carbonate concretions, overlain by interbedded siltstones and thin sandstones with banks of shelly coquina ("shell beds") (Fig. 11) as well as well-jointed benches of tough, dark brown calcareous sandstone containing comminuted shelly debris and thin shelly coquinas (Fig. 12).

3.2. Caenozoic sediments

Sandy to gravelly alluvial deposits of the Kudus Kloof Formation have been described by Hattingh (1994) and mapped in detail along the Sundays River Valley by Hattingh (2001) (Fig. 8). Representatives of Terrace 5 (dark green in Fig. 8), Terrace 6 (purple), Terrace 7 (mid blue), Terrace 8 (orange) and Terrace 9 (grey) are mapped within the Sontule Citrus study area. These terrace gravels are of inferred Middle to Late Pliocene age. The various gravel subunits are not readily distinguished on the ground, however, and they have often been modified by erosional downwasting. Occasional relict banks of coarse, clast-supported Kudus Kloof alluvial conglomerates are visible on hillslopes (Fig. 15). Some of the denser gravel layers may be eluvial / remanié deposits that have been condensed by downwasting from thicker gravel-containing sand bodies. The gravels are generally poorly sorted, subrounded to well-rounded and oligomict; they are predominantly composed of grey to brownish Cape Supergroup quartzite with occasional darker brown Sundays River sandstone clasts.

A well-developed horizon of heavily calcretised, non-shelly, poorly-sorted breccio-conglomerates of the Kudus Kloof Formation occurs at c.115 m amsl along the northern edge of the project area where it directly overlies a package of tabular-bedded, olive-green Sundays River Formation sandstone and blocky-weathering, grey green siltstones (Figs. 13 & 14). The conglomerate clasts are mainly subrounded to well-rounded quartzite pebbles, cobbles and boulders but locally blocks of reworked olive green sandstone are incorporated within the calcretised sandstone matrix. Calcrete veins penetrate downwards between the bedrock layers. Based on its elevation, this horizon may correspond to the Early Pliocene T4 terrace (115-125 m amsl) of Hattingh (2001). The extensive calcrete quarry at a similar to slightly higher elevation (c. 120 m amsl) (Fig. 6) may be related to the same alluvial terrace. Calcretised aeolianites and not just alluvium might also be represented here. The several meter thick, dense calcrete zone shows a greenish speckling, floating gritty grains and fine veins (Fig. 37); it is probably a composite unit and is capped by brown soils packed with calcrete rubble (Fig. 16).

Some test pits on the upland plateau expose sandy to bouldery alluvial sediments with interstitial calcrete derived from modified Kudus Kloof alluvium. Elsewhere deep, only sparsely gravelly orange-brown sandy soils might, at least in part, represent modified aeolian sands (cf Pliocene aeolianites and calcarenites of the Nanga Formation, Algoa Group, which are often secondarily rubified) (Fig. 20). They are best exposed in test pits where a well-developed subsurface calcrete hard pan at a depth of c.30-50 cm may sometimes be seen (Figs. 18 & 19). Flaked quartzite artefacts are common among the overlying surface gravels. Reworked colluvial gravels of quartzite, Sundays River sandstone and concretionary debris, calcrete blocks and saprolitic sandy to silty soils mantle the escarpment slopes which are underlain by Uitenhage Group bedrocks (Fig. 4).

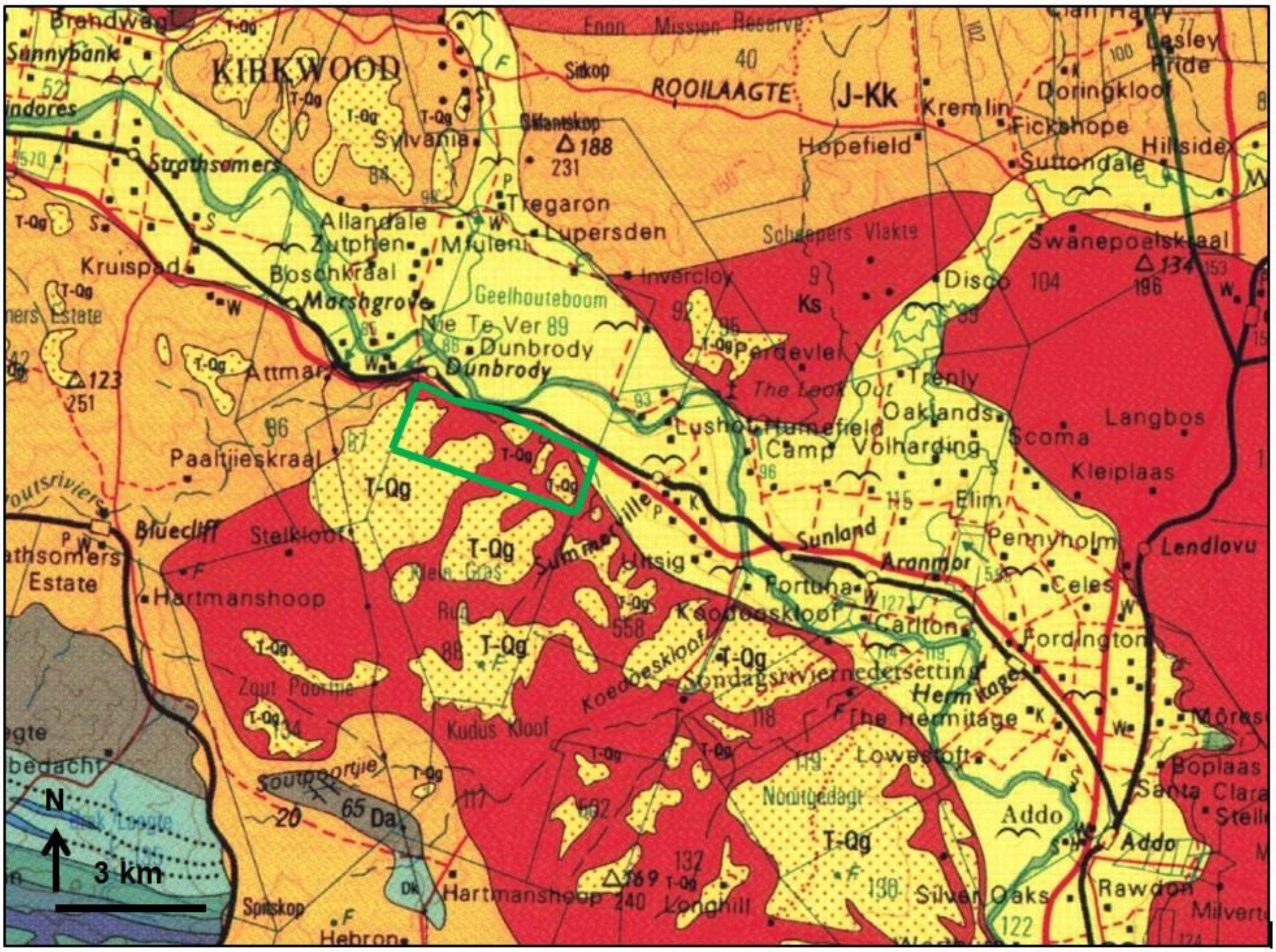


Figure 7: Extract from 1: 250 000 geological map 3324 Port Elizabeth (Council for Geoscience, Pretoria). The study area for the proposed Sontule Citrus agricultural project between Kirkwood and Addo in the Sundays River Valley, Eastern Cape (approximately indicated by the green rectangle) is underlain by Early Cretaceous marine sediments of the Sundays River Formation (Uitenhage Group) (Ks, red). A series of fluvial terrace gravel units of the Kudus Kloof Formation ("High Level Gravels") of Late Tertiary / Neogene age are also mapped here (T-Qg, yellow with red stipple) capping a stepped pediment surface incised into the Uitenhage Group bedrocks on the southern flanks of the Sundays River Valley.

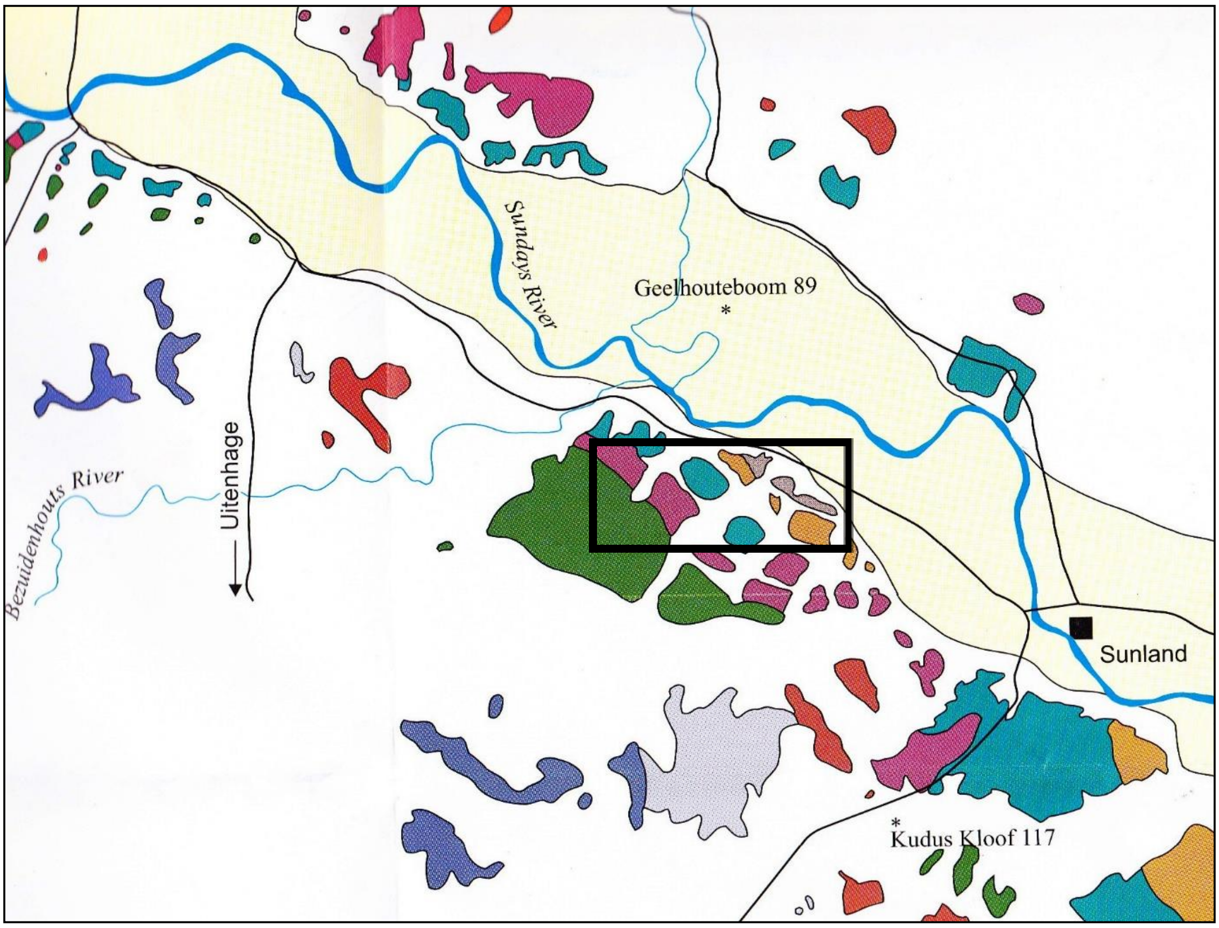


Figure 8: Extract from map of High Level Terrace Gravels of the Sundays River published by Hattingh (2001, Appendix 2) showing the representatives of Terrace 5 (dark green), Terrace 6 (purple), Terrace 7 (mid blue), Terrace 8 (orange) and Terrace 9 (grey) alluvial gravels within the Sontule Citrus study area (black rectangle). These terrace gravels of inferred Middle to Late Pliocene age are now grouped within the Kudus Kloof Formation whose type area on Kudus Kloof 117 lies some 5 km further to the SE (Hattingh 1994).

Figure 9: Small quarry excavated into gently dipping, purplish-brown and khaki sediments of the Sundays River Formation in the NW sector of the project area. The reddish to purplish hues seen here suggest a nearby continental influence and are more typical of the Kirkwood Formation which crops out just to the west; the two formations may inter-finger here.

Figure 10: The grey-green to khaki siltstones and thin sandstones within the upper part of the Sundays River Formation succession illustrated above are highly fossiliferous and contain many large-scale ferruginous concretions (hammer = 30 cm) (Locs. 924 to 929).

Figure 11: Thick unit of pale brown, well-sorted sandstone with darker, brownish, ferruginous carbonate concretions overlain by a several dm-thick shelly coquina (arrowed), Sundays River Formation (hammer = 30 cm) (Loc. 935) (See also Fig. 33).

Figure 12: Hillslope exposure of in situ and slightly displaced blocks of brownish calcareous sandstone of the Sundays River Formation that contain abundant fossil mollusc assemblages and coquinas (Loc. 946) (See also Figures 31 & 32).

Figure 13: Well-calcretized, poorly-sorted, quartzitic alluvial gravels capping a pediment surface incised into Uitenhage Group bedrocks at c. 115 m amsl – possibly Terrace 4 of the alluvial Kuduskloof Formation of inferred Early Pliocene age.

Figure 14: Extension of the same calcretised unit of the Kuduskloof Formation shown in the previous figure, here showing a calcrete hardpan directly overlying thin, tabular sandstones of the Sundays River Formation (hammer = 30 cm).

Figure 15: Coarse, poorly-sorted, quartzitic terrace gravels of the Kuduskloof Formation at c. 100 m amsl – possibly Terrace 5 of inferred Middle Pliocene age (hammer = 30 cm).

Figure 16: Thick sandy calcrete hardpan exposed on the margins of a shallow quarry in the central sector of the Remainder of Farm 632 and capped by dark brown soils with abundant calcrete rubble (hammer = 30 cm).

Figure 17: Well-developed calcrete hardpan beneath gravelly brown soils exposed in a shallow quarry area in the south-eastern sector of the project area (hammer = 30 cm).

Figure 18: Test pits within the proposed citrus plantation project areas often expose a clacrete hard pan 30 to 50 cm beneath the surface, capped by sparsely gravelly, orange-brown sandy soils (hammer = 30 cm).

Figure 19: Test pit into coarse alluvial gravels and sands that mantle large portions of the citrus plantation project areas, here at c. 126 m amsl and possibly derived from Terrace 4 of the Kuduskloof Formation.

Figure 20: Bright orange-brown, only sparsely gravelly sandy soils which cover parts of the plateau area might, at least in part, be derived from modified aeolianites such as the Nanaga Formation which is typically rubified in the coastal interior.

Figure 21: Readily gullied, khaki to grey-green silty soils on lower hillslopes are derived from the underlying Sundays River Formation mudrocks and grade downwards into saprolite.

4. PALAEONTOLOGICAL HERITAGE

The fossil record of the main sedimentary rock units represented within the study area on the Remainder of Farm 632 is outlined here, together with any new palaeontological data based on the recent site visit. GPS locality details of numbered fossil sites mentioned in the test and figure legends are tabulated in Appendix 1 of this chapter.

4.1. Fossils in the Sundays River Formation

In palaeontological terms the Sundays River Formation (Uitenhage Group) contains one of the most prolific and scientifically important marine biotas of Mesozoic age in southern Africa (See brief review by Almond 2010, from which the following section is largely abstracted). Fossils have been recorded from the Sundays River beds in the Algoa Basin since the early nineteenth century (1837). Cooper (1981) provides a good review of the earlier literature. Important collections were made, for example, by the famous Eastern Cape geologists W.G. Atherstone and A.G. Bain (see Sharpe 1856) and there has been a long history of palaeontological publications dealing with the Sundays River fauna since then. Among the key papers are those by Sharpe (1856), Kitchin (1908), Spath (1930), Du Toit (1954), Engelbrecht et al. (1962), Haughton (1969), McLachlan & McMillan (1976, 1979), Klinger & Kennedy (1979), Cooper (1981, 1991), Dingle et al. (1983), McMillan (2003) and Shone (1986, 2006). Well-illustrated accounts of Sundays River fossils have been given by MacRae (1999) and Cooper (2018). The ammonites and microfossils are of particular biostratigraphic (rock dating) importance, while the foraminiferans (a group of protozoans) are useful for palaeoenvironmental analysis (See extensive discussion in McMillan 2003). Despite the long history of palaeontological work on Sundays River fossils, there has been little systematic collection of fossils – especially macrofossils - from these beds in recent decades and most taxa remain poorly studied (e.g. most invertebrate groups, apart from the ammonites, trigoniid bivalves and foraminiferans). Much further research remains to be done here, however, and a lot of palaeontologically valuable material is undoubtedly being destroyed in the currently active brick pits in the Algoa Basin region.

The main invertebrate macrofossils recorded from the Sundays River Formation are a rich variety of molluscs. These include several cephalopod subgroups - mainly ammonites, plus much rarer nautiloids and belemnites. The cephalopod fauna has been revised recently by Cooper (1981, 1983) and is dominated by a series (14 spp.) of strongly ribbed, coiled ammonites of the Genus Olcostephanus, also well-known from Early Cretaceous marine faunas elsewhere in the world. Interestingly, clear examples of well-developed sexual dimorphism (male and female shells of different size and form) are shown in this genus. Much rarer partially coiled ammonites (Distoloceras) and straight-shelled, obliquely ribbed forms (Bochianites) also occur.

The Sundays River molluscs include a number of mainly small-bodied gastropods (c. 6 genera, including limpets), and over forty genera of bivalves (mussels, clams etc). In terms of abundance as well as biodiversity the bivalve molluscs are also the dominant group. The commonest form is the thick-shelled “Devil’s toenail” oyster Aetostreon (previously known as Exogyra or Gryphaea) which is often preserved in dense coquinas (shell beds) at the base of storm sandstones. Some of the other bivalves, such as the strongly–ribbed or knobbed trigoniids (eleven species in seven genera, recently revised by Cooper 1979, 1991) and the elongate-shelled Gervillella – all shallow infaunal forms - are also quite substantial (20-30 cm long or more) with robust shells. Encrusting oysters cemented onto shells, rocks or hardgrounds are common (e.g. Amphidonte). Dense storm-transported accumulations of scaphopod molluscs (tusk shells) were discovered during a recent field study by Almond (2011). Most of these South African fossils are badly in need of taxonomic and palaeobiological revision along the lines of recent work on similar-aged South America molluscs by Lazo (2007 and earlier papers).

More minor invertebrates – including stenohaline as well as euryhaline taxa - from the Sundays River Formation are solitary and branching colonial corals, tube-dwelling serpulid polychaetes, bryozoans, echinoderms (usually fragmentary crinoids or sea lilies, ophiuroids or brittle stars, sea cucumbers, regular echinoids) and shrimp-like crustaceans. However, more intensive collecting from these beds is likely to reveal further invertebrate taxa. This is suggested by the recent discovery of two new crustaceans (including several specimens of strongly tuberculate crabs) within Sundays River concretions (Dr Billy de Klerk, pers. comm., 2010), the scaphopods or tusk shells mentioned earlier, and recent new records of beetle remains south of Addo (Mostovski & Muller 2010). Sundays River trace fossils are poorly studied, but are locally abundant. They range from dense banks of cylindrical intrasediment burrows to a range of borings into wood, shells and hardgrounds (i.e. cemented substrata on the sea floor including, for example, exhumed early diagenetic concretions). A spectrum of microfossils from this stratigraphic unit include foraminiferans, ostracods, dinoflagellates and land-derived pollens and spores (Dingle et al. 1983, McMillan 2003). Among the rarer microfossil groups recorded are radiolarians, seed shrimps, and fragments of echinoderms (ossicles of crinoids, ophiuroids, holothurians and echinoids).

The Sundays River beds contain sparse, often unidentifiable plant fossils such as fragments of driftwood (sometimes insect- or perhaps mollusc-bored), leaf and twig debris, amber (fossil resin), lignite, charcoal and the reproductive structures of charophyte algae (stoneworts). Fossil vertebrates from the Sundays River Formation are very rare indeed. The best-known example is the partial skeleton of a 3 m-long plesiosaur (an extinct group of large marine reptiles), Leptocleidus capensis. This comes from the famous, but poorly-localized, site of Picnic Bush on the Swartkops River near Port Elizabeth (Andrews 1910; see MacRae 1999 and Cooper 2018 for good illustrations). Isolated dinosaur bones and teeth have also been mentioned (e.g. a dinosaur vertebra from Barkly Bridge south of Addo; Engelbrecht et al. 1962), though several earlier records probably stem from the older Kirkwood Formation. Gess (undated report) recently reported small vertebrate remains associated with marine molluscs and drift-wood from a site in the Sundays River Valley.

Early records of Cretaceous fossil remains from the Sundays River Formation of the Algoa Basin near Addo – including several reports of fossil molluscs (ammonites, bivalves, gastropods) as well as tubiculous serpulid worms - have been collated by McLachlan and Anderson (1976) (Fig. 32). They include records of various molluscan taxa along the low, north-facing riverine escarpment near Dunbrody, close to or within the present study area. Cretaceous fossils recorded during a recent field survey on Vissers Vale 96 some three kilometres to the east by Almond (2019) included a range of molluscan taxa associated with thin (20 cm or less thick), lenticular shelly coquinas within cliff and riverbank exposures of both siltstone and sandstone facies of the Sundays River Formation. The coquinas are made up of disarticulated and broken shells and are dominated by various oysters such as the encrusting Amphidonte / Ceratostreon, the toenail-shaped, free-living Aetostreon as well as rarer strongly-ornamented trigoniid bivalves.

Locally abundant, mollusc-dominated marine shelly fossil assemblages are recorded from a few small exposures of sandstone and mudrock facies along the Sundays River Formation escarpment in the north-central portion of the Sontule Citrus project area on the Remainder of Farm 632 (See fossil sites mapped in Figure A1 in Appendix 1). It is likely that fossils occur widely in this escarpment zone. Shelly coquinas in the higher portions of the Sundays River Formation succession here are commonly associated with thin, medium to coarse-grained, calcareous sandstone units, comprising comminuted shell debris, especially of various bivalve molluscs, as well as intact but usually disarticulated valves (Figs. 28, 31 & 32). Original shell material is usually preserved, but mouldic preservation within calcareous sandstone is also seen. Thin shell pavements are made of closely-packed, similarly orientated valves. Thin pebbly conglomeratic lenses contain shelly material as well as occasional fragments of ferruginized woody stem axes and subcylindrical rusty-brown bodies that possibly represent reworked, secondarily mineralized burrow casts (0.5 cm wide) (Figs. 29 & 30). Silty mudrock packages contain locally common, thick-shelled trigoniid bivalves (some specimens articulated and possibly in life position, others preserved within disgenetic nodules) and thin-shelled, irregularly shaped oysters (Amphidonte) (Figs. 23 & 26). The latter are variously preserved freely within the silty matrix, in compact clumps or stacks encrusting oyster or other shells, or affixed to hard substrates such as calcareous sandstones and carbonate concretions, some of which were exposed as hardgrounds on the sea floor. Impressive shelly coquinas up to a decimeter or so thick within siltstone packages contain myriads of loose to mutually consolidated mollusc valves (Amphidonte, trigoniids, Pinna, possible Mytiloperna, Isognomon etc) (Figs. 11, 33 to 35).

Local concentrations of angular blocks of pale greyish petrified wood preserving fibrous wood fabric (Fig. 36) are more typical of the Kirkwood Formation (“Wood Beds”). These fossils, as well as the purplish and reddy hues of some of the nearby siltstone exposures suggest that inter-tonguing of continental Kirkwood and marine Sundays River facies occurs in this area; the contact between these rock units is mapped just to the west of the Remainder of Farm 632 (Fig. 7).

5.2. Fossils in Late Caenozoic alluvial deposits

Neogene to Recent colluvial, alluvial and lag gravel, sand and clay deposits may also contain fossil remains of various types. In coarser sediments like river conglomerates these tend to be robust, highly disarticulated and abraded (e.g. rolled bones, teeth of vertebrates) but well-preserved skeletal remains of plants (e.g. wood, roots) and invertebrate animals (e.g. freshwater molluscs and crustaceans) as well as various trace fossils may be found within fine-grained alluvium. Embedded human artefacts such as stone tools that can be assigned to a specific interval of the archaeological time scale (e.g. Middle Stone Age) can be of value for constraining the age of Pleistocene to Recent drift deposits like alluvial terraces. Ancient to modern “High Level Gravels” tend to be coarse and to have suffered extensive reworking (e.g. winnowing and erosional downwasting), so they are generally unlikely to contain useful fossils. No fossils are reported from the Kudus Kloof Formation by Hattingh (1994, 2001); these fluvial terraces are dated by reference to correlated fossiliferous marine terraces along the coast. Fine-grained carbonaceous muds associated with vlei areas may contain peats, palynomorphs (pollens, spores) and other microfossils as well as the bones and teeth of mammals and other fauna that died in the area.

No gastropod shells or other body fossils were observed within the well-developed calcretes observed in elevated plateau areas on the Remainder of Farm 632. Narrow vermiform structures within dense calcrete might represent root traces (rhizoliths) (Fig. 37) while possible indications of possible meniscate back-filled burrows were also seen. Incipient calcretisation focused around subfossil plant roots is seen in road cuttings through older sandy soils (Fig. 38) while soils elsewhere occasionally contain subfossil shells of the large land snail Cochlitoma ("Achatina"), sometimes retaining faint colour markings.

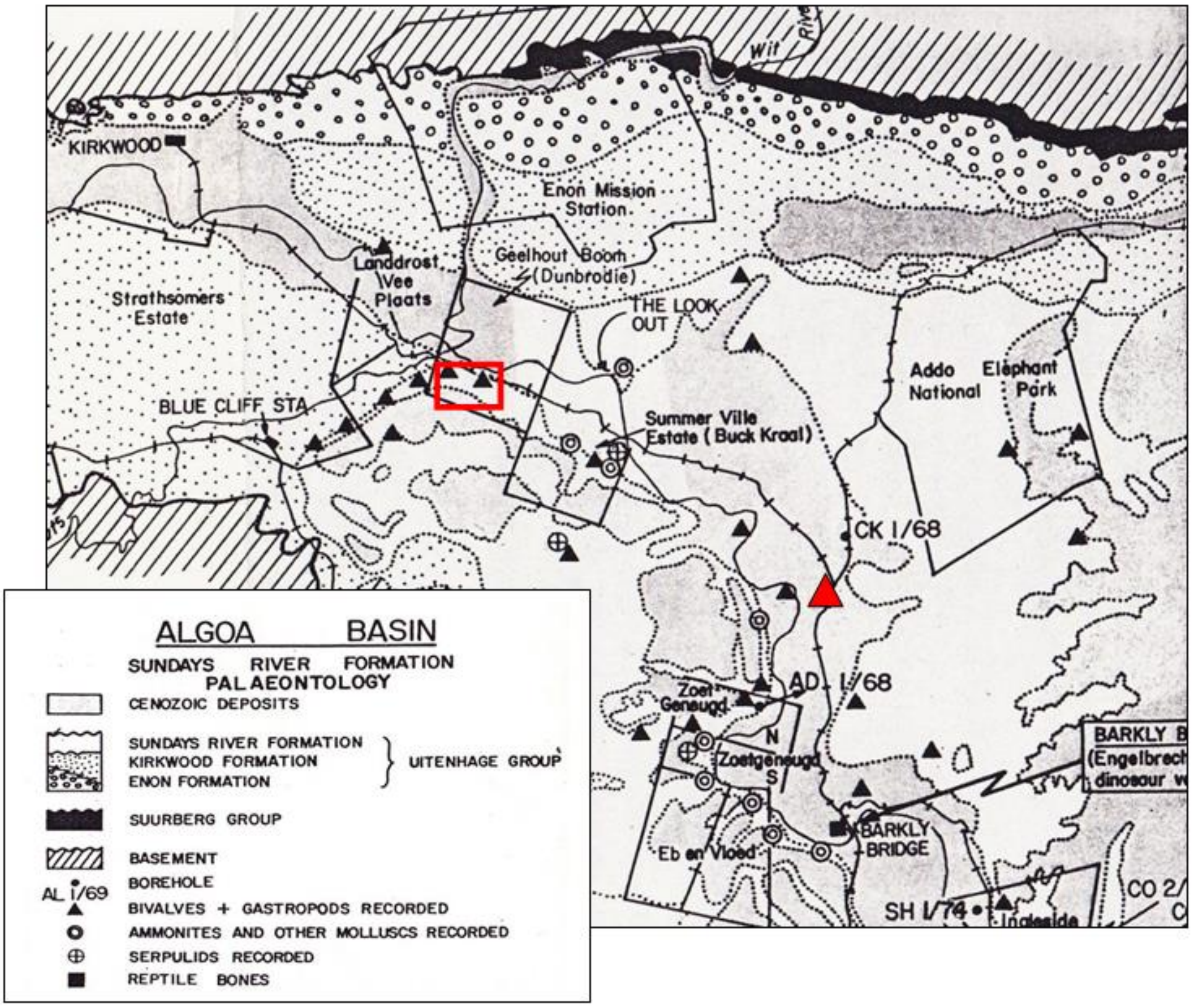


Figure 22: Fossil localities in the Sundays River Formation of the Algoa Basin near Addo (town marked by red triangle), with the present study area on the Remainder of Farm 632 near Dunbrody approximately indicated by a red rectangle. Several groups of marine invertebrates (molluscs, including bivalves, gastropods and ammonites, as well as serpulid worm tubes) are reported from Sundays River Formation beds on the flanks of the Sundays River Valley between Kirkwood and Addo, including the present study area, while various dinosaur and other vertebrate remains are recorded from Barclay Bridge to the south of Addo (Figure modified from McLachlan & Anderson 1976, their Fig. 8).

Figure 23: Concentration of thick-shelled, strongly ornamented, articulated and disarticulated trigoniid bivalves enclosed within a concretionary zone within siltstone facies of the Sundays River Formation (Loc. 928) (scale in cm and mm).

Figure 24: Articulated specimen of large, trigoniid bivalve apparently preserved in life position within siltstone facies (Loc. 929) (scale in cm).

Figure 25: Well-preserved valves of the small, thin-shelled oyster *Amphidonte* weathering out of siltstone facies of the Sundays River Formation. The largest shell seen here is 3.5 cm across (Loc. 929).

Figure 26: Stacks of superimposed *Amphidonte* oyster shells (scale in cm) (Loc. 929).

Figure 27: Dense cluster (c. 9 cm across) of *Amphidonte* oyster shells encrusting one another (Loc. 929).

Figure 28: Slab of brownish, gritty to pebbly calcareous sandstone containing comminuted shelly debris as well as probable reworked invertebrate burrow casts (see following figure for detail) (scale = 15 cm) (Loc. 926).

Figure 29: Close-up of rusty-brown, subcylindrical casts (0.5 cm wide, arrowed) of invertebrate burrows within the pebbly calcareous sandstone illustrated above (Loc. 926).

Figure 30: Small ferruginised woody stem axes preserved within pebbly calcareous sandstone facies (scale in cm and mm) (Loc. 925).

Figure 31: Thin pavement of wave-sorted, well-sorted, disarticulated bivalve shells preserved within brown-weathering calcareous sandstone (scale in cm and mm) (Loc. 947).

Figure 32: Comminuted shelly debris (largely bivalves) forming a shelly hash preserved within a brownish calcareous sandstone (scale in cm) (Loc. 946).

Figure 33: Thin, prominent weathering shelly bed within siltstone succession, with underlying apron of downwasted shells extending downslope (hammer = 30 cm) (Loc. 935).

Figure 34: Close-up of weathered-out bivalves from the shell bed illustrated above – mainly the thin-shelled oyster *Amphidonte* but also possible *Isognomon*, among other taxa (largest shell is c. 6 cm wide) (Loc. 935).

Figure 35a, b: Well-cemented cluster of intact and broken bivalve shells with detail of several shells seen in lower figure (scale in cm and mm) (Loc. 935).

Figure 36: Angular blocks of pale grey petrified log preserving fibrous woody fabric (scale in cm) (Loc. 930) (scale in cm and mm). These fossils suggest proximity to land and possible inter-tonguing of Kirkwood and Sundays River Formations in the study area.

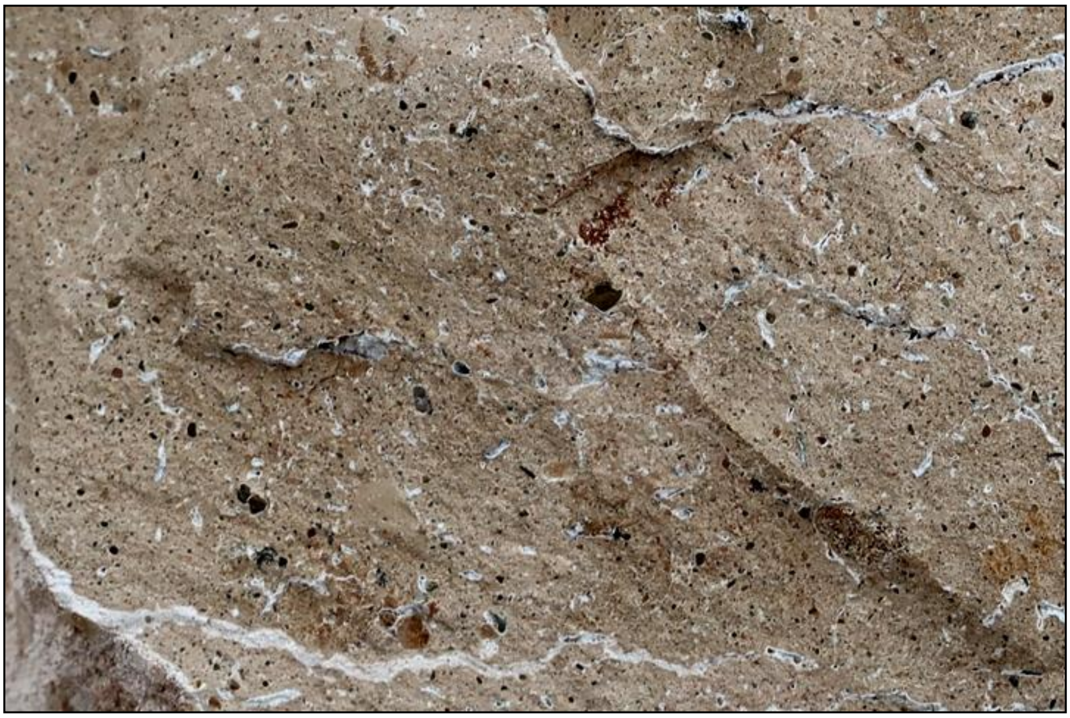


Figure 37: Close-up of dense, dark-speckled Late Caenozoic calcrete hardpan from quarry area showing pale vermiform structures that *might* be fine root traces, or perhaps abiogenic (field of view c. 6 cm across) (Loc. 951).

Figure 38: Road cutting through well-consolidated, orange-brown sandy sediment showing incipient pale calcretisation around subfossil plant roots (hammer = 30 cm) (Loc 957).

5. CONCLUSIONS & RECOMMENDATIONS

The Sontule Citrus agricultural project area on Remainder of Farm 632, situated between Kirkwood and Addo in the Sundays River Valley, Eastern Cape Province, is underlain at depth by fossiliferous marine sediments of the Sundays River Formation (Uitenhage Group) of Early Cretaceous age. Shelly invertebrate fossils have been previously recorded from the Cretaceous beds here in the scientific literature (e.g. McLachlan & McMillan 1976). During a recent one-day site visit several rich fossil sites yielding well-preserved bivalve molluscs as well as storm-generated coquinas (shell beds) of broken shelly remains and a few blocks of well-preserved petrified wood were recorded from small exposures of marine siltstones and calcareous sandstones along the low escarpment on the northern borders of the project area (See satellite locality map in Appendix 1 of this chapter). However, none of these fossil sites lies within the project footprint and therefore no mitigation measures are recommended in their regard.

The proposed agricultural development will be situated in an undulating, gently sloping plateau area which has already been partly disturbed by agriculture, farm tracks and quarrying and is largely vegetated by dense subtropical thicket. The Cretaceous bedrocks here are entirely mantled by deep (several meters) alluvial deposits of the Late Caenozoic Kudus Kloof Formation whose type area lies a few kilometres to the east. These sandy to gravelly sediments of inferred Pliocene age are often calcretised in the subsurface and have experienced erosional concentration through downwasting. They are generally unfossiliferous and no fossil remains, apart from possible calcretised plant root traces of low scientific interest, were recorded within them.

Given (1) the small (partially disturbed) footprint of the proposed agricultural developments, (2) the likely deeply weathered condition of the underlying Mesozoic bedrocks near-surface, as well as (3) the low palaeontological sensitivity of the overlying superficial sediments, the palaeontological heritage impact significance of all components of the proposed agricultural projects (i.e. new blocks of citrus plantation, new dam, internal roads, irrigation pipeline etc) is assessed as LOW (negative) without mitigation. Current impacts on palaeontological heritage within the wider project area involve on-going destruction of newly exposed fossils by natural weathering and erosion processes (Impacts due to farming activities or illegal fossil collection here are likely to be negligible). This assessment applies to the individual project components as well as their anticipated cumulative impact. In the absence of full data regarding potential impacts of comparable proposed or authorised agricultural developments in the Addo – Kirkwood region, cumulative impacts on local fossil heritage cannot be realistically assessed. However, given the large outcrop areas of the sedimentary formations concerned, they are likely to fall within acceptable limits.

There are no objections on palaeontological heritage grounds to authorisation of the proposed Sontule Citrus agricultural development. No further palaeontological heritage studies or specialist mitigation are required for the proposed developments, pending the potential discovery or exposure of any significant fossil remains (e.g. vertebrate bones and teeth, large blocks of petrified wood, shelly fossil horizons) during the construction phase. The ECO responsible for these developments should be alerted to the possibility of important fossil remains being found either on the surface or exposed by fresh excavations during construction.

Should fossil remains such as bones, shells or petrified wood be discovered during construction, these should be safeguarded (preferably in situ) and the ECO should alert the Eastern Cape Provincial Heritage Resources Authority (ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). This is so that appropriate mitigation (e.g. recording, sampling or collection) can be taken by a professional palaeontologist (See tabulated Chance Fossil Finds Procedure in Appendix 2 to this chapter). The specialist involved would require a collection permit from ECPHRA. Fossil material must be curated in an approved repository (e.g. museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013).

6. ACKNOWLEDGEMENTS

Ms Sandra Wren of Public Process Consultants, Port Elizabeth, is thanked for commissioning this palaeontological study and for providing the necessary background information. I am very grateful to Ms Madelon Tusenius for logistical back-up, palaeontological input as well as companionship in the field.

Table 1: Assessment of anticipated impacts of the proposed Sontule Citrus agricultural project on scientifically valuable palaeontological heritage on the Remainder of Farm 632 (construction phase)

Nature of the Impact	Potential disturbance, damage or destruction of scientifically valuable and legally protected fossil heritage resources due to surface clearance and excavations during the construction phase (*e.g.* for farm dam, citrus orchards, internal roads, underground pipelines).
Extent	Site Specific - The impact will be limited to the proposed development footprint.
Duration	Permanent
Consequence/ Intensity	Low
Probability	Improbable - The proposed development area will be restricted to areas which are covered by thick unfossiliferous superficial sediments (alluvium, topsoils).
Degree of Confidence	Medium
Reversibility	Irreversible – Once the palaeontological material has been removed or destroyed this impact cannot be reversed.
Irreplaceable Loss of Resources	Unlikely. Similar fossils to those recorded here are known elsewhere from the extensive Sundays River Formation outcrop area.
Status and Significance (without mitigation)	Low Negative (-)
Mitigation	• The construction phase of the projects should be monitored by an Environmental Control Officer (ECO), who should monitor for potential fossil material on an ongoing basis. • Should substantial fossil remains be exposed during construction, however, the ECO should safeguard these, preferably *in situ*, and alert ECPHRA as soon as possible so that appropriate action (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist. • In the event that fossilised material is uncovered, construction on the affected excavation should cease until a palaeontologist has assessed the material. • Fossilised material encountered at the site may only be removed or destroyed upon authorisation from the relevant Heritage Resources Authority (*i.e.* ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za) by the issuing of an appropriate permit. • A Chance Fossil Finds Protocol is to be appended to the Construction EMPr and implemented should any substantial fossil remains be uncovered. • Fossil material must be curated in an approved repository (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013).
Status and Significance (after mitigation)	Low Positive (+) - Providing appropriate palaeontological mitigation is carried out, the majority of developments involving bedrock excavation can make a positive contribution to our understanding of local palaeontological heritage.

7. REFERENCES

ALMOND, J.E. 2010. Palaeontological heritage assessment of the Coega IDZ, Eastern Cape Province, 112 pp. plus appendix. Natura Viva cc, Cape Town.

ALMOND, J.E. 2011. Palaeontological impact assessment: proposed windfarm on Grassridge 190, Geluksdal 590 and Bontrug 301, Nelson Mandela Bay Municipality, Eastern Cape Province, 45 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2012a. Proposed manganese export facility and associated infrastructure in the Coega Industrial Development Zone, Port of Ngqura and Tankatara area, Nelson Mandela Bay Municipality, Eastern Cape. Palaeontological heritage assessment, 47 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2012b. Expansion of River Bend Citrus Farm near Addo, Sundays River Valley Municipality, Eastern Palaeontological specialist study: desktop assessment, 12 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2013a. Venter Fert Composting and Fertiliser Plant, Farm 715 Division Uitenhage, Nelson Mandela Bay Municipality: Palaeontological Heritage Assessment, 41 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2013b. Proposed 16 Mtpa expansion of Transnet’s existing manganese ore export railway line & associated infrastructure between Hotazel and the Port of Ngqura, Northern & Eastern Cape. Part 2: De Aar to the Coega IDZ, Northern and Eastern Cape. Palaeontological specialist assessment: combined desktop and field-based study, 76 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2013c. Expansion of agricultural activities on Portion 5 of the Farm Nooitgedacht No. 118, Sunland, near Addo, Sundays River Valley Municipality, Eastern Cape. Palaeontological specialist study: desktop basic assessment, 17 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2014a. Agricultural Development of Portion 16 & Portion 17 of the Farm 203 Logan Braes near Addo, Nelson Mandela Bay Municipality, Eastern Cape. Palaeontological specialist study: desktop basic assessment, 17 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2014b. Proposed Dassiesridge Wind Energy Facility near Uitenhage, Cacadu District, Eastern Cape. Palaeontological specialist assessment: combined desktop and field-based study, 66 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2014c. Proposed Bulk Water Supply and Waste Water Services for the Langbos Community north of Addo, Sunday’s River Valley Municipality, Eastern Cape. Palaeontological specialist study: desktop basic assessment, 16 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016. Proposed subdivision and agricultural development of Portion 413 of the Farm Strathsomers Estate 42 near Kirkwood, Sundays River Valley Municipality, Eastern Cape. Palaeontological specialist study: combined desktop & field-based assessment, 24 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2018. Proposed agricultural development of Remainder of Portion 7, Farm Scheepers Vlakte 98 near Addo, Sundays River Valley Municipality, Eastern Cape. Palaeontological specialist study: combined desktop & field-based assessment, 29 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2019. Proposed agricultural and residential developments on the Remainder of Portion 1 of the farm Vissers Vale No. 96 near Addo, Sundays River Valley Municipality, Eastern

Cape. Palaeontological specialist study: combined desktop & field-based assessment, 34 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2020a. Proposed new dam on Portion 274 of Farm 42 Strathsomers Estate near Kirkwood, Sundays River Valley Municipality, Eastern Cape. Palaeontological specialist study: combined desktop & field-based assessment, 24 pp. Natura Viva cc. Cape Town.

ALMOND, J.E. 2020b. Proposed Tango citrus farming development on Portion 11 of Farm 100 near Kirkwood, Sundays River Valley Municipality, Eastern Cape. Palaeontological specialist study: combined desktop & field-based assessment, 27 pp. Natura Viva cc, Cape Town.

ALMOND, J.E., DE KLERK, W.J. & GESS, R. 2008. Palaeontological heritage of the Eastern Cape. Interim technical report for SAHRA, 25 pp.

ANDERSON, J.M. & ANDERSON, H.M. 1985. Palaeoflora of southern Africa. Prodromus of South African megafloras, Devonian to Lower Cretaceous, 423 pp, 226 pls. Botanical Research Institute, Pretoria & Balkema, Rotterdam.

ANDREWS, C.W. 1910. Description of a new plesiosaur (Plesiosaurus capensis sp. nov.) from the Uitenhage beds of Cape Colony. Annals of the South African Museum 7, 309-323, pl. 18, 4 textfigs.

ATHERSTONE, W.G. 1857. Geology of Uitenhage. The Eastern Province Monthly Magazine 1, 518-532 and 580 -595.

BAMFORD, M.K. 1986. Aspects of the palaeoflora of the Kirkwood and Sundays River Formations, Algoa Basin, South Africa. Unpublished M.Sc. Thesis, Univ. Witwatersrand, 160pp.

COOPER, M.R. 1979. A new species of Myophorella (Bivalvia, Trigoniidae) from the Sunday's River Formation, South Africa. Annals of the South African Museum 78 (3), 21-27.

COOPER, M.R. 1981. Revision of the Late Valanginian Cephalopoda from the Sundays River Formation of South Africa, with special reference to the Genus Olcostephanus. Annals of the South African Museum 83: 147-366, 206 figs.

COOPER, M.R. 1983. The ammonite genus Umgazaniceras in the Sundays River Formation. Transactions of the Geological Society of South Africa 86(1):63-64.

COOPER, M.R. 1991. Lower Cretaceous Trigonioida (Mollusca, Bivalvia) from the Algoa Basin, with a revised classification of the order. Annals of the South African Museum 100:1-52.

COOPER, M.R. 2018. The Cretaceous fossils of South-Central Africa, iv + 163 pp. CRC Press, London etc.

DINGLE, R.V., SIESSER, W.G. & NEWTON, A.R. 1983. Mesozoic and Tertiary geology of southern Africa. viii + 375 pp. Balkema, Rotterdam.

DU TOIT, A.L. 1954. The geology of South Africa (3rd edition). 611 pp, 41 pls, geological map insert.

ENGELBRECHT, L.N.J., COERTZE, F.J. & SNYMAN, A.A. 1962. Die geologie van die gebied tussen Port Elizabeth en Alexandria, Kaapprovinsie. Explanation to geology sheet 3325 D Port Elizabeth, 3326 C Alexandria and 3425 B, 54pp., 8 pls. Geological Survey of South Africa / Council for Geosciences, Pretoria.

GESS, R. (undated) Paleontological Heritage Assessment for Kadouw Leisure Estate, Sundays River Valley, 5 pp.

HATTINGH, J. 1994. Kudus Kloof Formation. SA Committee for Stratigraphy, Catalogue of South African Lithostratigraphic Units 5, 35-36. Council for Geoscience, Pretoria.

HATTINGH, J. 2001. Late Cenozoic drainage evolution in the Algoa Basin with special reference to the Sundays River Valley. Council for Geoscience, South Africa Bulletin 128, 141 pp, appendices.

HATTINGH, J. & GOEDHART, M.L. 1997. Neotectonic control on drainage evolution in the Algoa Basin, Eastern Cape. South African Journal of Geology 100, 43-52.

HAUGHTON, S.H. 1928. The geology of the country between Grahamstown and Port Elizabeth. An explanation of Cape Sheet No. 9 (Port Elizabeth), 45 pp. Geological Survey / Council for Geoscience, Pretoria.

HAUGHTON, S.H. 1969. Geological history of southern Africa, 535 pp. Geological Society of South Africa, Johannesburg.

HERITAGE WESTERN CAPE 2021. Guide for minimum standards for archaeology and palaeontology reports submitted to Heritage Western Cape - June 2021, 6 pp.

JUBB, R.A. 1976. Freshwater mussels, Unionidae, what is their distribution in South African Inland waters today? Piscator 97, 73–75.

JUBB, R.A. 1980. Note on freshwater mussels. The Eastern Cape Naturalist 70, 20-21.

KITCHIN, F.L. 1908. The invertebrate fauna and palaeontological relationships of the Uitenhage Series. Annals of the South African Museum 7(2):21-250, pls. 2-11.

KLINGER, H.C. & KENNEDY, W.J. 1979. Cretaceous faunas from southern Africa: Lower Cretaceous ammonites, including a new bochianitid genus from Umgazana, Transkei. Annals of the South African Museum 78: 11-19.

LAZO, D.G. 2007. Early Cretaceous bivalves of the Neuquén Basin, west-central Argentinia: notes on taxonomy, palaeobiogeography and palaeoecology. Geological Journal 42, 127-142.

LE ROUX, F.G. 2000. The geology of the Port Elizabeth – Uitenhage area. Explanation of 1: 50 000 geology Sheets 3325 DC and DD, 3425 BA Port Elizabeth, 3325 CD and 3425 AB Uitenhage, 3325 CB Uitenhage Noord and 3325 DA Addo, 55pp. Council for Geoscience, Pretoria.

MACRAE, C. 1999. Life etched in stone. Fossils of South Africa. 305pp. The Geological Society of South Africa, Johannesburg.

McLACHLAN, I.R. & McMILLAN, I.K. 1976. Review and stratigraphic significance of southern Cape Mesozoic palaeontology. Transactions of the Geological Society of South Africa. 79: 197-212.

McLACHLAN, I.R. & McMILLAN, I.K. 1979. Microfaunal biostratigraphy, chronostratigraphy and history of Mesozoic and Cenozoic deposits on the coastal margin of South Africa. In: Anderson, A.M. & Van Biljon, W.J. (Eds.) Some sedimentary basins and associated ore deposits of South Africa. Special Publication of the Geological Society of South Africa 6, 161-181.

McMILLAN, I.K. 1990. A foraminiferal biostratigraphy and chronostratigraphy for the Pliocene to Pleistocene upper Algoa Group, Eastern Cape, South Africa. South African Journal of Geology 93: 622-644.

McMILLAN, I. K., 2003. The Foraminifera of the Late Valanginian to Hauterivian (Early Cretaceous) Sundays River Formation of the Algoa Basin, Eastern Cape Province, South Africa. Annals of the South Africa Museum 106:1-274, 84 figs, 4 tables.

MOSTOVSKI, M. & MULLER, B. 2010. [Untitled article on fossil insects from the Sundays River and Kirkwood Formations]. PalNews 17 (3), 9-10.

RAATH, M., HILLER, N. & BAMFORD, M. 1998. Palaeontology, pp. 27-40 in Lubke, R. & De Moor, I. Field guide to the eastern and southern Cape coast. University of Cape Town Press, Cape Town, xxx + 561 pp, 49 pls.

RIGASSI, D.A. & DIXON, G.E. 1972. Cretaceous of the Cape Province, Republic of South Africa. Proceedings, Conference on African geology, Ibadan Dec. 1970, pp. 513-527.

SAHRA 2013. Minimum standards: palaeontological component of heritage impact assessment reports, 15 pp. South African Heritage Resources Agency, Cape Town.

SEWARD, A.C. 1903. Fossil floras of Cape Colony. Annals of the South African Museum 4, 1-122. CHECK PLS

SHARPE, D. 1856. Description of fossils from the secondary rocks of Sundays River and Zwartkops River, South Africa, collected by Dr. Atherstone and A. G. Bain, Esq. Transactions of the Geological Society, London (2nd Series) 7(4):193-203.

SHONE, R.W. 1976. The sedimentology of the Mesozoic Algoa Basin. Unpublished MSc thesis, University of Port Elizabeth, 48 pp.

SHONE, R.W. 1986. A new ophiuroid from the Sundays River Formation (Lower Cretaceous), South Africa. Journal of Paleontology 60, 904-910.

SHONE, R.W. 2006. Onshore post-Karoo Mesozoic deposits. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 541-552. Geological Society of South Africa, Marshalltown.

SPATH, L. F. 1930. On the Cephalopoda of the Uitenhage beds. Annals of the South African Museum 28(2):131-157, pls. 13-15, 1 text fig.

TANKARD, A.J., JACKSON, M.P.A., ERIKSSON, K.A., HOBDAY, D.K., HUNTER, D.R. & MINTER, W.E.L. 1982. Crustal evolution of southern Africa – 3.8 billion years of Earth history, xv + 523 pp., pls. Springer Verlag, New York.

TATE, R. 1867. On some secondary fossils from South Africa. Proceedings of the Quarterly Journal of the Geological Society of London 23, 139-175.

TOERIEN, D.K. & HILL, R.S. 1989. The geology of the Port Elizabeth area. Explanation to 1: 250 000 geology Sheet 3324 Port Elizabeth, 35 pp. Council for Geoscience. Pretoria.

WINTER, H. DE LA R. 1973. Geology of the Algoa Basin, South Africa. In: Blant, G. (Ed.) Sedimentary basins of the African coast. Part, 2 South and East Coast, pp. 17-48. Association of African Geological Surveys, Paris.

8. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest, Gauteng, KwaZulu-Natal, Mpumalanga and the Free State under the aegis of his Cape Town-based company Natura Viva cc. He has served as a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Dr John E. Almond
Palaeontologist
Natura Viva cc

APPENDIX 1: FOSSIL SITE DATA – JANUARY 2022

All GPS readings were taken in the field using a hand-held Garmin GPSmap 64s instrument. The datum used is WGS 84. Please note that:

- Locality data for South African fossil sites is not for public release, due to conservation concerns.
- The table does *not* represent all potential fossil sites within the project area but only those sites recorded during the 1-day field survey. The absence of recorded fossil sites in any area therefore does not mean that no fossils are present there.

Loc	**GPS data**	**Comments**
924	S33° 28' 40.6" E25° 32' 55.0"	Remainder of Farm 632 near Addo. Sundays River Fm. Shelly coquinas (molluscan debris, occasional intact bivalve valves) within calcareous sandstone concretions. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
925	S33° 28' 40.7" E25° 32' 54.6"	Remainder of Farm 632 near Addo. Sundays River Fm. Shelly coquinas (molluscan debris) associated with small rusty-brown woody stem axes, possible ferruginised subcylindrical burrow casts (0.5 cm diam.) within calcareous pebbly sandstone. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
926	S33° 28' 40.2" E25° 32' 55.3"	Remainder of Farm 632 near Addo. Sundays River Fm. Ferruginous gritty sandstone with pebbly conglomerates, reworked cyclindrical burrow casts, shelly debris. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
927	S33° 28' 39.9" E25° 32' 55.0"	Remainder of Farm 632 near Addo. Sundays River Fm. Thin-shelled oysters (*cf Amphidonte*) encrusting ferruginous sandstone of possible hardground origin. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
928	S33° 28' 39.4" E25° 32' 54.7"	Remainder of Farm 632 near Addo. Sundays River Fm. Ferruginous diagenetic concretions containing thick-shelled trigoniid bivalves. Clusters of thin-shelled encrusting oysters (*cf Amphidonte*). Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
929	S33° 28' 39.3" E25° 32' 54.5"	Remainder of Farm 632 near Addo. Sundays River Fm. Upper siltstone portion of exposed succession (beneath thin-bedded sandstones) containing abundant trigoniid bivalves, thin-shelled oysters. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
930	S33° 28' 41.4" E25° 32' 54.2"	Remainder of Farm 632 near Addo. Sundays River Fm. Several angular float blocks of pale grey petrified logs up to 20 cm long with clear woody fabric. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
931	S33° 28' 42.8" E25° 32' 53.8"	Remainder of Farm 632 near Addo. Possible subfossil *Cochlitoma* ("*Achatina*") in soils overlying saprolitic Sundays River formation siltstones. Proposed Field Rating IIIC Local Resource. Site lies outside project footprint so no mitigation required.
935	S33° 28' 53.8" E25° 32' 54.0"	Remainder of Farm 632 near Addo. Sundays River Fm. Dense shelly coquinas up to dm or so thick associated with siltstone and thin sandstones overlying thick sandstone package. Range of shelly taxa dominated by oysters (*Amphidonte*), possible trigoniids, pectinoids, *Isognomon*. Shells mainly disarticulated, intact or broken, locally bound within concretionary lenses. Proposed Field Rating IIIB Local Resource. Proposed Field Rating

		IIIB Local Resource. Site lies outside project footprint so no mitigation required.
945	S33° 28' 49.8" E25° 33' 03.0"	Remainder of Farm 632 near Addo. Sundays River Fm. Downwasted blocks of pale brownish shelly calcareous sandstone (oysters *inter alia*) in shallow stream valley. Proposed Field Rating IIIB Local Resource. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
946	S33° 28' 49.9" E25° 33' 03.6"	Remainder of Farm 632 near Addo. Sundays River Fm. Downwasted blocks of pale brownish shelly calcareous sandstone (intact and broken shells of bivalves) in shallow stream valley. Proposed Field Rating IIIB Local Resource. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
947	S33° 28' 49.9" E25° 33' 03.7"	Remainder of Farm 632 near Addo. Sundays River Fm. Downwasted to nearly *in situ* blocks of pale brownish shelly calcareous sandstone (intact and broken shells of bivalves, locally forming thin pavements) in shallow stream valley. Proposed Field Rating IIIB Local Resource. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
951	S33° 28' 52.4" E25° 33' 09.0"	Remainder of Farm 632 near Addo. Extensive shallow quarry into dense calcrete showing narrow, vermiform plant root traces (rhizoliths and / or possible occasional invertebrate burrows (equivocal). Proposed Field Rating IIIC Local Resource. Site lies outside project footprint so no mitigation required.
957	S33° 29' 13.2" E25° 33' 23.4"	Remainder of Farm 632 near Addo. Farm road cutting into partially calcretised orange-brown, non-pebbly sandy sediments (alluvial / aeolian) with calcrete haloes around subfossil plant roots. Proposed Field Rating IIIC Local Resource. Site lies outside project footprint so no mitigation required.

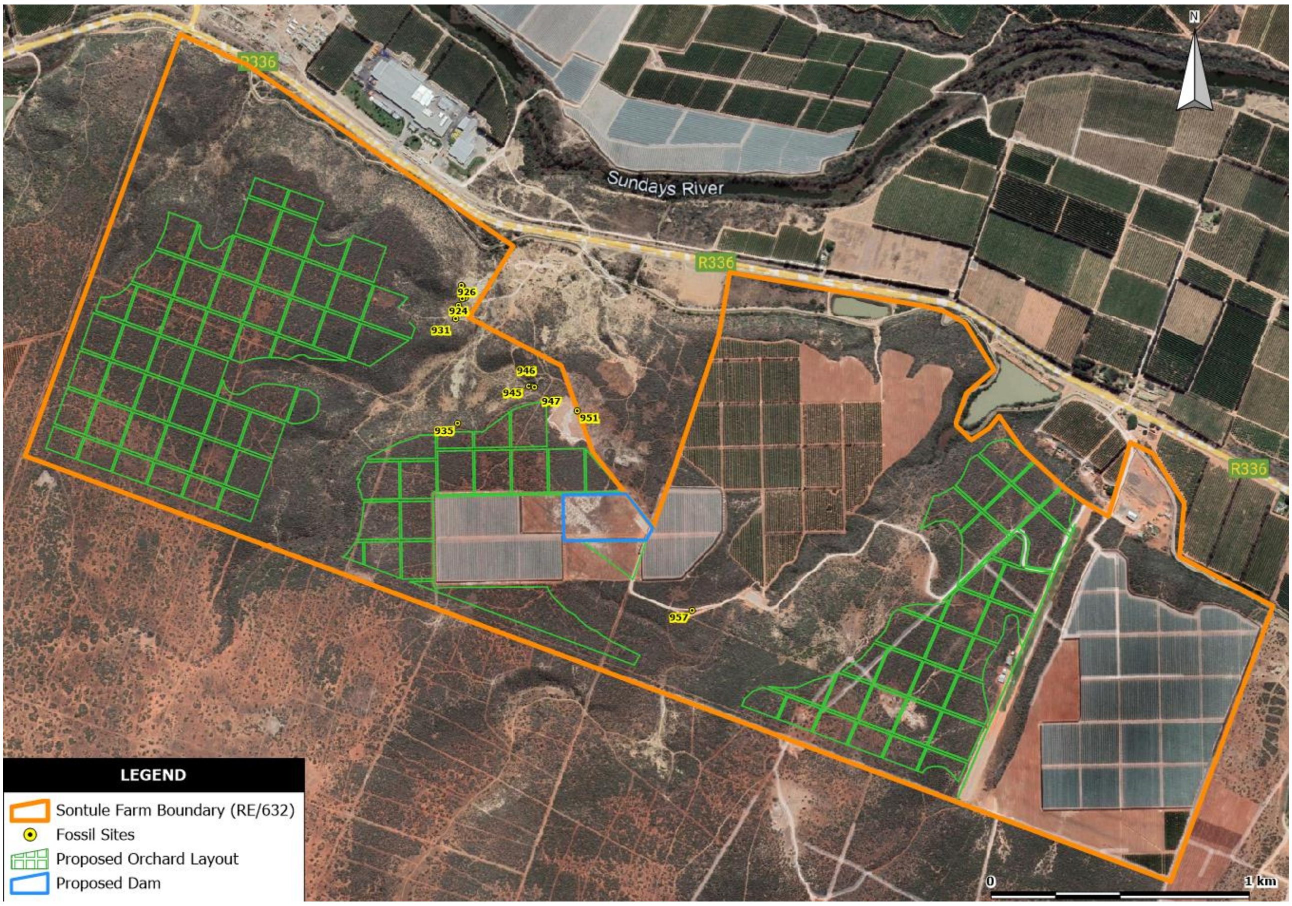


Figure A1.1: Google Earth© satellite image of the Sontule Citrus project area on the Remainder of Farm 632 near Addo showing location of recently recorded fossil and subfossil sites. None of the fossil sites lies within the footprint of the proposed agricultural development and no mitigation is required in their regard.

<table>
<tr><td colspan="3">APPENDIX 2: CHANCE FOSSIL FINDS PROCEDURE: Remainder of Farm 632 near Addo</td></tr>
<tr><td>Province & region:</td><td colspan="2">Eastern Cape, Sundays River Valley Municipality</td></tr>
<tr><td>Responsible Heritage Management Authority</td><td colspan="2">ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za).</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Early Cretaceous Sundays River Formation Uitenhage Group), Late Caenozoic Kudus Kloof Formation</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Shelly invertebrates, petrified wood, rare dinosaur bones and teeth, trace fossils in Sundays River beds.
Freshwater molluscs, calcretised trace fossils, possible bones and teeth of mammals in Caenozoic alluvium.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
Context – describe position of fossils within stratigraphy (rock layering), depth below surface
Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation
Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Authority for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):

Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Authority, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Authority</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Authority. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Authority minimum standards.</td></tr>
</table>

Chapter 11: Traffic Impact Assessment

Scoping and Environmental Impact Assessment: Sontule Citrus – Agricultural Expansion on Remainder of Farm 632, Sunland, Sundays River Valley Municipality

Draft EIA Report

September 2022

Prepared by:

Traffic Specialist
Compiled by: Jared Charlton
Reviewed by: Cary Hastie
Engineering Advice and Services
P O Box 13867
HUMEWOOD
6013
Tel: 041 581 2421
Email: caryh@easpe.co.za

Public Process Consultants
Environmental Impact Assessment and Public Participation Management

TRAFFIC IMPACT ASSESSMENT

FOR THE PROPOSED DEVELOPMENT OF ADDITIONAL CITRUS ORCHARDS ON REMAINDER OF FARM 632, UITENHAGE SUNDAYS RIVER VALLEY MUNICIPALITY

November 2021

Prepared for: **Public Process Consultants cc**
obo Sun Orange Farms (Pty) Ltd

Prepared by: **Engineering Advice and Services (Pty) Ltd**
(041) 5812421

DOCUMENT CONTROL SHEET

CLIENT REF: **PUBLIC PROCESS CONSULTANTS**

PROJECT NAME: **PROPOSED DEVELOPMENT OF ADDITIONAL CITRUS ORCHARDS ON REMAINDER 632 OF FARM 42, UITENHAGE**

DOCUMENT TITLE: **TRAFFIC IMPACT ASSESSMENT**

DOCUMENT FILE REF: F:\1900-1999\1966\Reports\REP001 - TIA Sun Orange Citrus, SRVM.docx

Version	**1**		
Compiled by	JK Charlton Candidate Eng Technologist (201580304)	November 2021	
Reviewed by	CGA Hastie Pr Tech. Eng (200070122)	November 2021	
Amendments made by			

DISTRIBUTION:
1) Original : Client (Public Process Consultants – Ms Sandy Wren)
2) Copy : Client – Sun Orange Farms (Pty) Ltd
3) Copy : South African National Roads Agency SOC Limited
4) Copy : EAS File 1966

PREPARED BY: Engineering Advice and Services (Pty) Ltd
P O Box 13867
HUMEWOOD
6013

Telephone: 041 581 2421
Email: caryh@easpe.co.za

CONTENTS

		Page
Document Control Sheet		11.i
Contents		11.ii
List of Tables		11.ii
List of Figures		11.ii
List of Annexures		11.ii
1	**Introduction**	**11.1**
1.1	Background	11.1
1.2	Methodology	11.1
2	**Land Use Rights, Development and Environs**	**11.1**
2.1	Land Use Rights	11.1
2.2	Development Overview	11.1
3	**Data Collection**	**11.3**
3.1	Historical Daily Traffic Volumes	11.3
3.2	Road Network	11.3
4	**Trip Generation and Distribution**	**11.4**
5	**Proposed Access Arrangements**	**11.4**
6	**Potential Impacts**	**11.6**
6.1	Impacts	11.6
6.2	Impact Assessment	11.6
7	**Proposed Mitigatory Measures**	**11.10**
7.1	Road Condition Measures	11.10
7.2	Traffic Safety Measures	11.10
8	**Management Actions**	**11.11**
9	**Conclusions**	**11.11**
10	**Recommendations**	**11.11**
11	**References**	**11.11**

LIST OF TABLES

Table 1: ADT and Annual Growth Rates 11.3
Table 2: Summary of Generated Trips 11.4
Table 3: Generic Table for rating of impacts 11.7
Table 4: Impact Assessment: Additional traffic volumes 11.7
Table 5: Impact Assessment: Traffic Safety Impact due to slow moving traffic 11.8
Table 6: Impact Assessment: Road and Intersection capacity (additional traffic loading) 11.8
Table 7: Impact Assessment: Traffic Safety Impact due to additional traffic 11.9
Table 8: Impact Assessment: Deterioration of Public Road Network 11.9
Table 9: Impact Assessment: Generation of Dust on Gravel Access Road 11.10

LIST OF FIGURES

Figure 1: Locality Plan 11.2
Figure 2: Proposed Access Arrangements 11.5

LIST OF ANNEXURES

ANNEXURE A Power of Attorney

ANNEXURE B Historical Traffic Data

1 INTRODUCTION

1.1 BACKGROUND

Engineering Advice & Services (Pty) Ltd was appointed by Public Process Consultants on behalf of Sun Orange Farms (Pty) Ltd during October 2021 to conduct a traffic impact assessment for proposed additional citrus orchards on remainder of Farm 632 situated in Sunlands in the Sundays River Valley Municipality.

1.2 METHODOLOGY

The approach followed in conducting the traffic impact assessment was in accordance with the guidelines contained in **TMH 16 Vol 1- South African Traffic Impact and Site Assessment Manual**[(1)].

Given the extent of the proposed development and in terms of the guidelines, the development is considered to be a medium-sized development and this assessment will thus consider impact for the development horizon (assumed to be 2025).

The methodology used was as follows:

- The expected trips that will be generated by the development were determined;
- The suitability of the access point to the public road network was determined; and
- The impacts on public roads that may be used to transport produce to packhouses were assessed in terms of operational safety taking into account road conditions and sight distances.

2 LAND USE RIGHTS, DEVELOPMENT AND ENVIRONS

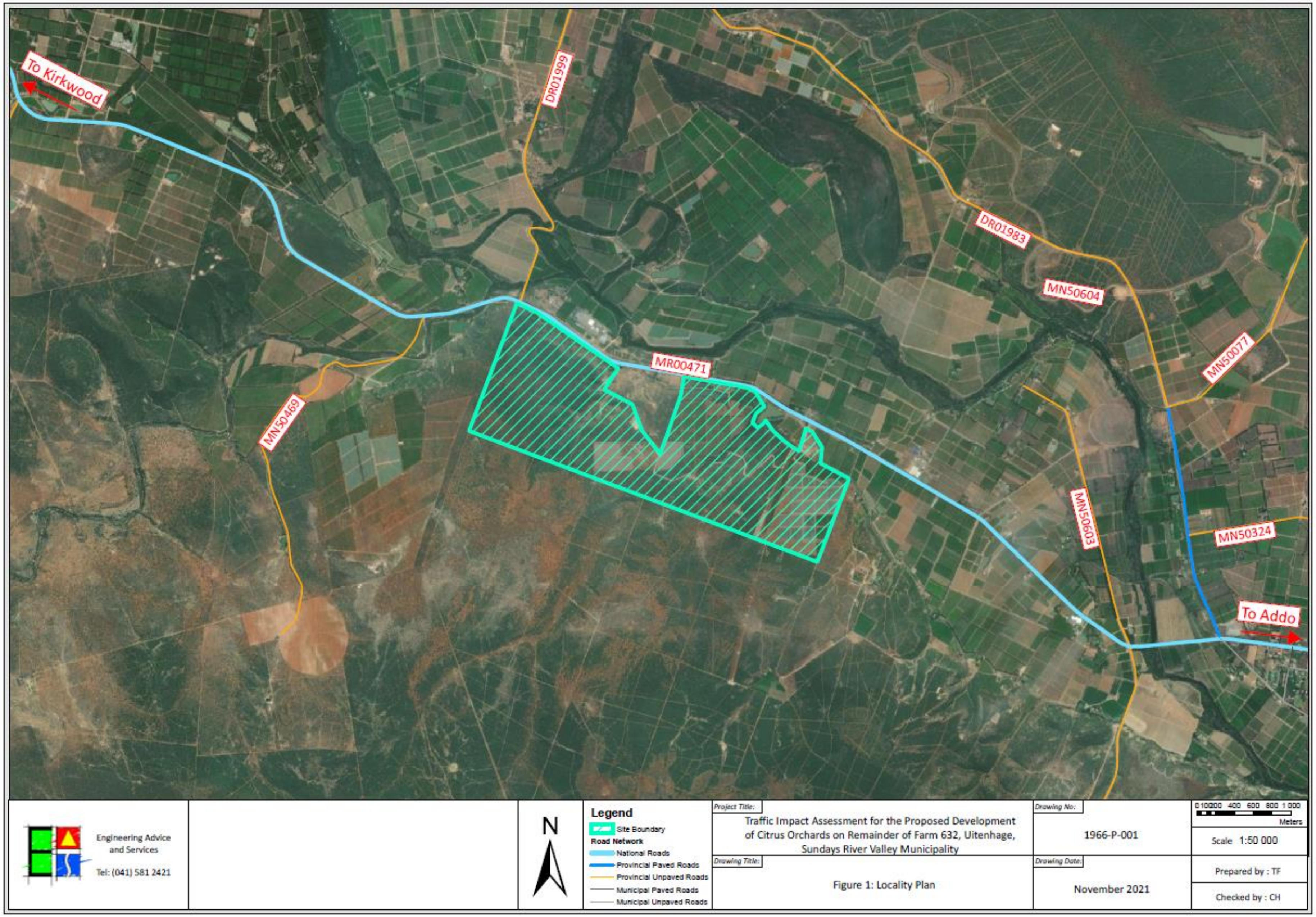
2.1 LAND USE RIGHTS

The site, which is zoned for Agricultural purposes, measures approximately 459 ha and is located south of the MR00471 (R336) as indicated on **Figure 1**. Approximately 133ha of the site is currently being used for the cultivation of citrus and associated infrastructure.

2.2 DEVELOPMENT OVERVIEW

It is proposed to use a portion of the undeveloped land for the cultivation of additional citrus trees and to construct a new storage dam and irrigation pipelines for irrigation purposes.

It is proposed that the additional infrastructure and citrus to be planted will amount to approximately 147 ha. Approximately 179 ha of the site will remain as natural vegetation.


To Kirkwood
DR01999
DR01983
MN50604
MR00471
MN50469
MN50077
MN50603
MN50324
To Addo
Engineering Advice and Services
Tel: (041) 581 2421
N
Legend
Site Boundary
Road Network
National Roads
Provincial Paved Roads
Provincial Unpaved Roads
Municipal Paved Roads
Municipal Unpaved Roads
Project Title:
Traffic Impact Assessment for the Proposed Development of Citrus Orchards on Remainder of Farm 632, Uitenhage, Sundays River Valley Municipality
Drawing Title:
Figure 1: Locality Plan
Drawing No:
1966-P-001
Drawing Date:
November 2021
Meters
Scale 1:50 000
Prepared by : TF
Checked by : CH

3 DATA COLLECTION

3.1 HISTORICAL DAILY TRAFFIC VOLUMES

Historical daily traffic volume data at count stations on MR471 (2122, 2134, 8211, 12104, 12106 & 12124), attached as **Annexure A** of this chapter, was sourced from the SANRAL database.

The data, summarised in **Table 1** below indicates that between 2016 and 2019, traffic growth on the R336 amounted to approximately 7.5% per annum with approximately 13% of vehicles travelling along the R336 comprising of heavy vehicles.

Table 1: ADT and Annual Growth Rates

Stn.	Description	ADT / ADTT	2015	2016	2017	2018	2019	2020	% p.a.
2122	ECDOT - MR00471 (R336) East of MR0047	ADT	4636	-	-	-	-	-	-
		ADTT	-	-	-	-	-	-	
12124	SANRAL - MR00471 (R336) East of MR0047	ADT	-	6905	-	-	-	-	-
		ADTT	-	801	-	-	-	-	
2134	ECDOT - MR00471 (R336) West of MR00470	ADT	4201	-	-	-	-	-	-
		ADTT	-	-	-	-	-	-	
8211	SANRAL - MR00471 (R336) West of MR00470	ADT	-	-	1578	1659	1773	1520	**6.00**
		ADTT	-	-	220	218	278	235	
12104	SANRAL - MR00471 (R336) West of Unifruiti	ADT	-	1433	-	1703	-	-	**9.01**
		ADTT	-	115	-	238	-	-	
12106	SANRAL - MR00471 (R336) East of Unifruiti	ADT	-	1480	-	-	-	-	-
		ADTT	-	170	-	-	-	-	
									7.51

Although traffic count data is available for 2020, this data was not used in the growth rate calculation given the COVID-19 pandemic and the countrywide level 5 lockdown that occurred during this period

View of MR00471 (R336) at the access

3.2 ROAD NETWORK

R336 (MR471) is a surfaced national road which links Addo with Kirkwood. In the vicinity of the site, the road comprises of a 3,7m wide traffic lane and narrow gravel shoulder in each direction. The posted speed limit is 80km/h.

The existing road network is indicated on **Figure 1.**

MR00471 is scheduled for upgrading in the near future with the proposed cross-section comprising of a 3.5m wide traffic lane and a 2.5m surfaced shoulder per direction.

4 TRIP GENERATION AND DISTRIBUTION

The proposed operation will include the harvesting of citrus and the transport of the fruit to a packhouse. Once the orchards are developed in 2-5 years' time and picking can commence it is estimated that approximately 9 060 tons will be produced and transported over the 100 day harvesting season.

Table 2: Summary of Generated Trips

Area	Operation	Season	Total Yield	Vehicle Type	Total Loads / Season	Trips per Day*
147ha	Delivery	April to Sept	9 060 tons	Tractor Trailer	378 loads	8 trips per day
	Collection			Interlink Truck	302 loads	6 trips per day

* Picking occurs over the entire harvesting season. Thus 378 loads over 100 week days which equates to 4 loaded trips delivering to the onsite sorting area and 4 empty trips returning to the orchard.
Similarly 3 empty interlinks arrive at the farm and 3 loaded depart to various destinations per day.

The duration of each pick is over the full harvesting season which equates to 4 tractor-trailer loads per day (8 one-way trips) delivering citrus to the onsite sorting area via the internal road network. Once the fruit has been sorted it is collected by 3 interlink truck loads per day (6 one-way trips) for delivery to a local packhouse or to a local warehouse for juicing.

Based on current daily volumes along MR00471 the use of the road by interlink trucks during the harvest season will result in a 1% increase in traffic per day (current volumes indicate under 1773 vehicles per day), a negligible impact when compared to the current traffic.

5 PROPOSED ACCESS ARRANGEMENTS

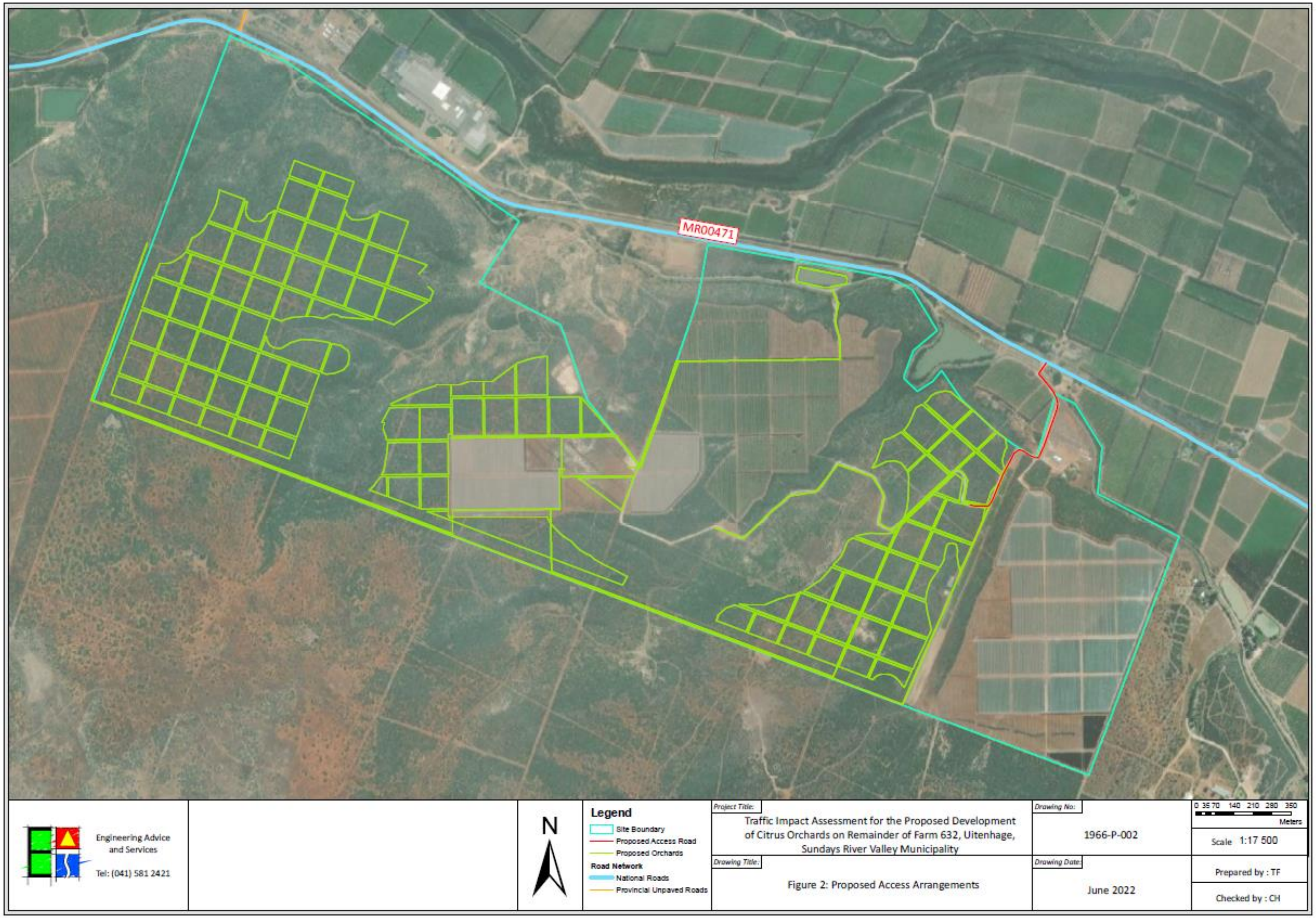
Access to the additional cultivated lands will be via the existing access road onto MR00471 (R336) located approximately 4.25km west of the MR00471 (R336) / MR0470 intersection as indicated on **Figure 2** below**.**

Shoulder sight distance at the MR00471 intersection with the access road was assessed in terms of **TRH 17: Geometric Design of Rural Roads** **(2)**. TRH17 recommends that a single unit and trailer vehicle entering a road with a design speed of 60kph turning left or right requires shoulder sight distance of 300m. The requirement for a passenger car is 150m.

Shoulder sight distance (SSD) from the existing access road onto MR00471 to both the east and west are in excess of the minimum requirements.

As stated above MR00471 is scheduled for upgrading in the near future. Assessment of the upgrading proposals indicate that the existing access point at km 34.70 will be formalised as a minor access as part of the road upgrade.

This configuration safely accommodates the existing and proposed additional vehicle usage.


MR00471
Engineering Advice and Services
Tel: (041) 581 2421
N
Legend
Site Boundary
Proposed Access Road
Proposed Orchards
Road Network
National Roads
Provincial Unpaved Roads
Project Title:
Traffic Impact Assessment for the Proposed Development of Citrus Orchards on Remainder of Farm 632, Uitenhage, Sundays River Valley Municipality
Drawing Title:
Figure 2: Proposed Access Arrangements
Drawing No:
1966-P-002
Drawing Date:
June 2022
0 35 70 140 210 280 350
Meters
Scale 1:17 500
Prepared by : TF
Checked by : CH

6 POTENTIAL IMPACTS

6.1 IMPACTS

The following potential traffic related impacts relating to the proposed development have been identified. Note that the impacts will occur both in the short-term (i.e. during the construction phase) and medium- to long-term (as development is on-going) and once it is complete (operational phase).

- Road Capacity

  Additional interlink truck trips generated by the proposed development will have minimal impact in terms of road capacity given the daily volumes along the road links and at the affected intersections and low trips generated by the proposed development;

- Access

  Access to the development will be provided from MR00471 via an existing access point;

- Road Condition

  Given low operational traffic volumes – an average of up to 6 interlink truck loads per day over a 100 week day picking season **-** it is not anticipated that significant damage will be caused to the road network, provided that the loads are within legislated limits;

- Traffic Safety

  Safety issues may arise as a result of faster moving traffic on MR00471 encountering slower moving tractors and interlink trucks;

- Emissions

  The extent of exhaust emissions from interlink trucks is unknown, but will be a negative factor; and

- Dust

  The quantity of dust generated by a vehicle depends on its shape, speed and the properties of the road surfacing material. While difficult to predict, an increase in traffic volumes will no doubt result in an increase in the generation of dust along the gravel access road which may impact on the following:

  - Visibility, which will impact on safety, particularly with regard to passing and following conditions;
  - Damage to vehicle moving parts; and
  - Acceleration of road damage due to loss of fine material as dust.

6.2 IMPACT ASSESSMENT

As described in **Sections 4** and **5** above, there will be an impact on MR00471 as a result of interlink trucks using these roads during harvesting season.

A general assessment has been undertaken of impacts on various factors, as provided in the tables below. Note that this assessment does not deal with issues relating to noise, emissions, job creation or environmental matters, as the author is not qualified to comment on these. If necessary, such key issues have been addressed in separate specialist assessments.

Table 4 below indicates the impact rating system used for the study, as provided by the appointed Environmental Assessment Practitioners, Public Process Consultants.

The assessment has been conducted both during the construction/development and operational phases of the development.

Table 3: Generic Table for rating of impacts

Nature of the Impact	This should include a description of the proposed impact to indicate if the impact is a direct, indirect or a cumulative impact.
Extent	Site specific, local, regional or national
Duration	Temporary, short term, medium term, long term or permanent
Intensity	High, medium or low
Probability	Improbable, probable, highly probable, definite
Reversibility	Reversible, Partially Reversible, Irreversible
Degree of Confidence	Low, medium or High
Status and Significance (without mitigation)	Low, medium or High indicating whether Positive (+), Negative (-) or Neutral (o)
Mitigation	Overview of mitigatory measures to mitigate potentially negative impacts or enhance potential positive impacts indicating how this mitigatory measure impacts on the significance of the impact
Status and Significance (after mitigation)	Low, medium or High indicating whether the status of the impact is Positive (+), Negative (-) or Neutral (o)

6.2.1 Construction Phase

Table 4: Impact Assessment: Additional traffic volumes

Description	Impact	Comment / Reason
Extent	Local	5km radius from site
Duration	Short term	During construction period
Intensity	High	Local residents use roads on a daily basis and will be directly affected.
Probability	Definite	Development will generate construction / earth moving vehicles.
Reversibility	Partially Reversible	By reducing construction period and establishing a construction camp on the farm during construction, the impact of construction vehicles can be minimised
Degree of Confidence	High	
Status and Significance of impact (without mitigation)	Medium (negative)	
Mitigation		Construction traffic volumes can be reduced by establishing a construction camp on the farm. Reduce the construction period as far as possible.
Status and Significance of impact (with mitigation)	Low (negative)	Construction volumes are low.

Table 5: Impact Assessment: Traffic Safety Impact due to slow moving traffic

Description	Impact	Comment / Reason
Extent	Local	5km radius from site – at access with MR00471
Duration	Short term	Additional traffic generated by development during construction.
Intensity	High	Local residents – particularly vulnerable road users - who use roads on a daily basis and will be directly affected.
Probability	Probable	Construction traffic delivering materials – however volumes are unknown. Earth moving machinery to enable vegetation clearing and site preparation.
Reversibility	Partially Reversible	Impact partially reversible if suitable temporary warning signage is erected.
Degree of Confidence	High	
Status and Significance of impact (without mitigation)	High (negative)	Accidents could mean loss of life.
Mitigation		Additional warning signage, compliance with Health and Safety requirements. Establish a construction camp on the farm.
Status and Significance of impact (with mitigation)	Medium (negative)	Accidents could mean loss of life but mitigatory measures can minimise impact.

6.2.2 Operational Phase

Table 6: Impact Assessment: Road and Intersection capacity (additional traffic loading)

Description	Impact	Comment / Reason
Extent	Local	5km radius from site – at access with MR00471
Duration	Long term	
Intensity	Medium	Local residents use roads on a daily basis and may be directly affected.
Probability	Probable	Interlink trucks using public roads.
Reversibility	Irreversible	Impact will occur every harvesting season.
Degree of Confidence	High	Surveys of current daily traffic volumes conducted historically.
Status and Significance of impact (without mitigation)	Low (negative)	Traffic volumes generated are low.
Mitigation		None
Status and Significance of impact (with mitigation)	Low (negative)	Traffic volumes generated are low.

Table 7: Impact Assessment: Traffic Safety Impact due to additional traffic

Description	Impact	Comment / Reason
Extent	Local	5km radius from site – at access with MR00471
Duration	Long term	Additional traffic generated by development – 3 interlink truck trips per day equating to 6 trips (3 in and 3 out) over 100 days each year
Intensity	Medium	Local residents use roads on a daily basis and may be directly affected.
Probability	Definite	Delivery and distribution traffic using road.
Reversibility	Partially Reversible	Impact partially reversible if suitable warning signage is in place.
Degree of Confidence	High	
Status and Significance of impact (without mitigation)	High (negative)	Accidents could mean loss of life.
Mitigation		Erect additional warning signage.
Status and Significance of impact (with mitigation)	Medium (negative)	Accidents could mean loss of life but mitigatory measures can minimise impact.

Table 8: Impact Assessment: Deterioration of Public Road Network

Description	Impact	Comment / Reason
Extent	Local	5km radius from site – at access with MR00471
Duration	Long term	Additional traffic generated by development – 3 interlink truck trips per day equating to 6 trips (3 in and 3 out) over 100 days each year
Intensity	Low	Additional traffic generated equates to 1% of existing daily traffic volumes and is considered to be negligible.
Probability	Definite	Delivery and distribution traffic using road.
Reversibility	Reversible	Road can be kept in good condition if maintained regularly, particularly after harvest season.
Degree of Confidence	High	
Status and Significance of impact (without mitigation)	Medium (negative)	Damage to road surface
Mitigation		The road can be kept in good condition if maintained regularly, particularly after harvest season.
Status and Significance of impact (with mitigation)	Low (negative)	

Table 9: Impact Assessment: Generation of Dust on Gravel Access Road

Description	Impact	Comment / Reason
Extent	Local	Along the gravel access road from the MR00471 junction to the orchards
Duration	Long term	Additional traffic generated by development – 3 interlink truck trips per day equating to 6 trips (3 in and 3 out) over 100 days each year
Intensity	Medium	Local residents use roads on a daily basis and may be directly affected.
Probability	Definite	Interlink trucks will generate dust along the gravel access road
Reversibility	Reversible	By regular maintenance loss of dust can be reversed
Degree of Confidence	Medium	Subjective opinion - exact extent and impact can be assessed by detailed materials investigation
Status and Significance of impact (without mitigation)	Medium negative	Increased dust generation due to increased traffic volumes.
Mitigation		Regular maintenance of the gravel access road.
Status and Significance of impact (with mitigation)	Neutral	Dust generation can be negated should the road be regularly maintained.

7 PROPOSED MITIGATORY MEASURES

Measures to improve the safety of the existing road and to mitigate against the impact of the additional traffic volumes generated are listed below.

7.1 ROAD CONDITION MEASURES

As discussed in **Section 3.2** above MR00471 is a national road under the jurisdiction of SANRAL (previously ECDOT). As such, it is assumed that the road is designed to accommodate high volumes of traffic and a relatively high proportion of heavy vehicle traffic. Based on the visual assessments conducted during the site inspection, it appears that regular maintenance is being conducted. It is vital that the relevant road authority continue to conduct regular maintenance on the road. It is noted that the road will be upgraded by SANRAL in the near future.

Given the condition of the road, the addition of 6 interlink truck trips per day over the picking season will have a minimal impact on the condition of the road should regular maintenance be conducted.

7.2 TRAFFIC SAFETY MEASURES

Problems could occur at the proposed access point should advance warning signs not be in place on approaches.

8 MANAGEMENT ACTIONS

The following management actions should be implemented in order to minimise the impact of the development on the infrastructural environment and road users:

- Warning traffic signs

  Appropriate warning traffic signs (in accordance with the South African Road Traffic Signs Manual [3]) should be erected to warn road users.

9 CONCLUSIONS

The following conclusions can be drawn from the study:

- Access to the proposed orchard expansion can be provided directly from MR00471 (R336) via the existing access point at km 34.700 as indicated on Error! Reference source not found.; and
- A total of 604 trips per picking season (302 in and 302 out) equating to 6 per day generated at full development will have minimal impact on the operational capacity of the adjacent road network should regular maintenance be conducted.

10 RECOMMENDATIONS

In view of the findings of this study, it is recommended that:

- This TIA be approved by SANRAL SOC;
- Access to the proposed development be gained via the existing access point at km 34.700 on MR00471 (R336) as indicated on **Figure 2**Error! Reference source not found.**;** and
- Suitable warning signage be erected on the approaches to the access point as indicated on **Figure 2**.

11 REFERENCES

1. *Joubert, Sampson, et al*, **TMH 16 Volume 1- South African Traffic Impact and Site Assessment Manual**, COTO, September 2013.
2. NITRR, **TRH 17 -Geometric Design of Rural Roads,** CSRA, September 1984.
3. Department of Transport, **South African Road Traffic Signs Manual 3rd Edition**, May 2012

ANNEXURE A Power of Attorney

ANNEXURE B Historical Traffic Data

Proposed Proposed Development of Citrus Orchards on Remainder of Farm 632, Uitenhage

24 Hr Historical - Count Volumes

Count Station	Location	ADT / ADTT	2015	2016	2017	2018	2019	2020	Total Growth (%)	Average Growth Per Annum (from 2001)
2122	ECDOT - MR00471 (R336) - East of MR0047	ADT	4636	-	-	-	-	-		%
		ADTT	-	-	-	-	-	-		
12124	SANRAL - MR00471 (R336) - East of MR0047	ADT	-	6905	-	-	-	-		
		ADTT	-	801	-	-	-	-		
2134	ECDOT - MR00471 (R336) - West of MR00470	ADT	4201	-	-	-	-	-		
		ADTT	-	-	-	-	-	-		
8211	SANRAL - MR00471 (R336) - West of MR00470	ADT	-	-	1578	1659	1773	1520	12.36	6.00 %
		ADTT	-	-	220	218	278	235		
12104	SANRAL - MR00471 (R336) - West of Unifruiti	ADT	-	1433	-	1703	-	-	18.84	9.01 %
		ADTT	-	115	-	238	-	-		
12106	SANRAL - MR00471 (R336) - East of Unifruiti	ADT	-	1480	-	-	-	-		
		ADTT	-	170	-	-	-	-		
					AVERAGE (All stations)					7.51 %

Station Information

Site Number	02122	**Site Identifier**	22449
Site Name	R336/MR00472 E		
Site Description	East of R336/MR00472 junction		
Site Type	Secondary (Temp)	**Owner**	EC DOT
Physical Lanes	4	**Responsibility**	NON-TOLL
Logical Lanes	4	**Installation Date**	2006-06-12
GPS Longitude	25.4469	**Termination Date**	
GPS Lattitude	-33.430780	**Status**	Discontinued
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	100
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	20.90

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To Addo			East	2	1
2	To Kirkwood			West	1	1

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 10

Station Traffic Highlights

Traffic Highlights of Site 02122

1.1	Site No			02122
1.2	Site Name			R336/MR00472 E
1.3	Site Description			East of R336/MR00472 junction
1.4	Road Description			Route : R336 Section : 01 Distance : 20.90 km
1.5	GPS Position			-33.430780 25.4469
1.6	Number of Lanes			4
1.7	Station Type			Secondary (Temp)
1.8	Requested Period			01 Jan 2015 - 31 Dec 2015
1.9	Length of Records Requested (hours)			8,760
1.10	Actual First & Last Dates			11 Aug 2015 - 14 Aug 2015
1.11	Actual Available Data (hours)			66
1.12	Percentage Data Available for Requested Period			0.8%
		To Addo	To Kirkwood	Total
2.1	Total Number of Vehicles	6,244	6,506	12,750
2.2	Average Daily Traffic (ADT)	2,271	2,366	4,636
2.3	Average Daily Truck Traffic (ADTT)	0	0	0
2.4	Percentage of Trucks	0.0%	0.0%	0.0%
2.5	Truck Split % (short:medium:long)	0 : 0 : 0	0 : 0 : 0	0 : 0 : 0
2.6	Percentage of Night Traffic [20h00 - 6h00]	6.1%	7.7%	6.9%
3.1	Speed Limit (km/hr)			100
3.2	Average Speed (km/hr)	0.0	0.0	0.0
3.3	Average Speed - Light Vehicles (km/hr)	0.0	0.0	0.0
3.4	Average Speed - Heavy Vehicles (km/hr)	0.0	0.0	0.0
3.5	Average Night Speed (km/hr)	0.0	0.0	0.0
3.6	15th Centile Speed (km/hr)	0.0	0.0	0.0
3.7	85th Centile Speed (km/hr)	0.0	0.0	0.0
3.8	Percentage of Vehicles in Excess of Speed Limit	0.0%	0.0%	0.0%
4.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0.0%	0.0%	0.0%
4.2	Highest Volume on the Road (vehs/hr)		13 Aug 2015 (07:00 - 08:00)	442
4.3	Highest Volume in the East (vehs/hr)		11 Aug 2015 (17:00 - 18:00)	262
4.4	Highest Volume in the West (vehs/hr)		12 Aug 2015 (07:00 - 08:00)	260
4.5	Highest Volume in a Lane (vehs/hr)		11 Aug 2015 (17:00 - 18:00)	262
4.6	15th Highest Volume on the Road (vehs/hr)		13 Aug 2015 (09:00 - 10:00)	374
4.7	15th Highest Volume in the East Direction (vehs/hr)		12 Aug 2015 (09:00 - 10:00)	184
4.8	15th Highest Volume in the West Direction (vehs/hr)		12 Aug 2015 (12:00 - 13:00)	184
4.9	30th Highest Volume on the Road (vehs/hr)		11 Aug 2015 (18:00 - 19:00)	210
4.10	30th Highest Volume in the East Direction (vehs/hr)		13 Aug 2015 (06:00 - 07:00)	84
4.11	30th Highest Volume in the West Direction (vehs/hr)		12 Aug 2015 (16:00 - 17:00)	124
5.1	Percentage of Vehicles less than 2s behind vehicle ahead	0.0%	0.0%	0.0%
6.1	Total Number of Heavy Vehicles	0	0	0
6.2	Estimated Average Number of axles per Truck	0.0	0.0	0.0
6.3	Estimated Truck Mass (Ton/Truck)	0.0	0.0	0.0

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 11

6.4	Estimated Average E80 / Truck	0.0	0.0	0.0
6.5	Estimated Daily E80 on the Road			0
6.6	Estimated Daily E80 in the East Direction			0
6.7	Estimated Daily E80 in the West Direction			0
6.8	Estimated Daily E80 in the Worst East Lane			0
6.9	Estimated Daily E80 in the Worst West Lane			0
6.10	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
6.11	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
6.12	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 12

Station Typical Flow Graphs

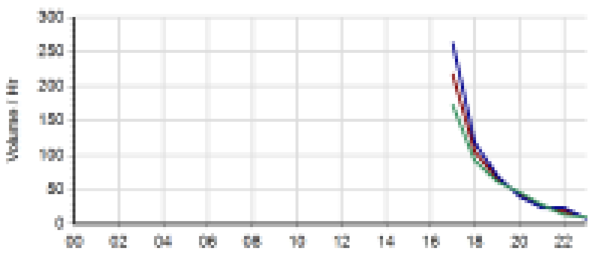
Site	02122 - R336/MR00472 E
Region	South
Actual Period	11 Aug 2015 - 14 Aug 2015
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

Line		Bar	
	Total		Total
	To Addo		Light
	To Kirkwood		Heavy

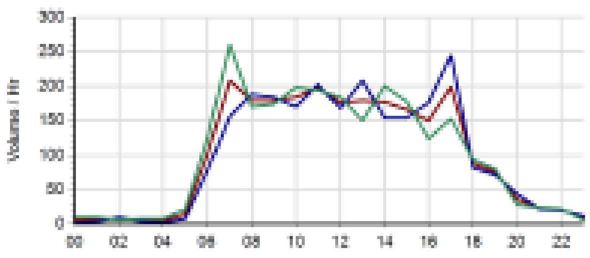
Typical Flow for a Monday

No Data Available

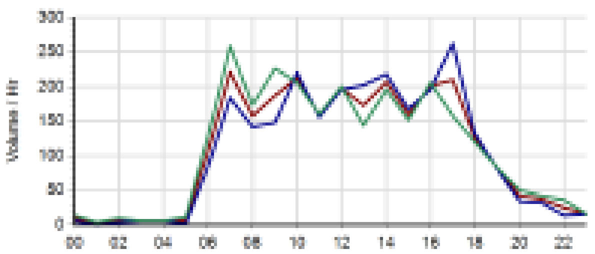
Typical Flow for a Tuesday



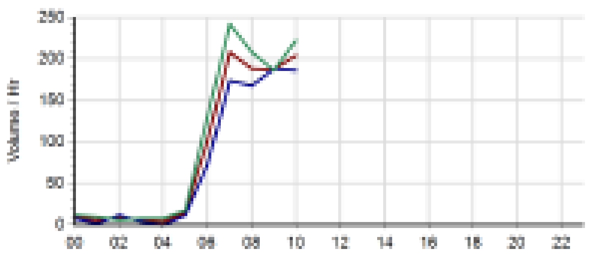
Typical Flow for a Wednesday



Typical Flow for a Thursday



Typical Flow for a Friday



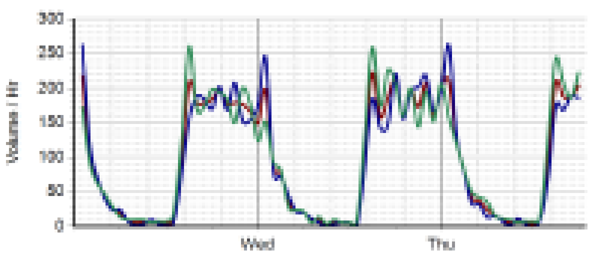
Typical Flow for a Saturday

No Data Available

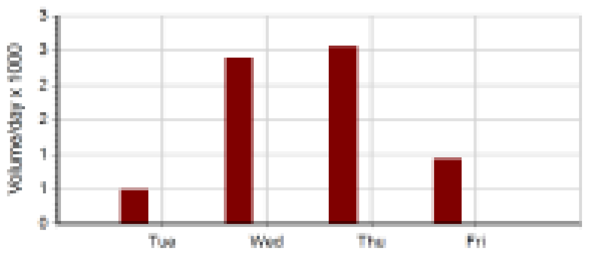
Typical Flow for a Sunday

No Data Available

Typical Flow for a Week



Typical Flow for a Week



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 13

Station Light/Heavy Volume by Lane

Site	02122 R336/MR00472 E

Date	Dur. (Hr)	To Addo		
		Lane 1		
		Light	Heavy	Total
Jan 2015				
Feb 2015				
Mar 2015				
Apr 2015				
May 2015				
Jun 2015				
Jul 2015				
Aug 2015	132	6,244		6,244
Sep 2015				
Oct 2015				
Nov 2015				
Dec 2015				
	Total	6,244		6,244

Date	Dur. (Hr)	To Kirkwood		
		Lane 2		
		Light	Heavy	Total
Jan 2015				
Feb 2015				
Mar 2015				
Apr 2015				
May 2015				
Jun 2015				
Jul 2015				
Aug 2015	132	6,506		6,506
Sep 2015				
Oct 2015				
Nov 2015				
Dec 2015				
	Total	6,506		6,506

SANRAL Yearbook

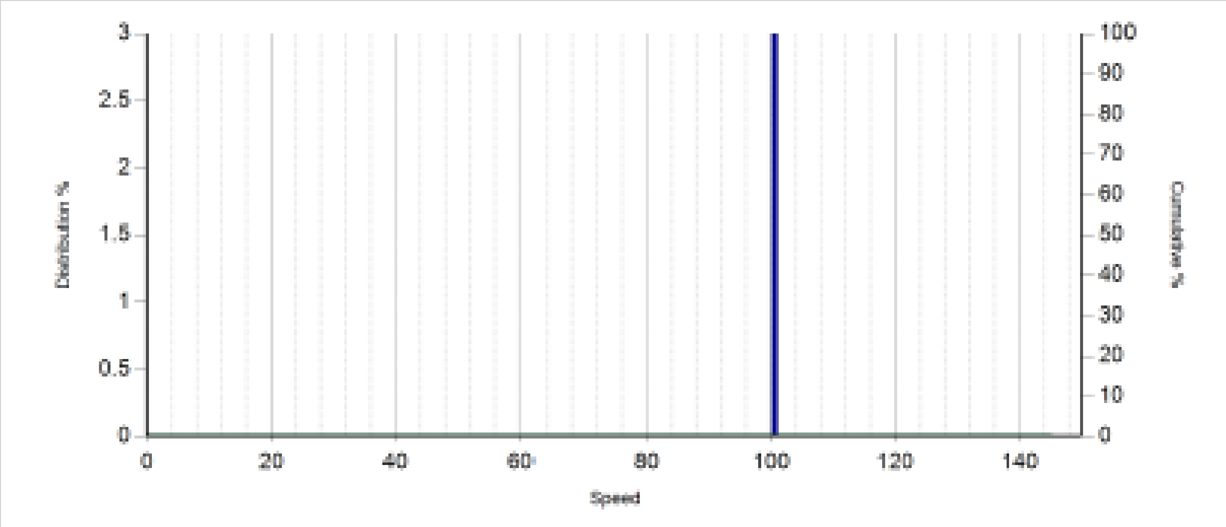
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 14

Station Speed Distribution

Site	02122 - R336/MR00472 E	Distribution
Speed Limit	100 km/hr	Cumulative
Period	01 Jan 2015 - 31 Dec 2015	Speed Limit

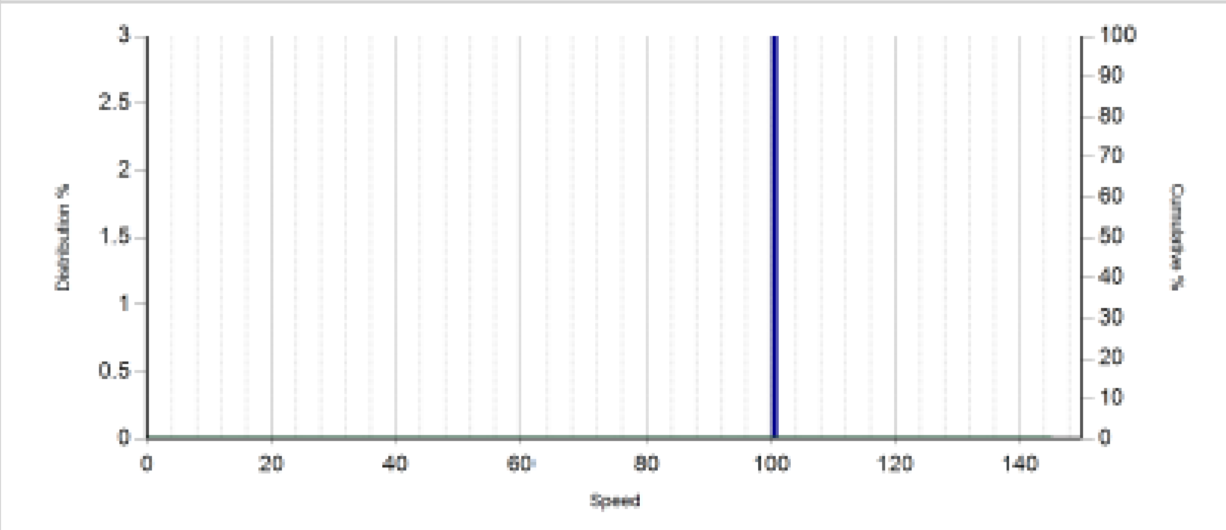
Lane 1 - To Addo



Station Speed Distribution

Site	02122 - R336/MR00472 E	Distribution
Speed Limit	100 km/hr	Cumulative
Period	01 Jan 2015 - 31 Dec 2015	Speed Limit

Lane 2 - To Kirkwood



SANRAL Yearbook

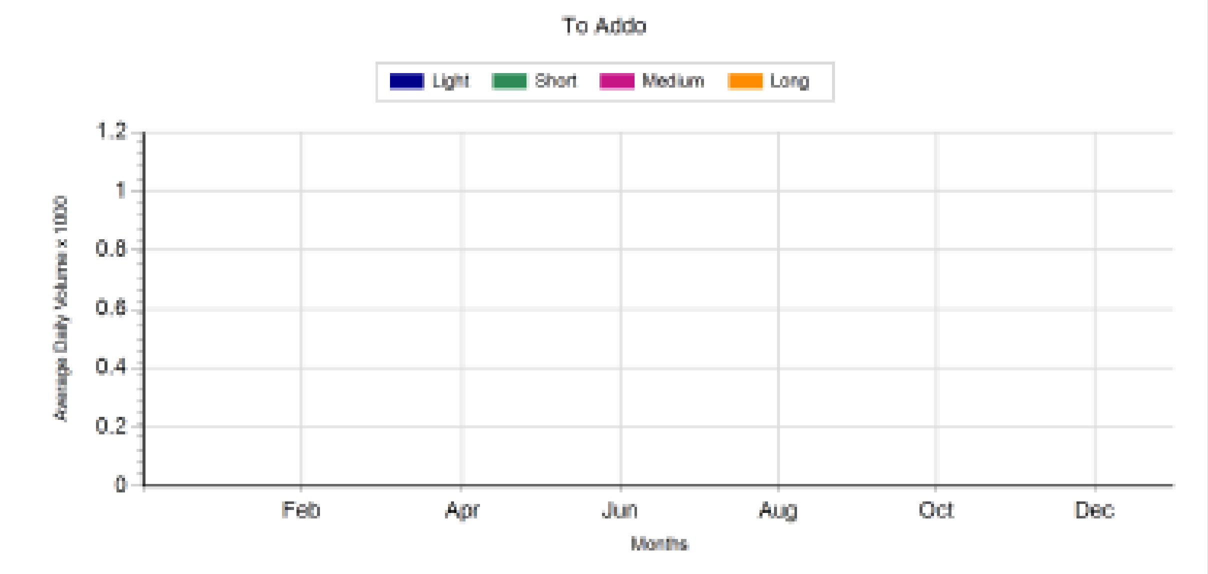
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 15

Station Extended Light/Heavy Class

Site	02122 R336/MR00472 E

To Addo							
Month	% Data	Light	Short	Medium	Long	Heavy Total	Total
Jan 2015	0.0						
Feb 2015	0.0						
Mar 2015	0.0						
Apr 2015	0.0						
May 2015	0.0						
Jun 2015	0.0						
Jul 2015	0.0						
Aug 2015	17.7	6,244				0	6,244
Sep 2015	0.0						
Oct 2015	0.0						
Nov 2015	0.0						
Dec 2015	0.0						
Total	1.5	6,244				0	6,244



SANRAL Yearbook

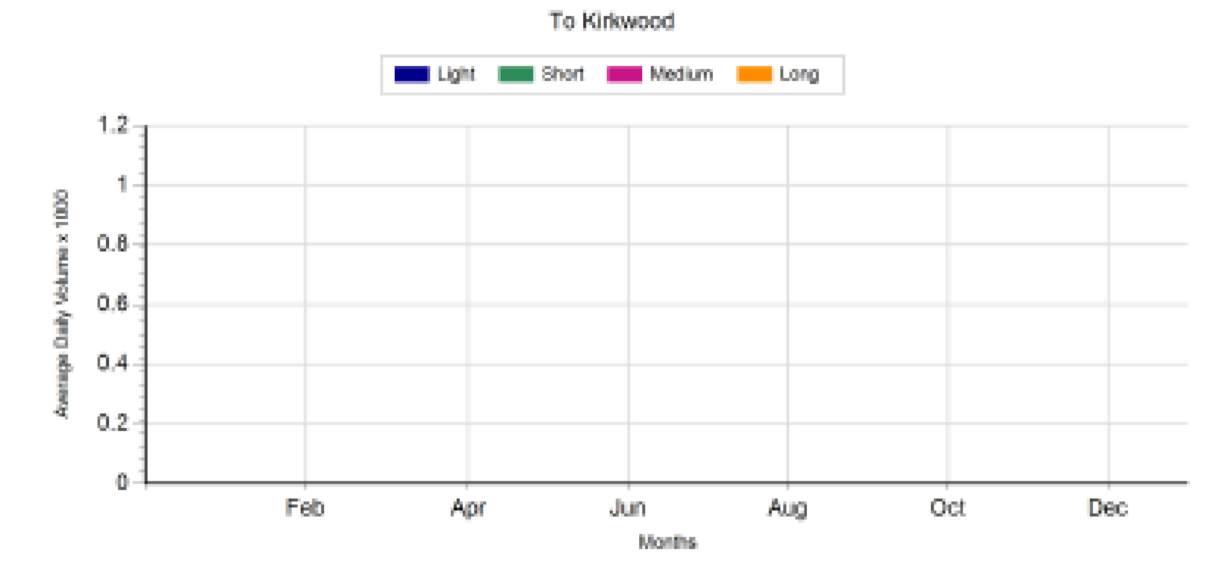
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 16

Station Extended Light/Heavy Class

Site	02122 R336/MR00472 E

To Kirkwood							
Month	**% Data**	**Light**	**Short**	**Medium**	**Long**	**Heavy Total**	**Total**
Jan 2015	0.0						
Feb 2015	0.0						
Mar 2015	0.0						
Apr 2015	0.0						
May 2015	0.0						
Jun 2015	0.0						
Jul 2015	0.0						
Aug 2015	17.7	6,506				0	6,506
Sep 2015	0.0						
Oct 2015	0.0						
Nov 2015	0.0						
Dec 2015	0.0						
Total	1.5	6,506				0	6,506



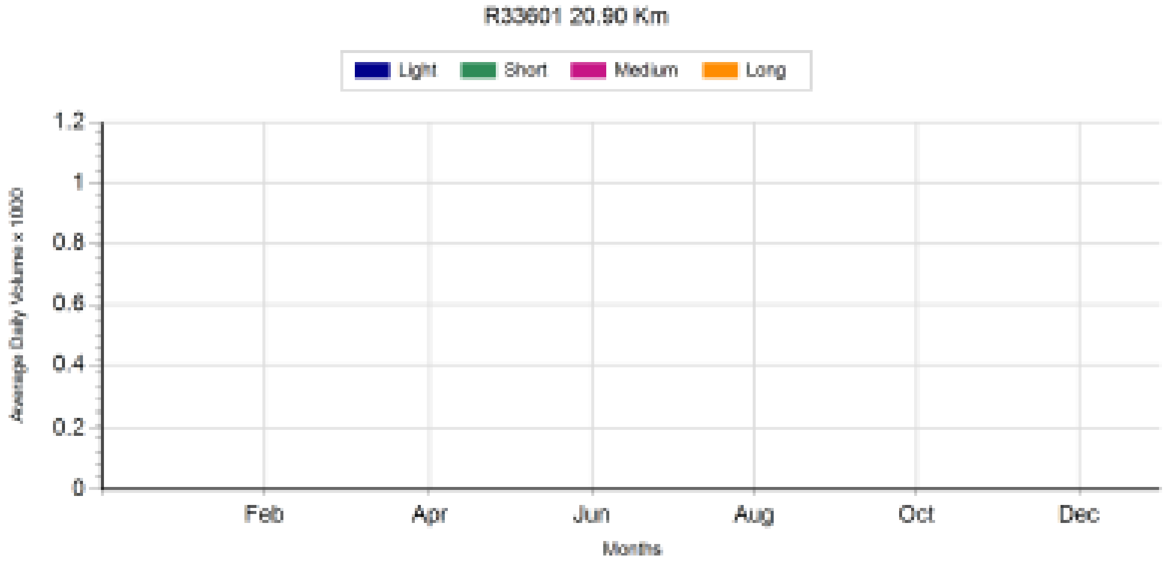
SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 17

Site	02122 R336/MR00472 E

R33601 20.90 Km							
Month	% Data	Light	Short	Medium	Long	Heavy Total	Total
Jan 2015	0.0						
Feb 2015	0.0						
Mar 2015	0.0						
Apr 2015	0.0						
May 2015	0.0						
Jun 2015	0.0						
Jul 2015	0.0						
Aug 2015	17.7	12,750				0	12,750
Sep 2015	0.0						
Oct 2015	0.0						
Nov 2015	0.0						
Dec 2015	0.0						
Total	1.5	12,750				0	12,750



Station Information

Site Number	02134	**Site Identifier**	22357
Site Name	MR00471 / MR00470 W		
Site Description	West of MR00471 / MR00470 junction		
Site Type	Secondary (Temp)	**Owner**	EC DOT
Physical Lanes	4	**Responsibility**	NON-TOLL
Logical Lanes	4	**Installation Date**	2006-09-18
GPS Longitude	25.6075	**Termination Date**	
GPS Lattitude	-33.502220	**Status**	Discontinued
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	100
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	38.64

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To Addo			East	1	1
2	To Kirkwood			West	2	1

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 19

Station Traffic Highlights

Traffic Highlights of Site 02134

1.1	Site No			02134
1.2	Site Name			MR00471 / MR00470 W
1.3	Site Description			West of MR00471 / MR00470 junction
1.4	Road Description			Route : R336 Section : 01 Distance : 38.64 km
1.5	GPS Position			-33.502220 25.6075
1.6	Number of Lanes			4
1.7	Station Type			Secondary (Temp)
1.8	Requested Period			01 Jan 2015 - 31 Dec 2015
1.9	Length of Records Requested (hours)			8,760
1.10	Actual First & Last Dates			08 Jun 2015 - 11 Jun 2015
1.11	Actual Available Data (hours)			70
1.12	Percentage Data Available for Requested Period			0.8%
		To Addo	**To Kirkwood**	**Total**
2.1	Total Number of Vehicles	6,374	5,878	12,252
2.2	Average Daily Traffic (ADT)	2,185	2,015	4,201
2.3	Average Daily Truck Traffic (ADTT)	0	0	0
2.4	Percentage of Trucks	0.0%	0.0%	0.0%
2.5	Truck Split % (short:medium:long)	0 : 0 : 0	0 : 0 : 0	0 : 0 : 0
2.6	Percentage of Night Traffic [20h00 - 6h00]	4.7%	5.5%	5.1%
3.1	Speed Limit (km/hr)			100
3.2	Average Speed (km/hr)	0.0	0.0	0.0
3.3	Average Speed - Light Vehicles (km/hr)	0.0	0.0	0.0
3.4	Average Speed - Heavy Vehicles (km/hr)	0.0	0.0	0.0
3.5	Average Night Speed (km/hr)	0.0	0.0	0.0
3.6	15th Centile Speed (km/hr)	0.0	0.0	0.0
3.7	85th Centile Speed (km/hr)	0.0	0.0	0.0
3.8	Percentage of Vehicles in Excess of Speed Limit	0.0%	0.0%	0.0%
4.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0.0%	0.0%	0.0%
4.2	Highest Volume on the Road (vehs/hr)		08 Jun 2015 (17:00 - 18:00)	416
4.3	Highest Volume in the East (vehs/hr)		09 Jun 2015 (17:00 - 18:00)	236
4.4	Highest Volume in the West (vehs/hr)		10 Jun 2015 (08:00 - 09:00)	196
4.5	Highest Volume in a Lane (vehs/hr)		09 Jun 2015 (17:00 - 18:00)	236
4.6	15th Highest Volume on the Road (vehs/hr)		09 Jun 2015 (16:00 - 17:00)	344
4.7	15th Highest Volume in the East Direction (vehs/hr)		09 Jun 2015 (08:00 - 09:00)	174
4.8	15th Highest Volume in the West Direction (vehs/hr)		10 Jun 2015 (12:00 - 13:00)	160
4.9	30th Highest Volume on the Road (vehs/hr)		09 Jun 2015 (15:00 - 16:00)	272
4.10	30th Highest Volume in the East Direction (vehs/hr)		10 Jun 2015 (13:00 - 14:00)	138
4.11	30th Highest Volume in the West Direction (vehs/hr)		08 Jun 2015 (13:00 - 14:00)	118
5.1	Percentage of Vehicles less than 2s behind vehicle ahead	0.0%	0.0%	0.0%
6.1	Total Number of Heavy Vehicles	0	0	0
6.2	Estimated Average Number of axles per Truck	0.0	0.0	0.0
6.3	Estimated Truck Mass (Ton/Truck)	0.0	0.0	0.0

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 20

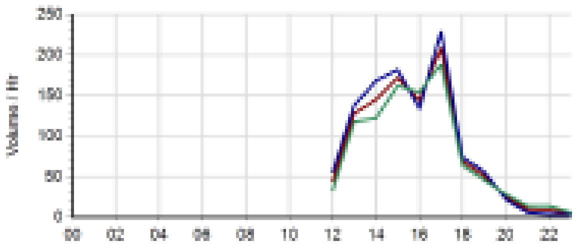
6.4	Estimated Average E80 / Truck	0.0	0.0	0.0
6.5	Estimated Daily E80 on the Road			0
6.6	Estimated Daily E80 in the East Direction			0
6.7	Estimated Daily E80 in the West Direction			0
6.8	Estimated Daily E80 in the Worst East Lane			0
6.9	Estimated Daily E80 in the Worst West Lane			0
6.10	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
6.11	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
6.12	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

Station Typical Flow Graphs

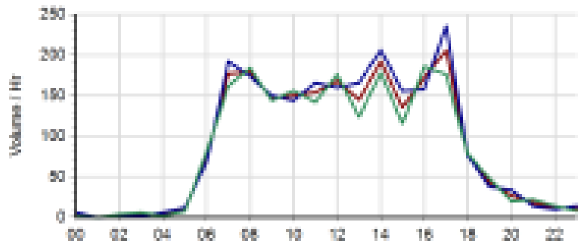
Site	02134 - MR00471 / MR00470 W
Region	South
Actual Period	08 Jun 2015 - 11 Jun 2015
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

Total — Total
To Addo — Light
To Kirkwood — Heavy

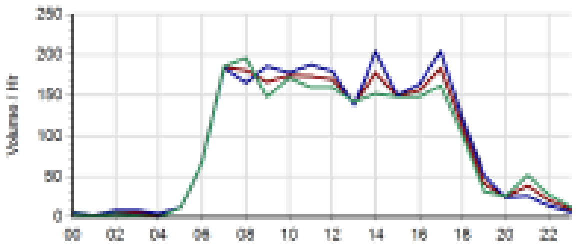
Typical Flow for a Monday



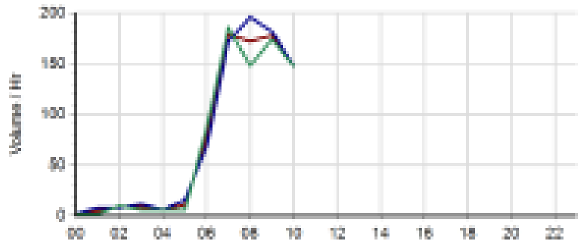
Typical Flow for a Tuesday



Typical Flow for a Wednesday



Typical Flow for a Thursday



Typical Flow for a Friday

No Data Available

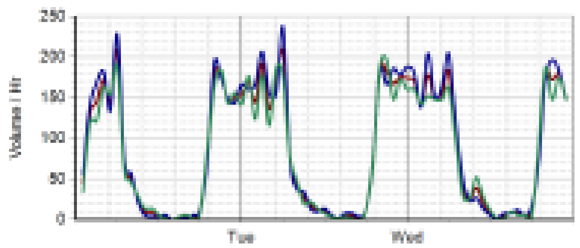
Typical Flow for a Saturday

No Data Available

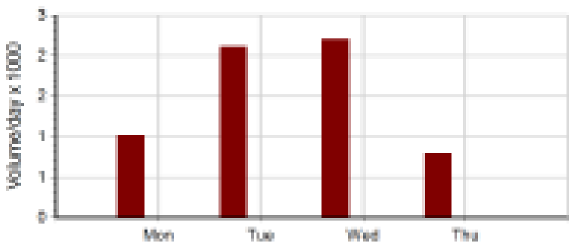
Typical Flow for a Sunday

No Data Available

Typical Flow for a Week



Typical Flow for a Week



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 22

Station Light/Heavy Volume by Lane

Site	02134 MR00471 / MR00470 W

Date	Dur. (Hr)	To Addo		
		Lane 1		
		Light	Heavy	Total
Jan 2015				
Feb 2015				
Mar 2015				
Apr 2015				
May 2015				
Jun 2015	141	6,374		6,374
Jul 2015				
Aug 2015				
Sep 2015				
Oct 2015				
Nov 2015				
Dec 2015				
	Total	6,374		6,374

Date	Dur. (Hr)	To Kirkwood		
		Lane 2		
		Light	Heavy	Total
Jan 2015				
Feb 2015				
Mar 2015				
Apr 2015				
May 2015				
Jun 2015	141	5,878		5,878
Jul 2015				
Aug 2015				
Sep 2015				
Oct 2015				
Nov 2015				
Dec 2015				
	Total	5,878		5,878

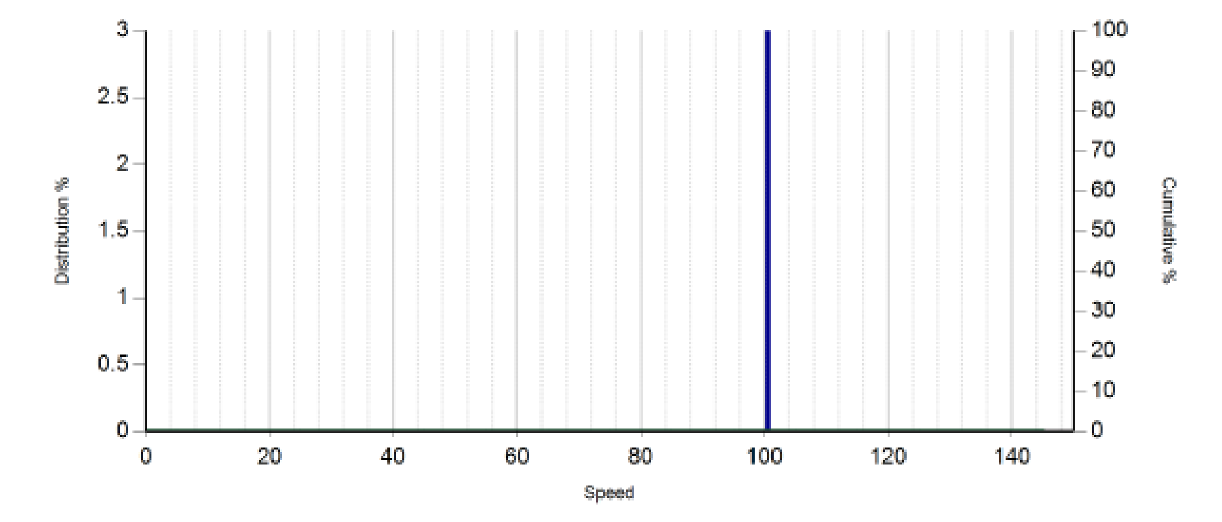
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Speed Distribution

Site	02134 - MR00471 / MR00470 W
Speed Limit	100 km/hr
Period	01 Jan 2015 - 31 Dec 2015

Distribution
Cumulative
Speed Limit

Lane 1 - To Addo

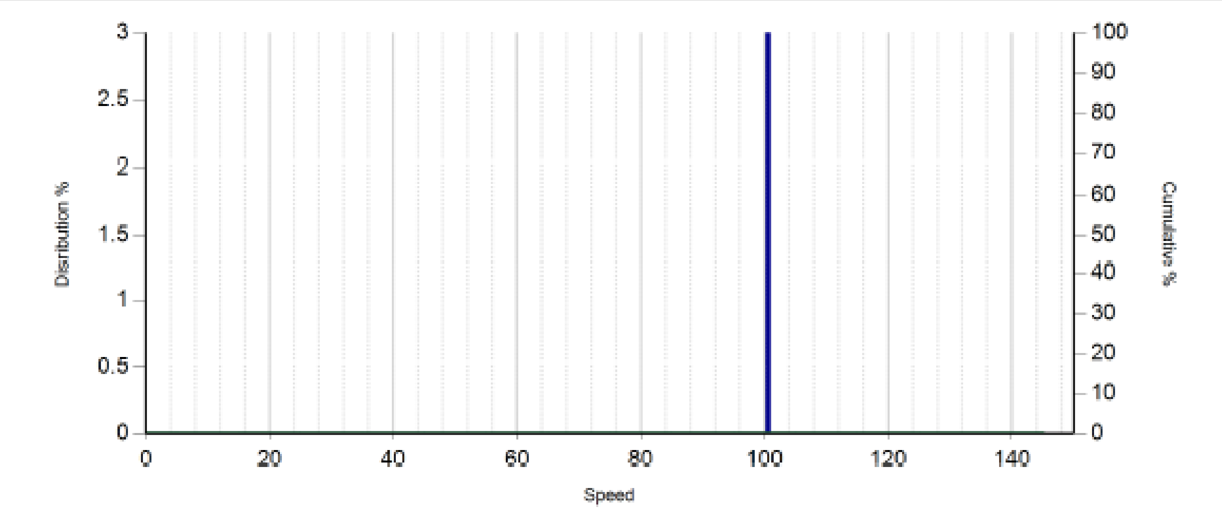


Station Speed Distribution

Site	02134 - MR00471 / MR00470 W
Speed Limit	100 km/hr
Period	01 Jan 2015 - 31 Dec 2015

Distribution
Cumulative
Speed Limit

Lane 2 - To Kirkwood



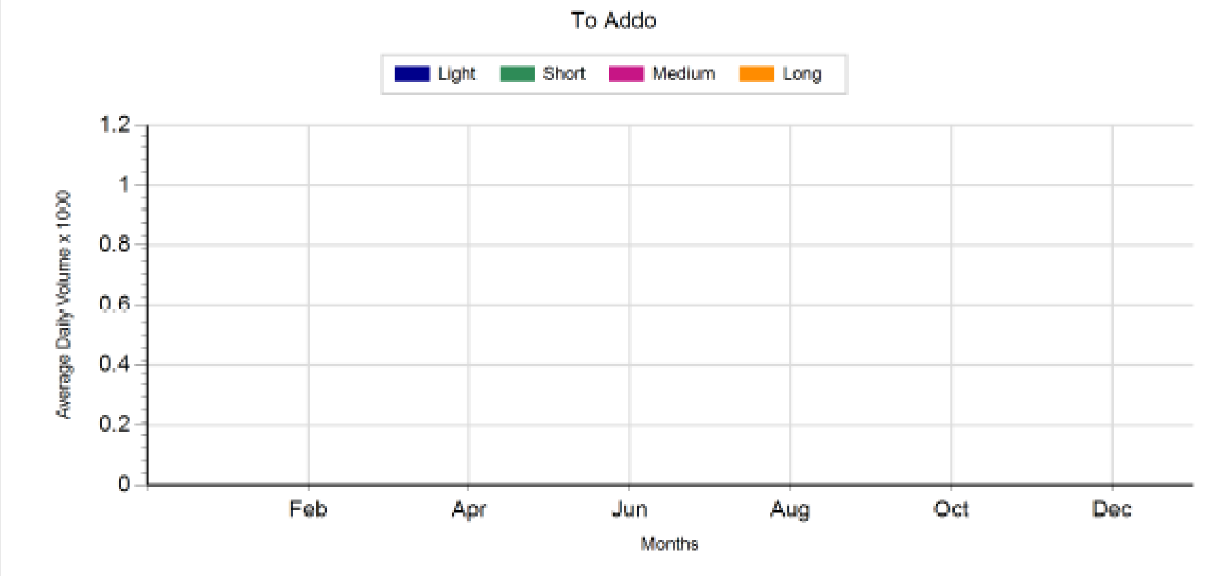
SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 24

Station Extended Light/Heavy Class

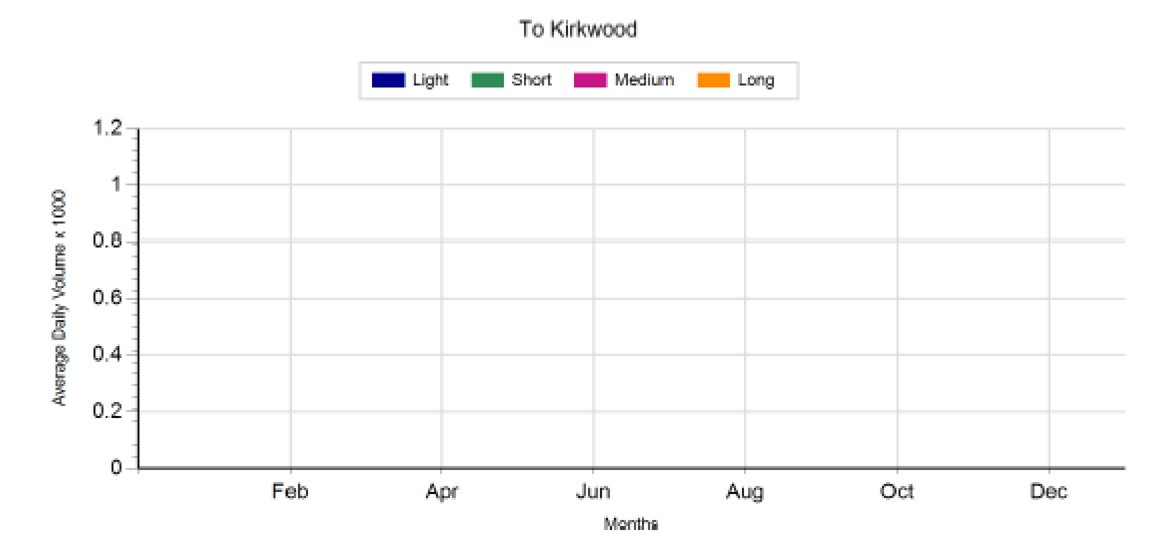
Site	02134 MR00471 / MR00470 W						
To Addo							
Month	% Data	Light	Short	Medium	Long	Heavy Total	Total
Jan 2015	0.0						
Feb 2015	0.0						
Mar 2015	0.0						
Apr 2015	0.0						
May 2015	0.0						
Jun 2015	19.5	6,374				0	6,374
Jul 2015	0.0						
Aug 2015	0.0						
Sep 2015	0.0						
Oct 2015	0.0						
Nov 2015	0.0						
Dec 2015	0.0						
Total	1.6	6,374				0	6,374



Station Extended Light/Heavy Class

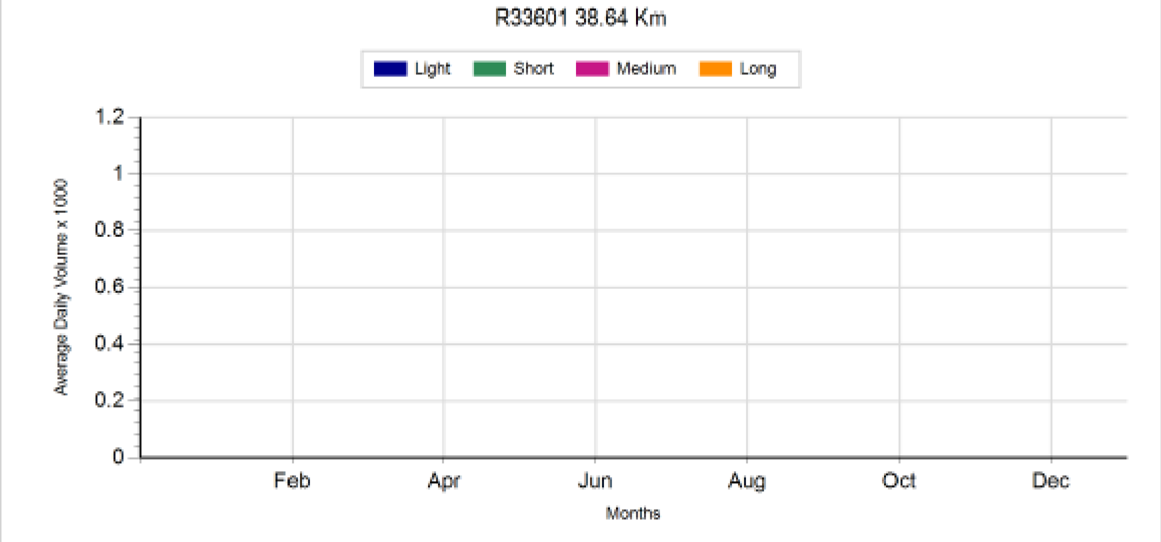
Site	02134 MR00471 / MR00470 W

To Kirkwood							
Month	**% Data**	**Light**	**Short**	**Medium**	**Long**	**Heavy Total**	**Total**
Jan 2015	0.0						
Feb 2015	0.0						
Mar 2015	0.0						
Apr 2015	0.0						
May 2015	0.0						
Jun 2015	19.5	5,878				0	5,878
Jul 2015	0.0						
Aug 2015	0.0						
Sep 2015	0.0						
Oct 2015	0.0						
Nov 2015	0.0						
Dec 2015	0.0						
Total	1.6	5,878				0	5,878



Site	02134 MR00471 / MR00470 W

R33601 38.64 Km							
Month	% Data	Light	Short	Medium	Long	Heavy Total	Total
Jan 2015	0.0						
Feb 2015	0.0						
Mar 2015	0.0						
Apr 2015	0.0						
May 2015	0.0						
Jun 2015	19.5	12,252				0	12,252
Jul 2015	0.0						
Aug 2015	0.0						
Sep 2015	0.0						
Oct 2015	0.0						
Nov 2015	0.0						
Dec 2015	0.0						
Total	1.6	12,252				0	12,252



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 27

Station Information

Site Number	12124	**Site Identifier**	27883
Site Name	EC_R336_01_20.5		
Site Description	Between Kirkwood and Paterson		
Site Type	Secondary (Temp)	**Owner**	SANRAL
Physical Lanes	2	**Responsibility**	NON-TOLL
Logical Lanes	2	**Installation Date**	2016-11-04
GPS Longitude	25.446417	**Termination Date**	
GPS Latitude	-33.430637	**Status**	In Use
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	100
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	20.85
Authority	SANRAL	**Contract No**	NRA 53000/2016/1
Contract Org	Mikros Traffic Monitoring (Pty) Ltd	**Station History Type**	Full Site
System Type	C1		

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To Paterson	1	To Paterson	East	2	1
2	To Kirkwood	2	To Kirkwood	West	1	1

PHOTO

Direction 1

To Paterson

PHOTO

Direction 2

To Kirkwood

PHOTO

As Built

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 11

Traffic Highlights of Site: EC_R336_01_20.5 (12124)	
Site No	12124
Site Name	EC_R336_01_20.5
Site Description	Between Kirkwood and Paterson
Road Description	Route : R336 Section : 01E Distance : 20.85 km
GPS Position	Latitude: -33.430637 Longitude: 25.446417
Number of Lanes	2
Station Type	Secondary (Temp)
Requested Data Period	01 Jan 2016 - 31 Dec 2016
First and Last Data Dates	06 Nov 2016 - 14 Nov 2016
Data Available for Requested Period as Percentage	2%
Last Full Day Count for ADT and ADTT	13 Nov 2016
Number of Full Days in Requested Period	8

Highlights per Stream		Str 1: To Paterson	Str 2: To Kirkwood	Value
1.1	Total Number of Vehicles	3,610	3,295	6,905
1.2	Average Daily Traffic (ADT)	420	381	801
1.3	Average Daily Truck Traffic (ADTT)	58	67	125
1.4	Percentage of Trucks	13.5 %	17.8 %	15.6 %
1.5	Truck Split % (Short : Medium : Long)	50 : 27 : 23	28 : 35 : 37	39 : 31 : 30
1.6	Percentage of Night Traffic [20h00 - 6h00)	7.8 %	9.5 %	8.6 %
2.1	Speed Limit			100
2.2	Average Speed (km/hr)	92.9	85.3	89.1
2.3	Average Speed - Light Vehicles (km/hr	93.8	85.5	89.7
2.4	Average Speed - Heavy Vehicles (km/hr)	85.0	80.9	83.0
2.5	Average Night Speed (km/hr)	96.4	87.3	91.9
2.6	15th Centile Speed (km/hr)	75.8	70.6	73.2
2.7	85th Centile Speed (km/hr)	108.9	101.7	105.3
2.8	Percentage of Vehicles in Excess of Speed Limit	57.7 %	53.2 %	55.4 %
3.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0 %	0 %	0.00%
3.2	Percentage of Vehicles less than 2s behind vehicle ahead	0 %	0 %	0 %

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 12

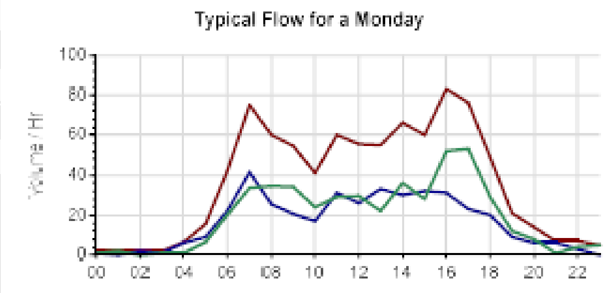
4.1	Total Number of Heavy Vehicles	489	586	1,075
4.2	Estimated Average Number of axles per Truck	4.0	4.9	4.5
4.3	Estimated Truck Mass (Ton/Truck)	23.1	28.8	26.0
4.4	Estimated Average E80 / Truck	1.7	2.3	2.00
4.5	Estimated Daily E80 on the Road			298.0
4.6	Estimated Daily E80 in the East Direction			407.0
4.7	Estimated Daily E80 in the West Direction			488.0
4.8	Estimated Daily E80 in the Worst East Lane			488.0
4.9	Estimated Daily E80 in the Worst West Lane			407.0
5.1	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
5.2	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
5.3	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

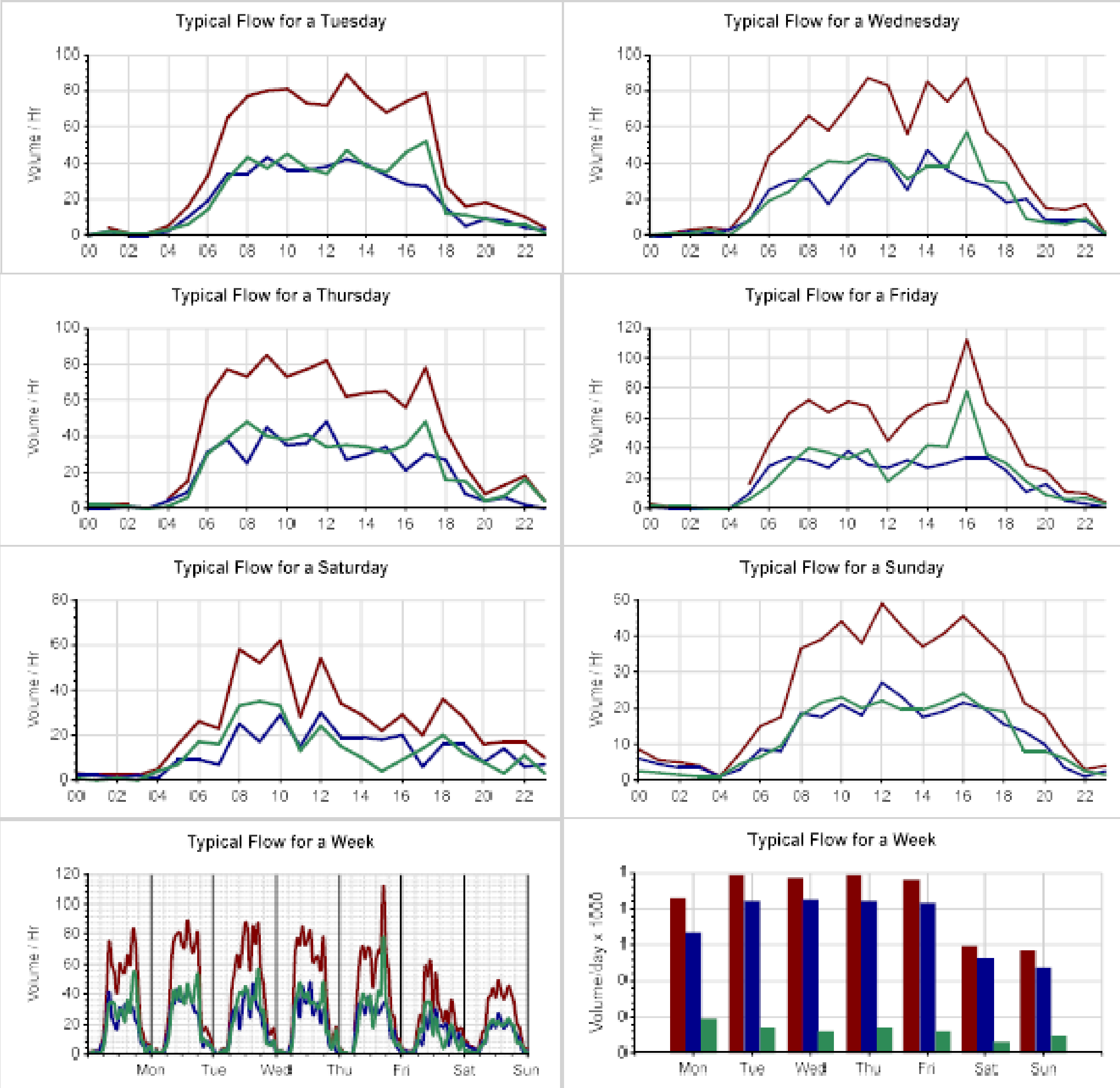
Traffic Volumes		Date and Time	Value
6.1	Highest Volume on the Road (vehs/hr)	11 Nov 2016 (16:00 - 17:00)	112
6.2	Highest Volume in the East (vehs/hr)	11 Nov 2016 (16:00 - 17:00)	78
6.3	Highest Volume in the West (vehs/hr)	10 Nov 2016 (12:00 - 13:00)	48
6.4	Highest Volume in a Lane (vehs/hr)	11 Nov 2016 (16:00 - 17:00)	78
6.5	15th Highest Volume on the Road (vehs/hr)	08 Nov 2016 (08:00 - 09:00)	77
6.6	15th Highest Volume in the East Direction (vehs/hr)	11 Nov 2016 (14:00 - 15:00)	42
6.7	15th Highest Volume in the West Direction (vehs/hr)	07 Nov 2016 (07:00 - 08:00)	36
6.8	30th Highest Volume on the Road (vehs/hr)	07 Nov 2016 (07:00 - 08:00)	72
6.9	30th Highest Volume in the East Direction (vehs/hr)	08 Nov 2016 (09:00 - 10:00)	37
6.10	30th Highest Volume in the West Direction (vehs/hr)	14 Nov 2016 (09:00 - 10:00)	32

Station Typical Flow Graphs

Site	12124 - EC_R336_01_20.5
Region	South
Actual Period	06 Nov 2016 - 14 Nov 2016
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

Total	Total
To Kirkwood	Light
To Paterson	Heavy





SANRAL

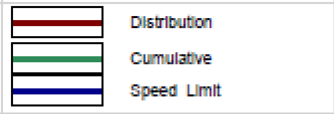
SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 14

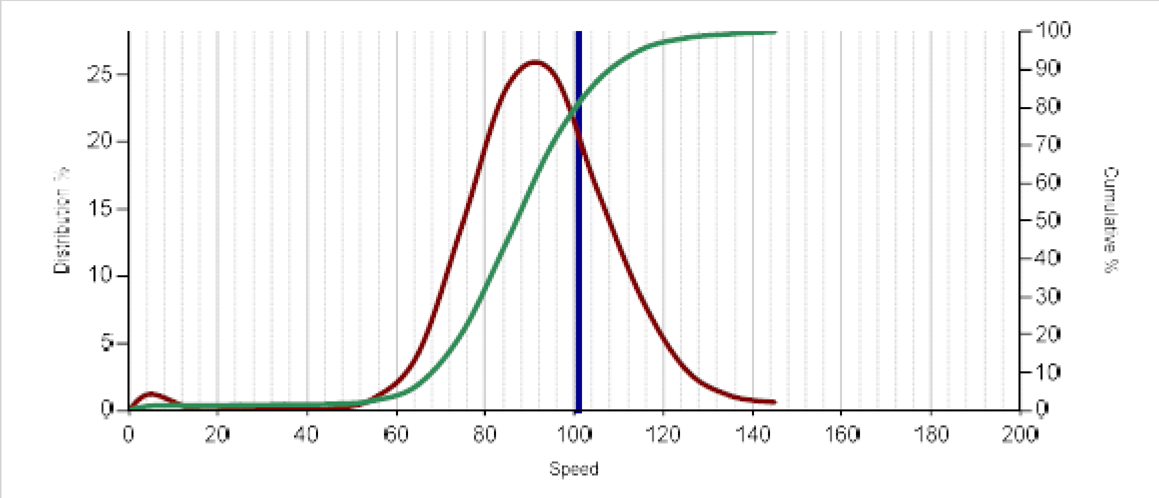
Station Speed Distribution

Site	12124 - EC_R336_01_20.5
Speed Limit	100 km/hr
Period	01 Jan 2016 - 31 Dec 2016



Station Speed Distribution

Site	12124 - EC_R336_01_20.5
Speed Limit	100 km/hr
Period	01 Jan 2016 - 31 Dec 2016



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 15

Station Information

Site Number	12104	**Site Identifier**	27879
Site Name	EC_R336_01_30.4		
Site Description	Between Kirkwood and Paterson		
Site Type	Secondary (Temp)	**Owner**	SANRAL
Physical Lanes	2	**Responsibility**	NON-TOLL
Logical Lanes	2	**Installation Date**	2016-11-04
GPS Longitude	25.530251	**Termination Date**	
GPS Lattitude	-33.471416	**Status**	In Use
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	80
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	30.37
Authority	SANRAL	**Contract No**	NRA 53000/2016/1
Contract Org	Mikros Traffic Monitoring (Pty) Ltd	**Station History Type**	Full Site
System Type	C1		

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To Paterson	1	To Paterson	East	2	1
2	To Kirkwood	2	To Kirkwood	West	1	1

PHOTO

Direction 1

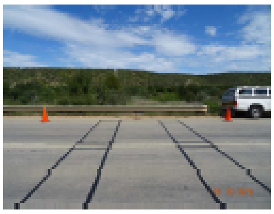
To Paterson

PHOTO

Direction 2

To Kirkwood

PHOTO



As Built

SANRAL

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Traffic Highlights of Site: EC_R336_01_30.4 (12104)	
Site No	12104
Site Name	EC_R336_01_30.4
Site Description	Between Kirkwood and Paterson
Road Description	Route : R336 Section : 01E Distance : 30.37 km
GPS Position	Latitude: -33.471416 Longitude: 25.530251
Number of Lanes	2
Station Type	Secondary (Temp)

Requested Data Period	01 Jan 2016 - 31 Dec 2016
First and Last Data Dates	04 Nov 2016 - 14 Nov 2016
Data Available for Requested Period as Percentage	3%

Last Full Day Count for ADT and ADTT	13 Nov 2016
Number of Full Days in Requested Period	9

Highlights per Stream		Str 1: To Paterson	Str 2: To Kirkwood	Value
1.1	Total Number of Vehicles	7,153	7,073	14,226
1.2	Average Daily Traffic (ADT)	717	716	1,433
1.3	Average Daily Truck Traffic (ADTT)	61	54	115
1.4	Percentage of Trucks	8.6 %	7.5 %	8.1 %
1.5	Truck Split % (Short : Medium : Long)	70 : 18 : 12	70 : 17 : 13	70 : 18 : 12
1.6	Percentage of Night Traffic [20h00 - 6h00)	7.5 %	8.7 %	8.1 %
2.1	Speed Limit			80
2.2	Average Speed (km/hr)	91.5	91.4	91.5
2.3	Average Speed - Light Vehicles (km/hr	92.1	92.3	92.2
2.4	Average Speed - Heavy Vehicles (km/hr)	82.5	77.2	79.9
2.5	Average Night Speed (km/hr)	90.5	91.9	91.2
2.6	15th Centile Speed (km/hr)	74.5	74.7	74.6
2.7	85th Centile Speed (km/hr)	110.0	108.5	109.3
2.8	Percentage of Vehicles in Excess of Speed Limit	86.4 %	86.6 %	86.5 %
3.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0 %	0 %	0.00%
3.2	Percentage of Vehicles less than 2s behind vehicle ahead	0 %	0 %	0 %

SANRAL
BUILDING SOUTH AFRICA THROUGH BETTER ROADS

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 17

4.1	Total Number of Heavy Vehicles	617	533	1,150
4.2	Estimated Average Number of axles per Truck	3.1	3.2	3.2
4.3	Estimated Truck Mass (Ton/Truck)	18.1	18.2	18.2
4.4	Estimated Average E80 / Truck	1.2	1.2	1.20
4.5	Estimated Daily E80 on the Road			264.0
4.6	Estimated Daily E80 in the East Direction			425.0
4.7	Estimated Daily E80 in the West Direction			367.0
4.8	Estimated Daily E80 in the Worst East Lane			425.0
4.9	Estimated Daily E80 in the Worst West Lane			367.0
5.1	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
5.2	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
5.3	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

Traffic Volumes		Date and Time	Value
6.1	Highest Volume on the Road (vehs/hr)	14 Nov 2016 (07:00 - 08:00)	174
6.2	Highest Volume in the East (vehs/hr)	08 Nov 2016 (07:00 - 08:00)	101
6.3	Highest Volume in the West (vehs/hr)	11 Nov 2016 (16:00 - 17:00)	95
6.4	Highest Volume in a Lane (vehs/hr)	08 Nov 2016 (07:00 - 08:00)	101
6.5	15th Highest Volume on the Road (vehs/hr)	08 Nov 2016 (09:00 - 10:00)	145
6.6	15th Highest Volume in the East Direction (vehs/hr)	08 Nov 2016 (13:00 - 14:00)	70
6.7	15th Highest Volume in the West Direction (vehs/hr)	11 Nov 2016 (13:00 - 14:00)	77
6.8	30th Highest Volume on the Road (vehs/hr)	10 Nov 2016 (10:00 - 11:00)	136
6.9	30th Highest Volume in the East Direction (vehs/hr)	08 Nov 2016 (14:00 - 15:00)	67
6.10	30th Highest Volume in the West Direction (vehs/hr)	08 Nov 2016 (07:00 - 08:00)	69

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

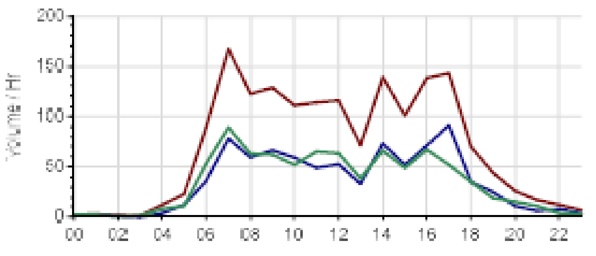
Station Data - 16

Station Typical Flow Graphs

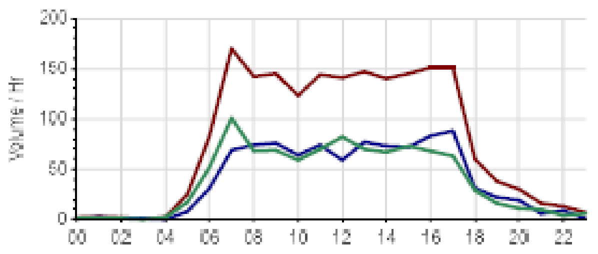
Site	12104 - EC_R336_01_30.4
Region	South
Actual Period	04 Nov 2016 - 14 Nov 2016
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

Total	Total
To Kirkwood	Light
To Paterson	Heavy

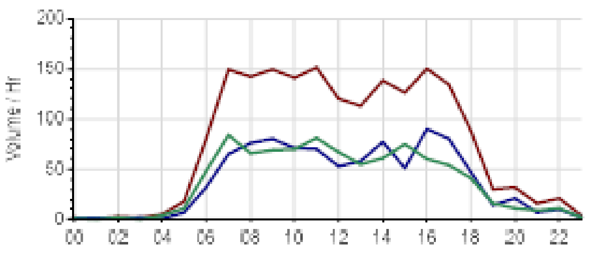
Typical Flow for a Monday



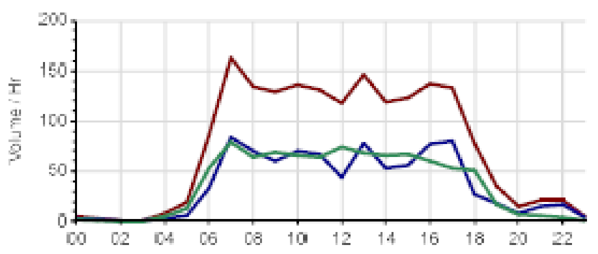
Typical Flow for a Tuesday



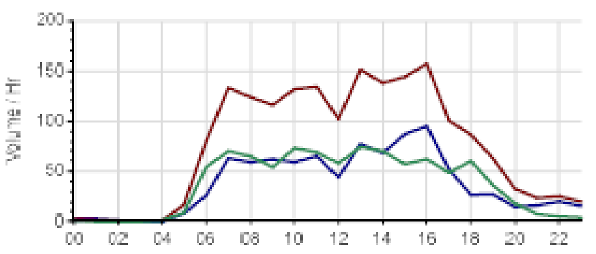
Typical Flow for a Wednesday



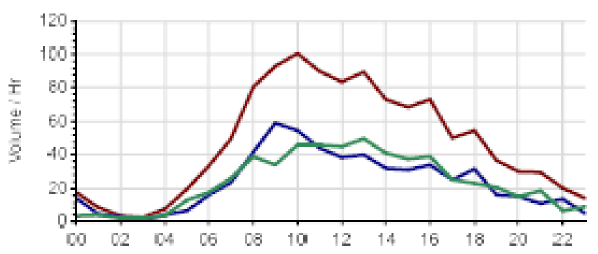
Typical Flow for a Thursday



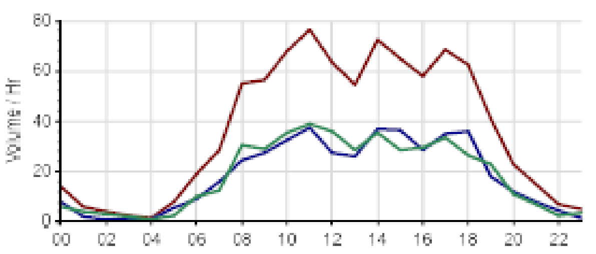
Typical Flow for a Friday



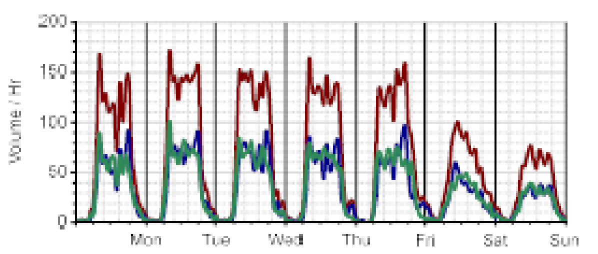
Typical Flow for a Saturday



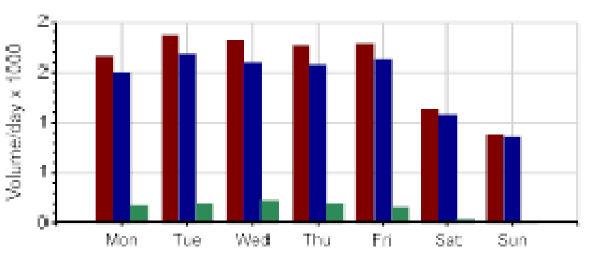
Typical Flow for a Sunday



Typical Flow for a Week



Typical Flow for a Week



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

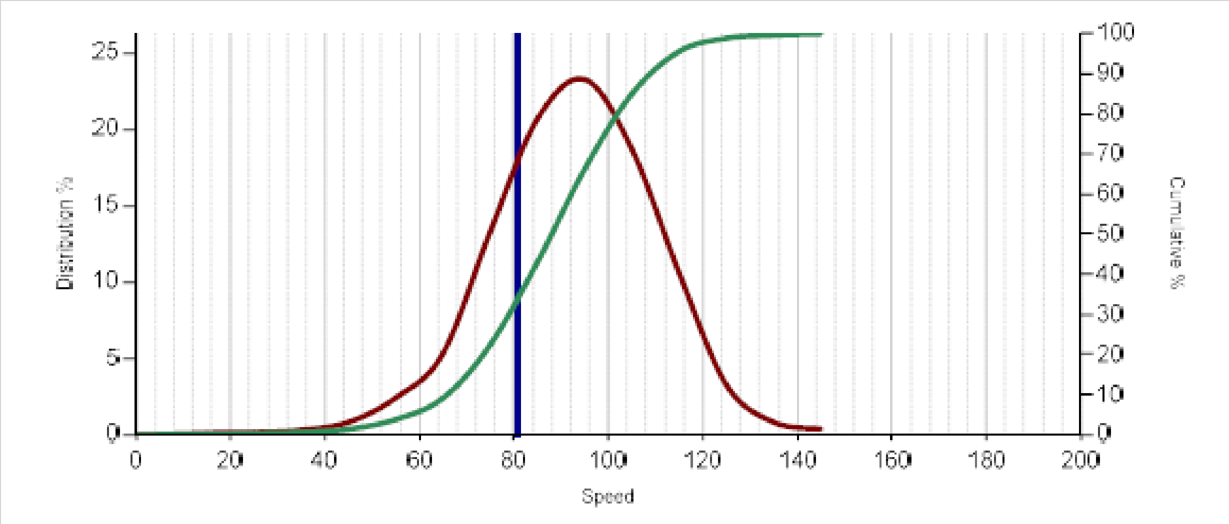
Station Data - 19

Station Speed Distribution

Site	12104 - EC_R336_01_30.4
Speed Limit	80 km/hr
Period	01 Jan 2016 - 31 Dec 2016

Distribution
Cumulative
Speed Limit

Lane 1 - To Paterson

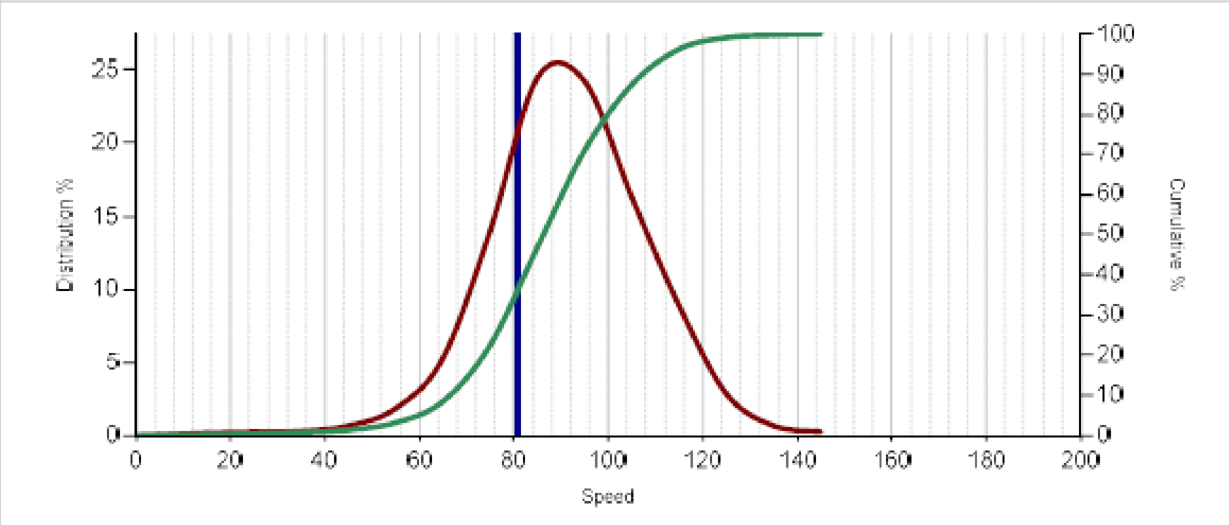


Station Speed Distribution

Site	12104 - EC_R336_01_30.4
Speed Limit	80 km/hr
Period	01 Jan 2016 - 31 Dec 2016

Distribution
Cumulative
Speed Limit

Lane 2 - To Kirkwood



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 20

Station Information

Site Number	12106	**Site Identifier**	27880
Site Name	EC_R336_01_33.7		
Site Description	Between Kirkwood and Paterson		
Site Type	Secondary (Temp)	**Owner**	SANRAL
Physical Lanes	2	**Responsibility**	NON-TOLL
Logical Lanes	2	**Installation Date**	2016-10-27
GPS Longitude	25.564453	**Termination Date**	
GPS Lattitude	-33.477962	**Status**	In Use
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	120
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	33.79
Authority	SANRAL	**Contract No**	NRA 53000/2016/1
Contract Org	Mikros Traffic Monitoring (Pty) Ltd	**Station History Type**	Full Site
System Type	C1		

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To Paterson	1	To Paterson	East	2	1
2	To Kirkwood	2	To Kirkwood	West	1	1

PHOTO

Direction 1

To Paterson

PHOTO

Direction 2

To Kirkwood

PHOTO

As Built

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 21

Traffic Highlights of Site: EC_R336_01_33.7 (12106)	
Site No	12106
Site Name	EC_R336_01_33.7
Site Description	Between Kirkwood and Paterson
Road Description	Route : R336 Section : 01E Distance : 33.79 km
GPS Position	Latitude: -33.477962 Longitude: 25.564453
Number of Lanes	2
Station Type	Secondary (Temp)

Requested Data Period	01 Jan 2016 - 31 Dec 2016
First and Last Data Dates	27 Oct 2016 - 04 Nov 2016
Data Available for Requested Period as Percentage	2%

Last Full Day Count for ADT and ADTT	03 Nov 2016
Number of Full Days in Requested Period	7

Highlights per Stream		Str 1: To Paterson	Str 2: To Kirkwood	Value
1.1	Total Number of Vehicles	6,207	6,258	12,465
1.2	Average Daily Traffic (ADT)	741	739	1,480
1.3	Average Daily Truck Traffic (ADTT)	82	88	170
1.4	Percentage of Trucks	11.4 %	11.9 %	11.6 %
1.5	Truck Split % (Short : Medium : Long)	66 : 18 : 16	69 : 17 : 14	68 : 18 : 15
1.6	Percentage of Night Traffic [20h00 - 6h00)	6.5 %	7.1 %	6.8 %
2.1	Speed Limit			120
2.2	Average Speed (km/hr)	91.4	88.6	90.0
2.3	Average Speed - Light Vehicles (km/hr	92.1	89.4	90.8
2.4	Average Speed - Heavy Vehicles (km/hr)	84.2	81.8	83.0
2.5	Average Night Speed (km/hr)	90.4	87.3	88.9
2.6	15th Centile Speed (km/hr)	76.2	73.8	75.0
2.7	85th Centile Speed (km/hr)	109.1	106.7	107.9
2.8	Percentage of Vehicles in Excess of Speed Limit	38.9 %	39.0 %	39.0 %
3.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0 %	0 %	0.00%
3.2	Percentage of Vehicles less than 2s behind vehicle ahead	0 %	0 %	0 %

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 22

4.1	Total Number of Heavy Vehicles	705	747	1,452
4.2	Estimated Average Number of axles per Truck	3.3	3.2	3.3
4.3	Estimated Truck Mass (Ton/Truck)	19.2	18.4	18.8
4.4	Estimated Average E80 / Truck	1.3	1.2	1.25
4.5	Estimated Daily E80 on the Road			421.0
4.6	Estimated Daily E80 in the East Direction			613.0
4.7	Estimated Daily E80 in the West Direction			650.0
4.8	Estimated Daily E80 in the Worst East Lane			613.0
4.9	Estimated Daily E80 in the Worst West Lane			650.0
5.1	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
5.2	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
5.3	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

Traffic Volumes		Date and Time	Value
6.1	Highest Volume on the Road (vehs/hr)	01 Nov 2016 (17:00 - 18:00)	176
6.2	Highest Volume in the East (vehs/hr)	02 Nov 2016 (07:00 - 08:00)	86
6.3	Highest Volume in the West (vehs/hr)	01 Nov 2016 (17:00 - 18:00)	97
6.4	Highest Volume in a Lane (vehs/hr)	01 Nov 2016 (17:00 - 18:00)	97
6.5	15th Highest Volume on the Road (vehs/hr)	02 Nov 2016 (14:00 - 15:00)	145
6.6	15th Highest Volume in the East Direction (vehs/hr)	02 Nov 2016 (11:00 - 12:00)	76
6.7	15th Highest Volume in the West Direction (vehs/hr)	01 Nov 2016 (07:00 - 08:00)	76
6.8	30th Highest Volume on the Road (vehs/hr)	03 Nov 2016 (16:00 - 17:00)	131
6.9	30th Highest Volume in the East Direction (vehs/hr)	01 Nov 2016 (10:00 - 11:00)	65
6.10	30th Highest Volume in the West Direction (vehs/hr)	28 Oct 2016 (07:00 - 08:00)	67

SANRAL Yearbook

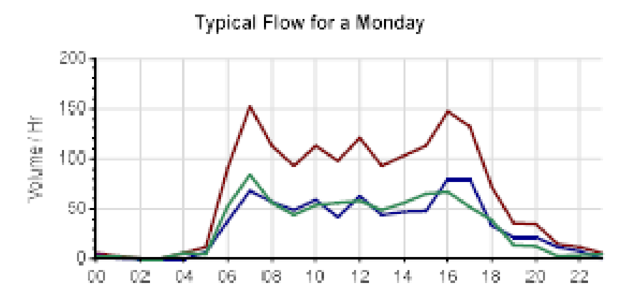
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

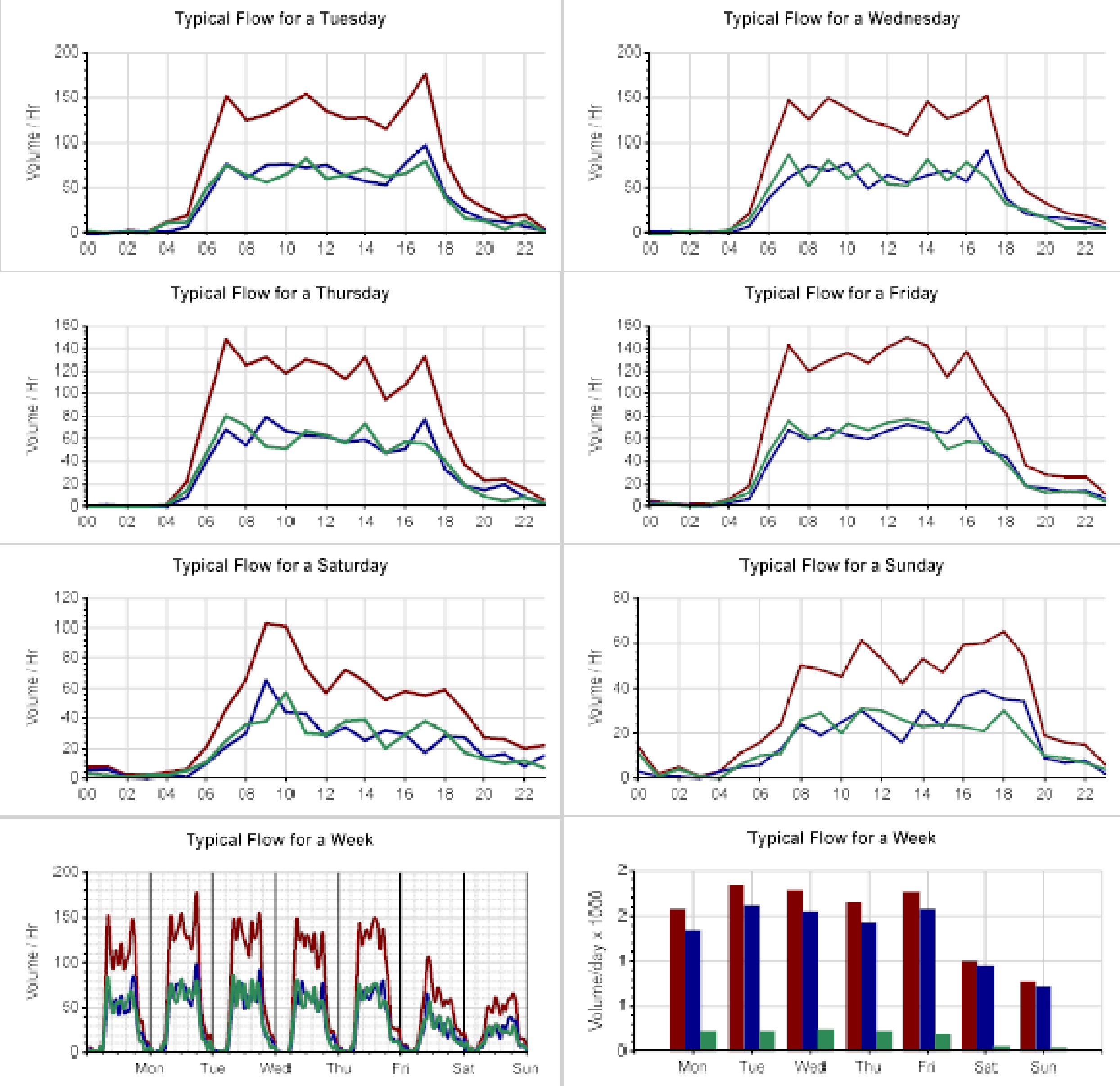
Station Data - 23

Station Typical Flow Graphs

Site	12106 - EC_R336_01_33.7
Region	South
Actual Period	27 Oct 2016 - 04 Nov 2016
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

Line		Bar	
Red line	Total	Red bar	Total
Blue line	To Kirkwood	Blue bar	Light
Green line	To Paterson	Green bar	Heavy





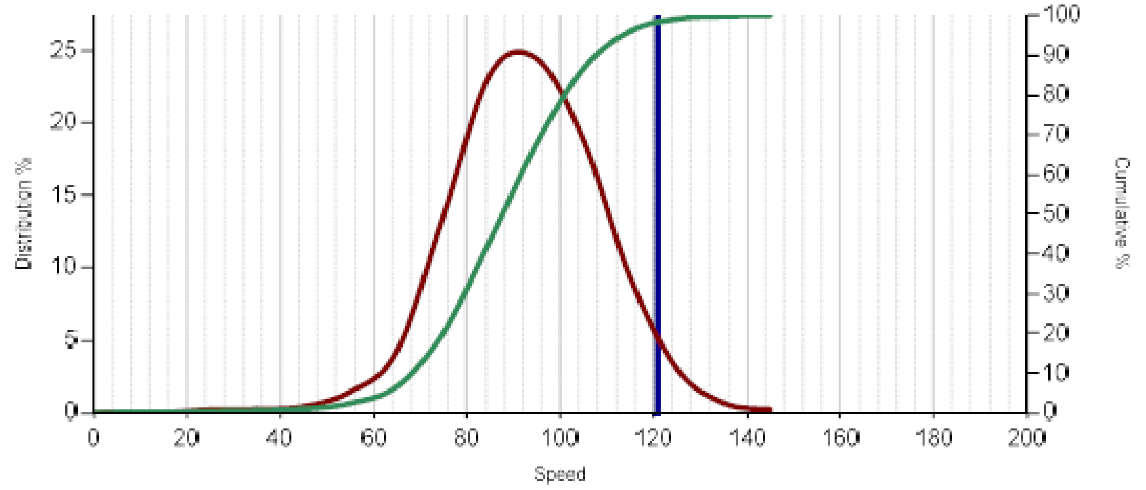
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Speed Distribution

Site	12106 - EC_R336_01_33.7
Speed Limit	120 km/hr
Period	01 Jan 2016 - 31 Dec 2016

Distribution
Cumulative
Speed Limit

Lane 1 - To Paterson

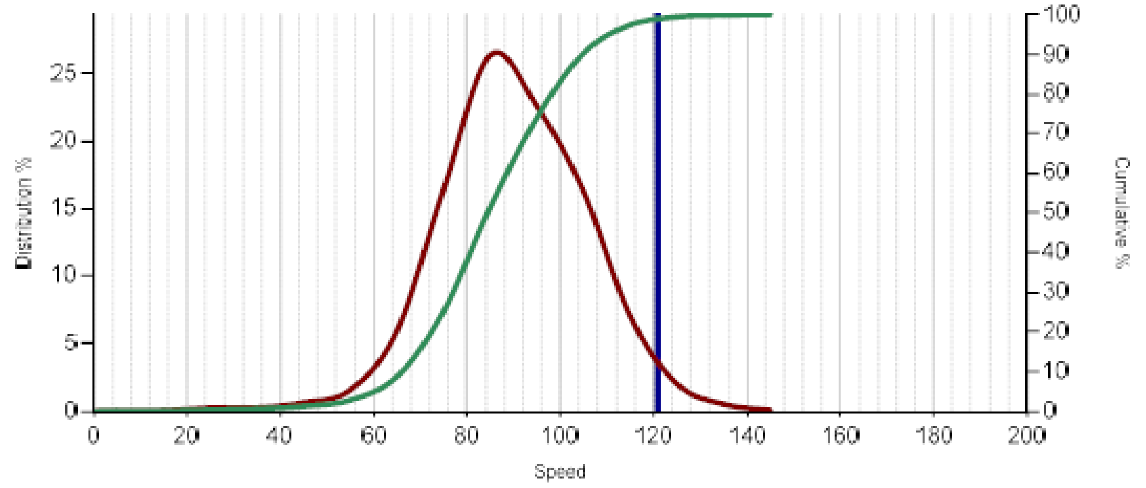


Station Speed Distribution

Site	12106 - EC_R336_01_33.7
Speed Limit	120 km/hr
Period	01 Jan 2016 - 31 Dec 2016

Distribution
Cumulative
Speed Limit

Lane 2 - To Kirkwood



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 25

Station Information

Site Number	8211	**Site Identifier**	27127
Site Name	R336 Sunland		
Site Description	Between Kirkwood & R335 Addo Intersection		
Site Type	Permanent	**Owner**	SANRAL
Physical Lanes	2	**Responsibility**	NON-TOLL
Logical Lanes	2	**Installation Date**	2017-06-05
GPS Longitude	25.575787	**Termination Date**	
GPS Lattitude	-33.48296	**Status**	In Use
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	80
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	34.98
Authority	SANRAL	**Contract No**	NRA 53000/141/2
Contract Org	Mikros Traffic Monitoring (Pty) Ltd	**Station History Type**	Full Site
System Type	C1		

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To R335 Addo	1	To R335 Addo	East	2	1
2	To Kirkwood	2	To Kirkwood	West	1	1

NO PHOTO AVAILABLE.

NO PHOTO AVAILABLE.

PHOTO

Direction 1

NO DATA FOUND.

Direction 2

NO DATA FOUND.

As Built

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 1

Traffic Highlights of Site: R336 Sunland (8211)	
Site No	8211
Site Name	R336 Sunland
Site Description	Between Kirkwood & R335 Addo Intersection
Road Description	Route : R336 Section : 01E Distance : 34.98 km
GPS Position	Latitude: -33.48296 Longitude: 25.575787
Number of Lanes	2
Station Type	Permanent

Requested Data Period	01 Jan 2017 - 31 Dec 2017
First and Last Data Dates	09 Jun 2017 - 31 Dec 2017
Data Available for Requested Period as Percentage	55%

Last Full Day Count for ADT and ADTT	31 Dec 2017
Number of Full Days in Requested Period	197

Highlights per Stream		Str 1: To R335 Addo	Str 2: To Kirkwood	Value
1.1	Total Number of Vehicles	160,569	157,826	318,395
1.2	Average Daily Traffic (ADT)	796	782	1,578
1.3	Average Daily Truck Traffic (ADTT)	112	108	220
1.4	Percentage of Trucks	14.3 %	14.1 %	14.2 %
1.5	Truck Split % (Short : Medium : Long)	48 : 21 : 31	49 : 21 : 30	48 : 21 : 30
1.6	Percentage of Night Traffic [20h00 - 6h00)	7.0 %	6.9 %	6.9 %
2.1	Speed Limit			80
2.2	Average Speed (km/hr)	92.8	91.6	92.2
2.3	Average Speed - Light Vehicles (km/hr	94.6	93.8	94.2
2.4	Average Speed - Heavy Vehicles (km/hr)	79.4	78.7	79.1
2.5	Average Night Speed (km/hr)	92.6	91.6	92.1
2.6	15th Centile Speed (km/hr)	74.3	73.3	73.8
2.7	85th Centile Speed (km/hr)	112.8	111.3	112.1
2.8	Percentage of Vehicles in Excess of Speed Limit	86.2 %	85.3 %	85.8 %
3.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0 %	0 %	0.00%
3.2	Percentage of Vehicles less than 2s behind vehicle ahead	0 %	0 %	0 %

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 2

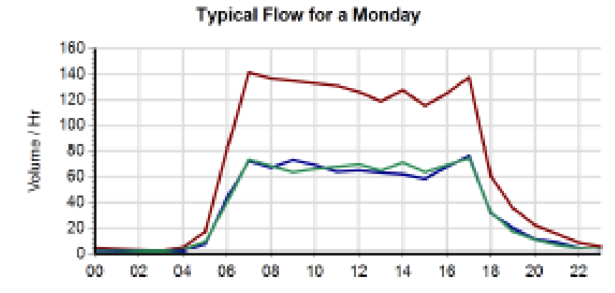
4.1	Total Number of Heavy Vehicles	23,021	22,223	45,244
4.2	Estimated Average Number of axles per Truck	4.2	4.1	4.2
4.3	Estimated Truck Mass (Ton/Truck)	24.2	23.9	24.1
4.4	Estimated Average E80 / Truck	1.9	1.9	1.90
4.5	Estimated Daily E80 on the Road			529.0
4.6	Estimated Daily E80 in the East Direction			807.0
4.7	Estimated Daily E80 in the West Direction			779.0
4.8	Estimated Daily E80 in the Worst East Lane			807.0
4.9	Estimated Daily E80 in the Worst West Lane			779.0
5.1	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
5.2	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
5.3	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

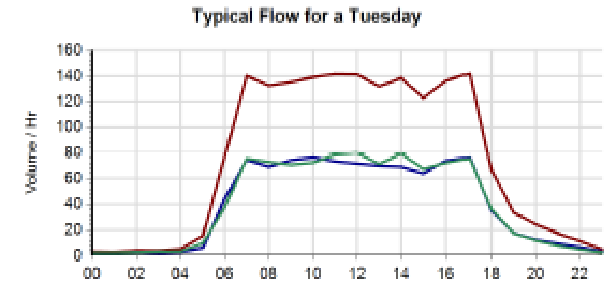
Traffic Volumes		Date and Time	Value
6.1	Highest Volume on the Road (vehs/hr)	30 Jun 2017 (16:00 - 17:00)	278
6.2	Highest Volume in the East (vehs/hr)	02 Jul 2017 (16:00 - 17:00)	136
6.3	Highest Volume in the West (vehs/hr)	01 Jul 2017 (10:00 - 11:00)	212
6.4	Highest Volume in a Lane (vehs/hr)	01 Jul 2017 (10:00 - 11:00)	212
6.5	15th Highest Volume on the Road (vehs/hr)	14 Jun 2017 (12:00 - 13:00)	221
6.6	15th Highest Volume in the East Direction (vehs/hr)	27 Jun 2017 (12:00 - 13:00)	112
6.7	15th Highest Volume in the West Direction (vehs/hr)	07 Jul 2017 (16:00 - 17:00)	120
6.8	30th Highest Volume on the Road (vehs/hr)	15 Jun 2017 (16:00 - 17:00)	206
6.9	30th Highest Volume in the East Direction (vehs/hr)	23 Jun 2017 (10:00 - 11:00)	107
6.10	30th Highest Volume in the West Direction (vehs/hr)	14 Jun 2017 (17:00 - 18:00)	107

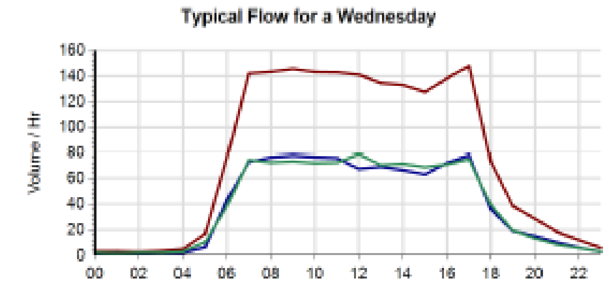
Station Typical Flow Graphs

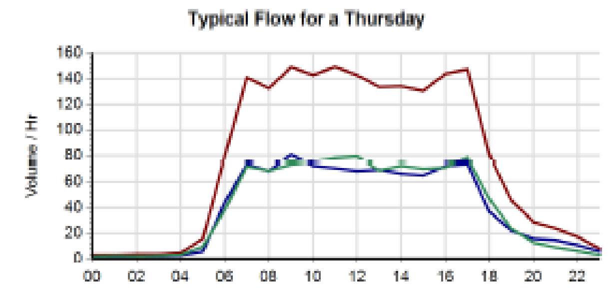
Site	8211 - R336 Sunland
Region	South
Actual Period	09 Jun 2017 - 31 Dec 2017
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

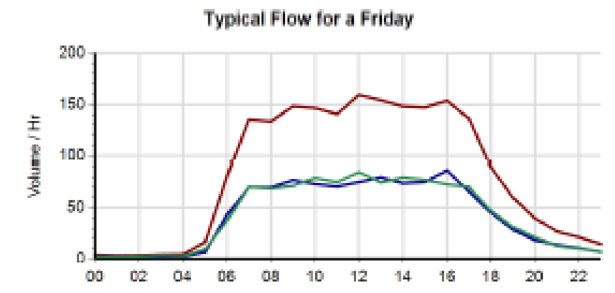
Total	Total
To Kirkwood	Light
To R335 Addo	Heavy

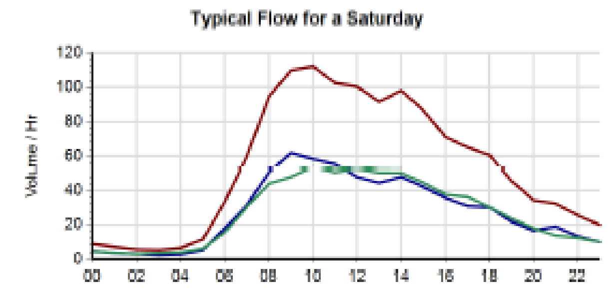


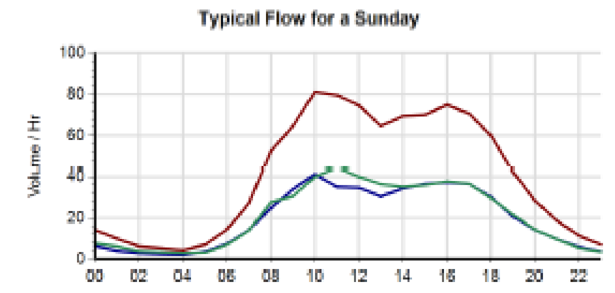


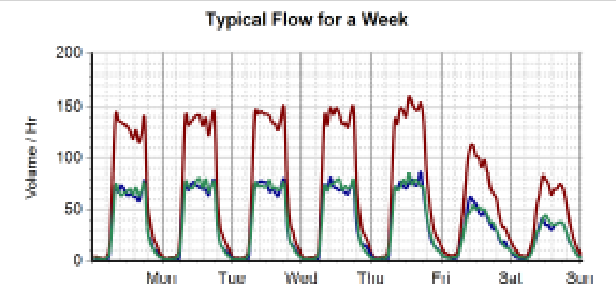


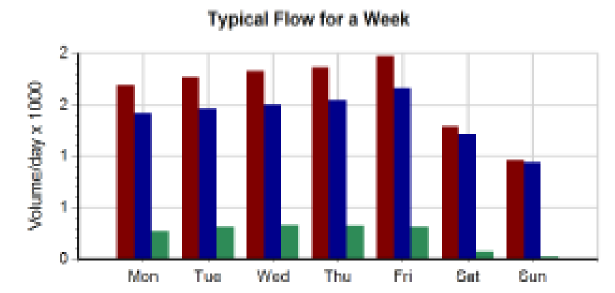












SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

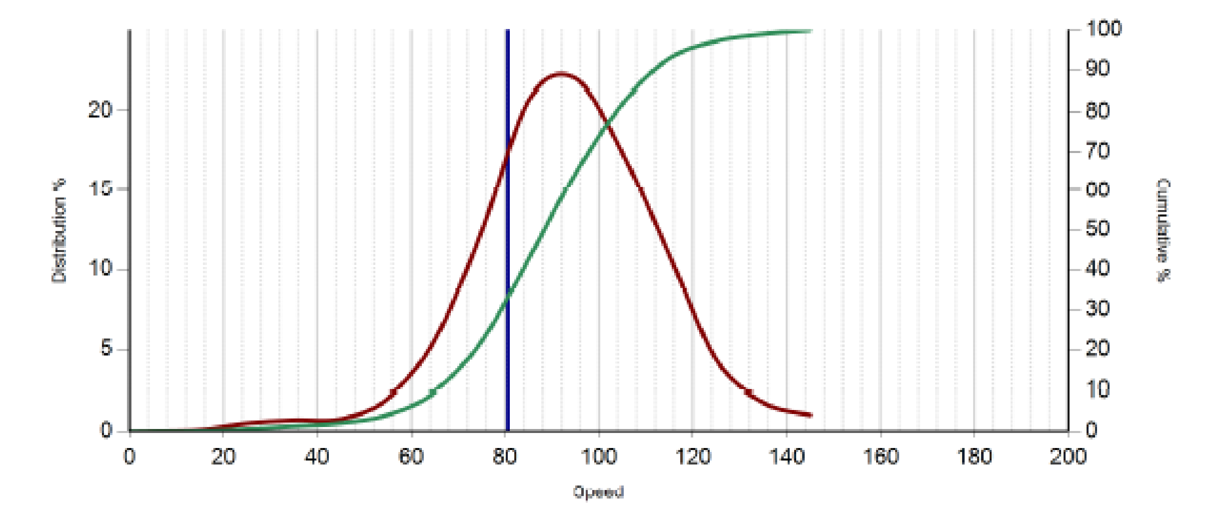
Station Data - 4

Station Speed Distribution

Site	8211 - R336 Sunland
Speed Limit	80 km/hr
Period	01 Jan 2017 - 31 Dec 2017

Distribution
Cumulative
Speed Limit

Lane 1 - To R335 Addo

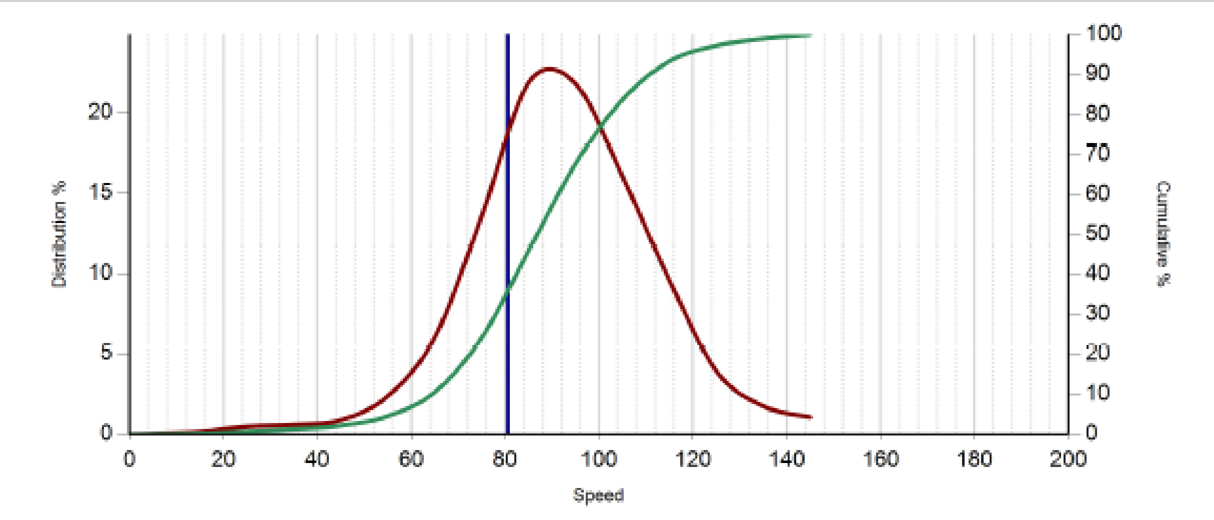


Station Speed Distribution

Site	8211 - R336 Sunland
Speed Limit	80 km/hr
Period	01 Jan 2017 - 31 Dec 2017

Distribution
Cumulative
Speed Limit

Lane 2 - To Kirkwood



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 5

Station Information

Site Number	12104	**Site Identifier**	27879
Site Name	EC_R336_01_30.4		
Site Description	Between Kirkwood and Paterson		
Site Type	Secondary (Temp)	**Owner**	SANRAL
Physical Lanes	2	**Responsibility**	NON-TOLL
Logical Lanes	2	**Installation Date**	2016-11-04
GPS Longitude	25.530251	**Termination Date**	
GPS Lattitude	-33.471416	**Status**	In Use
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	80
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	30.37
Authority	SANRAL	**Contract No**	NRA 53000/2016/1
Contract Org	Mikros Traffic Monitoring (Pty) Ltd	**Station History Type**	Full Site
System Type	C1		

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To Paterson	1	To Paterson	East	2	1
2	To Kirkwood	2	To Kirkwood	West	1	1

PHOTO

Direction 1

To Paterson

PHOTO

Direction 2

To Kirkwood

PHOTO

As Built

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 16

Traffic Highlights of Site: EC_R336_01_30.4 (12104)	
Site No	12104
Site Name	EC_R336_01_30.4
Site Description	Between Kirkwood and Paterson
Road Description	Route : R336 Section : 01E Distance : 30.37 km
GPS Position	Latitude: -33.471416 Longitude: 25.530251
Number of Lanes	2
Station Type	Secondary (Temp)
Requested Data Period	01 Jan 2018 - 31 Dec 2018
First and Last Data Dates	23 Jan 2018 - 01 Nov 2018
Data Available for Requested Period as Percentage	21%
Last Full Day Count for ADT and ADTT	01 Nov 2018
Number of Full Days in Requested Period	72

Highlights per Stream		Str 1: To Paterson	Str 2: To Kirkwood	Value
1.1	Total Number of Vehicles	64,741	64,516	129,257
1.2	Average Daily Traffic (ADT)	853	850	1,703
1.3	Average Daily Truck Traffic (ADTT)	119	119	238
1.4	Percentage of Trucks	14.1 %	14.1 %	14.1 %
1.5	Truck Split % (Short : Medium : Long)	54 : 16 : 30	55 : 16 : 29	54 : 16 : 30
1.6	Percentage of Night Traffic [20h00 - 6h00)	6.6 %	6.6 %	6.6 %
2.1	Speed Limit			80
2.2	Average Speed (km/hr)	87.7	88.5	88.1
2.3	Average Speed - Light Vehicles (km/hr	89.9	90.7	90.3
2.4	Average Speed - Heavy Vehicles (km/hr)	76.1	76.0	76.1
2.5	Average Night Speed (km/hr)	86.5	87.8	87.2
2.6	15th Centile Speed (km/hr)	71.6	71.9	71.8
2.7	85th Centile Speed (km/hr)	106.7	106.7	106.7
2.8	Percentage of Vehicles in Excess of Speed Limit	83.2 %	83.7 %	83.4 %
3.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0 %	0 %	0.00%
3.2	Percentage of Vehicles less than 2s behind vehicle ahead	0 %	0 %	0 %

SANRAL
BUILDING SOUTH AFRICA THROUGH BETTER ROADS
SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 17

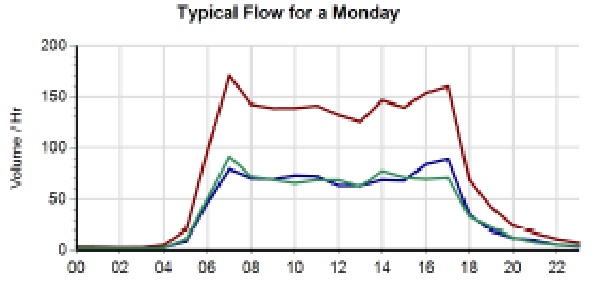
4.1	Total Number of Heavy Vehicles	9,123	9,105	18,228
4.2	Estimated Average Number of axles per Truck	4.0	3.9	4.0
4.3	Estimated Truck Mass (Ton/Truck)	22.9	22.6	22.8
4.4	Estimated Average E80 / Truck	1.8	1.7	1.75
4.5	Estimated Daily E80 on the Road			544.0
4.6	Estimated Daily E80 in the East Direction			817.0
4.7	Estimated Daily E80 in the West Direction			815.0
4.8	Estimated Daily E80 in the Worst East Lane			817.0
4.9	Estimated Daily E80 in the Worst West Lane			815.0
5.1	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
5.2	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
5.3	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

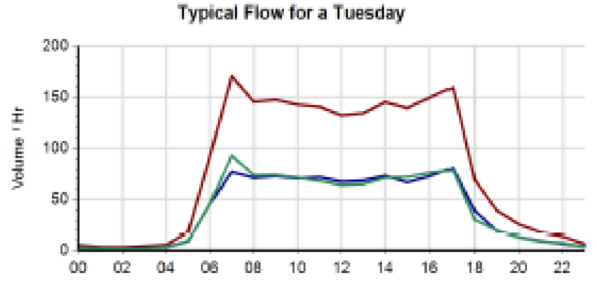
Traffic Volumes		Date and Time	Value
6.1	Highest Volume on the Road (vehs/hr)	27 Jul 2018 (13:00 - 14:00)	227
6.2	Highest Volume in the East (vehs/hr)	08 Aug 2018 (07:00 - 08:00)	131
6.3	Highest Volume in the West (vehs/hr)	24 Jul 2018 (17:00 - 18:00)	138
6.4	Highest Volume in a Lane (vehs/hr)	24 Jul 2018 (17:00 - 18:00)	138
6.5	15th Highest Volume on the Road (vehs/hr)	26 Jul 2018 (17:00 - 18:00)	202
6.6	15th Highest Volume in the East Direction (vehs/hr)	08 Aug 2018 (14:00 - 15:00)	110
6.7	15th Highest Volume in the West Direction (vehs/hr)	03 Aug 2018 (10:00 - 11:00)	109
6.8	30th Highest Volume on the Road (vehs/hr)	25 Jul 2018 (08:00 - 09:00)	193
6.9	30th Highest Volume in the East Direction (vehs/hr)	12 Apr 2018 (17:00 - 18:00)	103
6.10	30th Highest Volume in the West Direction (vehs/hr)	26 Apr 2018 (07:00 - 08:00)	103

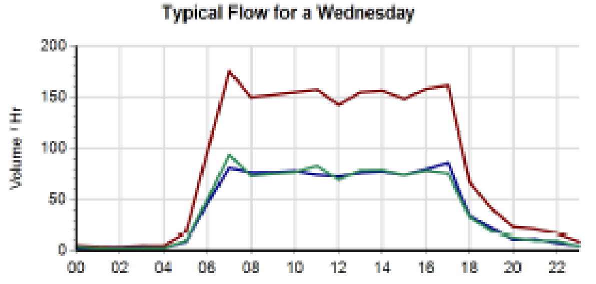
Station Typical Flow Graphs

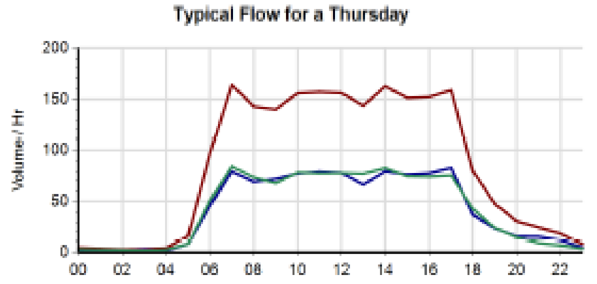
Site	12104 - EC_R336_01_30.4
Region	South
Actual Period	23 Jan 2018 - 01 Nov 2018
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

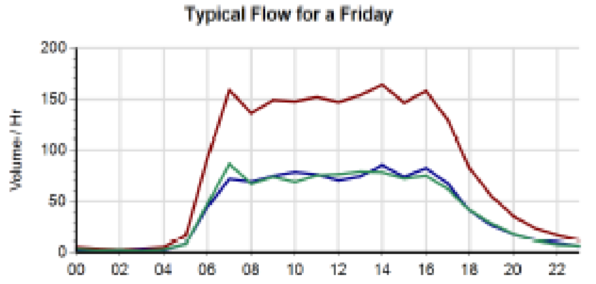
Total	Total
To Kirkwood	Light
To Paterson	Heavy

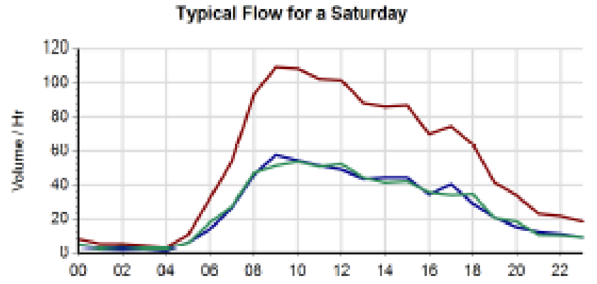


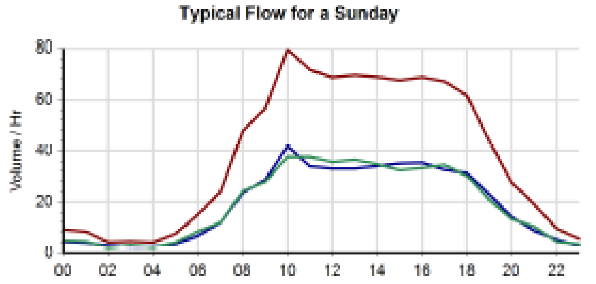


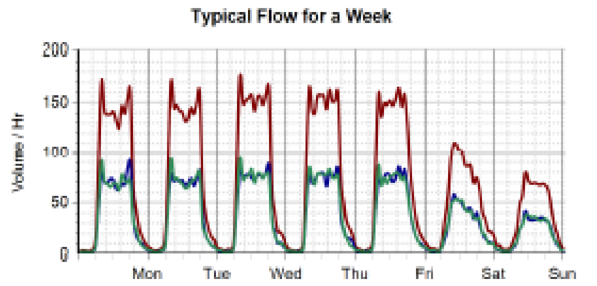


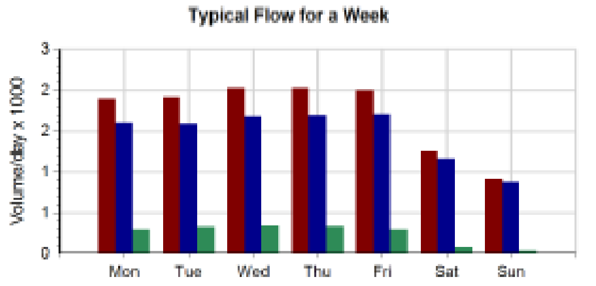












SANRAL Yearbook

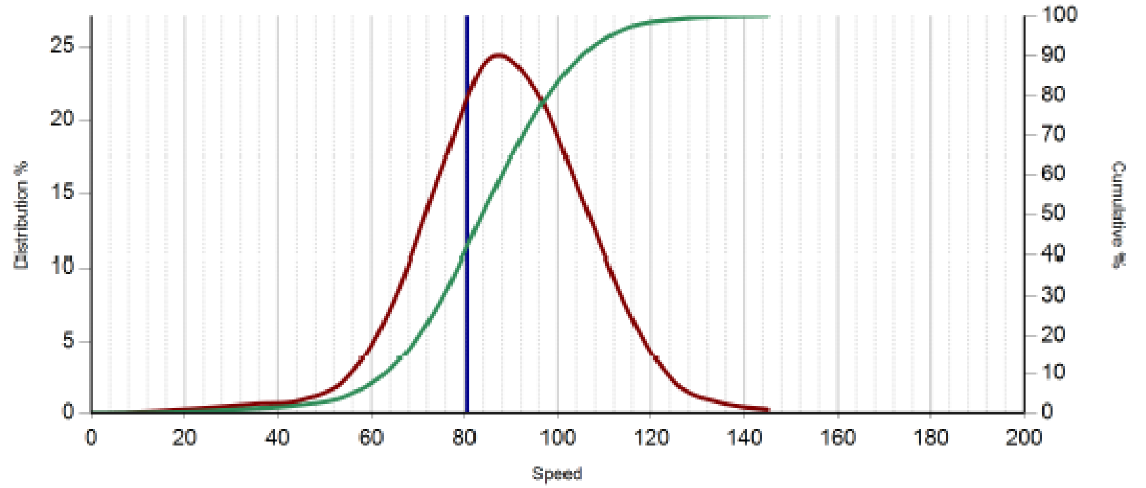
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 19

Station Speed Distribution

Site	12104 - EC_R336_01_30.4		Distribution
Speed Limit	80 km/hr		Cumulative
Period	01 Jan 2018 - 31 Dec 2018		Speed Limit

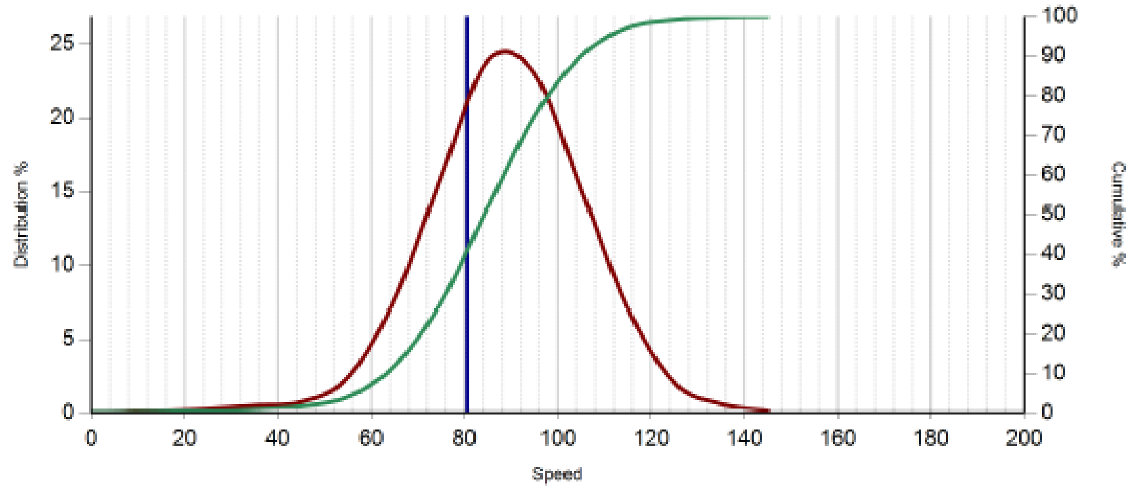
Lane 1 - To Paterson



Station Speed Distribution

Site	12104 - EC_R336_01_30.4		Distribution
Speed Limit	80 km/hr		Cumulative
Period	01 Jan 2018 - 31 Dec 2018		Speed Limit

Lane 2 - To Kirkwood



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 20

Station Information

Site Number	8211	**Site Identifier**	27127
Site Name	R336 Sunland		
Site Description	Between Kirkwood & R335 Addo Intersection		
Site Type	Permanent	**Owner**	SANRAL
Physical Lanes	2	**Responsibility**	NON-TOLL
Logical Lanes	2	**Installation Date**	2017-06-05
GPS Longitude	25.575787	**Termination Date**	
GPS Lattitude	-33.48296	**Status**	In Use
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	80
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	34.98
Authority	SANRAL	**Contract No**	NRA 53000/141/2
Contract Org	Mikros Traffic Monitoring (Pty) Ltd	**Station History Type**	Full Site
System Type	C1		

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To R335 Addo	1	To R335 Addo	East	2	1
2	To Kirkwood	2	To Kirkwood	West	1	1

NO PHOTO AVAILABLE.

NO PHOTO AVAILABLE.

PHOTO

Direction 1

NO DATA FOUND.

Direction 2

NO DATA FOUND.

As Built

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 21

Traffic Highlights of Site: R336 Sunland (8211)	
Site No	8211
Site Name	R336 Sunland
Site Description	Between Kirkwood & R335 Addo Intersection
Road Description	Route : R336 Section : 01E Distance : 34.98 km
GPS Position	Latitude: -33.48296 Longitude: 25.575787
Number of Lanes	2
Station Type	Permanent

Requested Data Period	01 Jan 2018 - 31 Dec 2018
First and Last Data Dates	01 Jan 2018 - 31 Dec 2018
Data Available for Requested Period as Percentage	100%

Last Full Day Count for ADT and ADTT	31 Dec 2018
Number of Full Days in Requested Period	365

Highlights per Stream		Str 1: To R335 Addo	Str 2: To Kirkwood	Value
1.1	Total Number of Vehicles	304,506	301,002	605,508
1.2	Average Daily Traffic (ADT)	834	825	1,659
1.3	Average Daily Truck Traffic (ADTT)	111	107	218
1.4	Percentage of Trucks	13.3 %	13.0 %	13.1 %
1.5	Truck Split % (Short : Medium : Long)	45 : 24 : 31	46 : 23 : 31	46 : 24 : 31
1.6	Percentage of Night Traffic [20h00 - 6h00)	6.9 %	6.9 %	6.9 %
2.1	Speed Limit			80
2.2	Average Speed (km/hr)	93.8	92.8	93.3
2.3	Average Speed - Light Vehicles (km/hr	96.2	95.2	95.7
2.4	Average Speed - Heavy Vehicles (km/hr)	78.9	78.5	78.7
2.5	Average Night Speed (km/hr)	93.2	92.7	93.0
2.6	15th Centile Speed (km/hr)	75.8	74.8	75.3
2.7	85th Centile Speed (km/hr)	113.1	111.6	112.4
2.8	Percentage of Vehicles in Excess of Speed Limit	87.3 %	86.5 %	86.9 %
3.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0 %	0 %	0.00%
3.2	Percentage of Vehicles less than 2s behind vehicle ahead	0 %	0 %	0 %

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 22

4.1	Total Number of Heavy Vehicles	40,359	39,096	79,455
4.2	Estimated Average Number of axles per Truck	4.3	4.2	4.3
4.3	Estimated Truck Mass (Ton/Truck)	24.8	24.6	24.7
4.4	Estimated Average E80 / Truck	1.9	1.9	1.90
4.5	Estimated Daily E80 on the Road			491.0
4.6	Estimated Daily E80 in the East Direction			748.0
4.7	Estimated Daily E80 in the West Direction			725.0
4.8	Estimated Daily E80 in the Worst East Lane			748.0
4.9	Estimated Daily E80 in the Worst West Lane			725.0
5.1	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
5.2	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
5.3	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

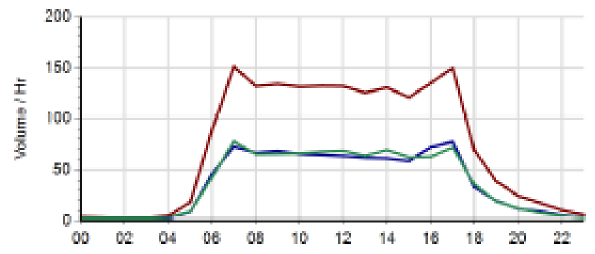
Traffic Volumes		Date and Time	Value
6.1	Highest Volume on the Road (vehs/hr)	30 Jun 2018 (10:00 - 11:00)	293
6.2	Highest Volume in the East (vehs/hr)	29 Jun 2018 (15:00 - 16:00)	140
6.3	Highest Volume in the West (vehs/hr)	30 Jun 2018 (10:00 - 11:00)	223
6.4	Highest Volume in a Lane (vehs/hr)	30 Jun 2018 (10:00 - 11:00)	223
6.5	15th Highest Volume on the Road (vehs/hr)	08 Aug 2018 (07:00 - 08:00)	217
6.6	15th Highest Volume in the East Direction (vehs/hr)	08 Aug 2018 (07:00 - 08:00)	114
6.7	15th Highest Volume in the West Direction (vehs/hr)	30 Jun 2018 (13:00 - 14:00)	119
6.8	30th Highest Volume on the Road (vehs/hr)	26 Jul 2018 (17:00 - 18:00)	210
6.9	30th Highest Volume in the East Direction (vehs/hr)	07 Aug 2018 (15:00 - 16:00)	108
6.10	30th Highest Volume in the West Direction (vehs/hr)	21 Sep 2018 (16:00 - 17:00)	114

Station Typical Flow Graphs

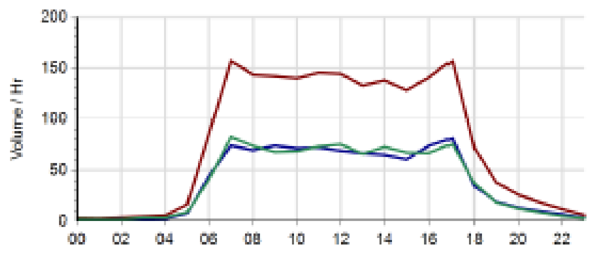
Site	8211 - R336 Sunland
Region	South
Actual Period	01 Jan 2018 - 31 Dec 2018
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

Total	Total
To Kirkwood	Light
To R335 Addo	Heavy

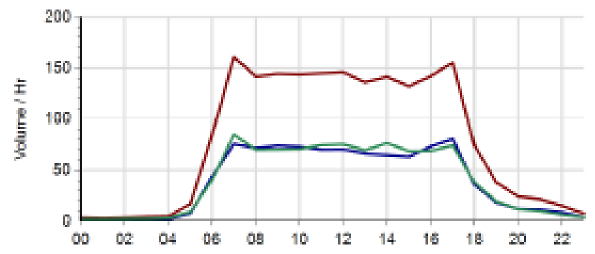
Typical Flow for a Monday



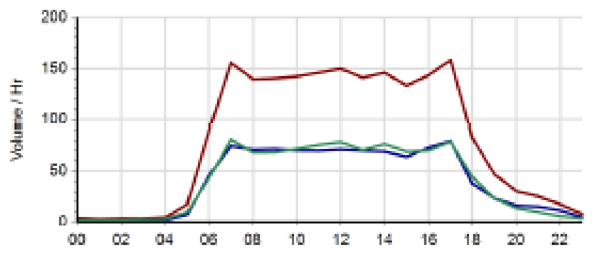
Typical Flow for a Tuesday



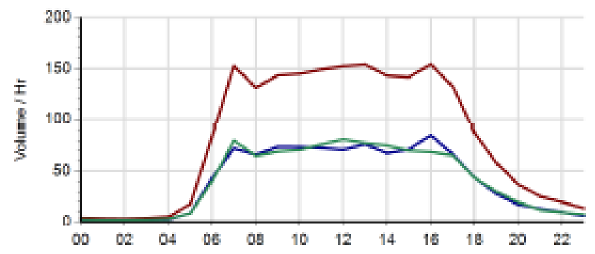
Typical Flow for a Wednesday



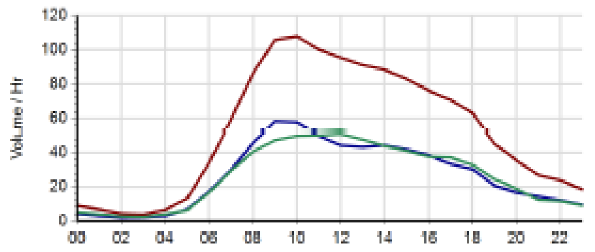
Typical Flow for a Thursday



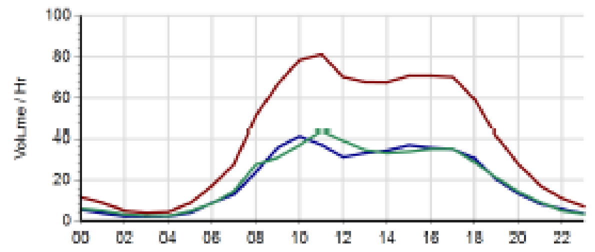
Typical Flow for a Friday



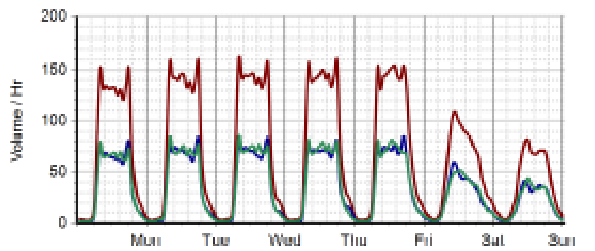
Typical Flow for a Saturday



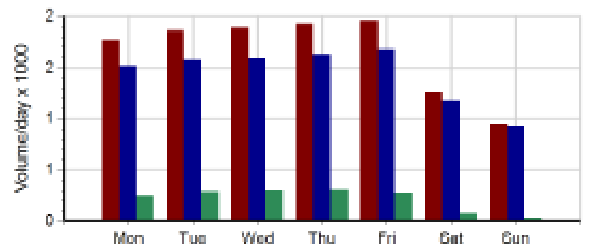
Typical Flow for a Sunday



Typical Flow for a Week



Typical Flow for a Week



SANRAL Yearbook

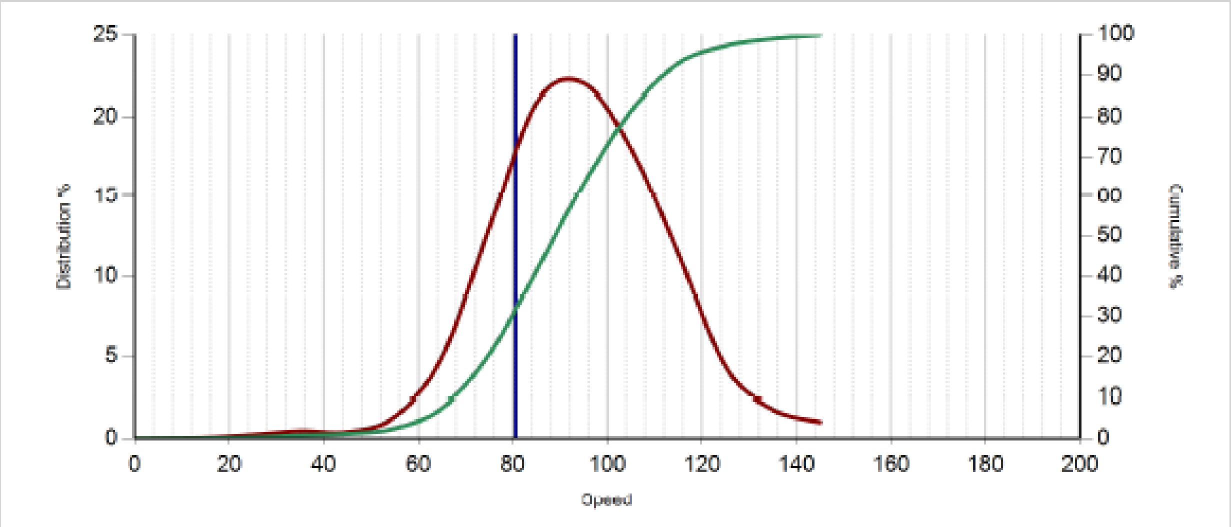
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 24

Station Speed Distribution

Site	8211 - R336 Sunland		Distribution
Speed Limit	80 km/hr		Cumulative
Period	01 Jan 2018 - 31 Dec 2018		Speed Limit

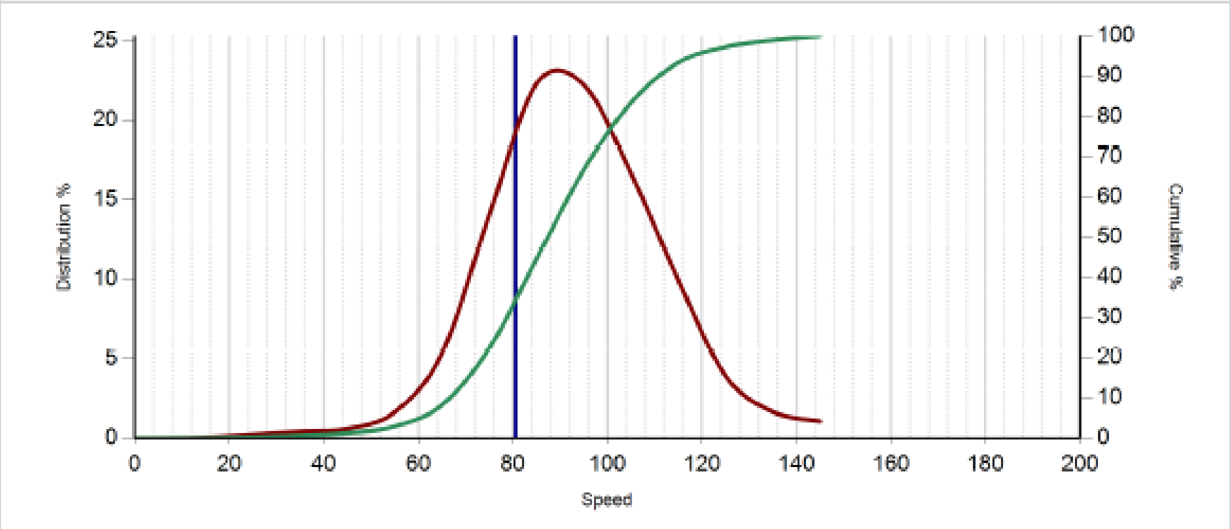
Lane 1 - To R335 Addo



Station Speed Distribution

Site	8211 - R336 Sunland		Distribution
Speed Limit	80 km/hr		Cumulative
Period	01 Jan 2018 - 31 Dec 2018		Speed Limit

Lane 2 - To Kirkwood



SANRAL
BUILDING SOUTH AFRICA THROUGH BETTER ROADS
SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 25

Station Information

Site Number	8211	**Site Identifier**	27127
Site Name	R336 Sunland		
Site Description	Between Kirkwood & R335 Addo Intersection		
Site Type	Permanent	**Owner**	SANRAL
Physical Lanes	2	**Responsibility**	NON-TOLL
Logical Lanes	2	**Installation Date**	2017-06-05
GPS Longitude	25.575787	**Termination Date**	
GPS Lattitude	-33.48296	**Status**	In Use
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	80
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	34.98
Authority	SANRAL	**Contract No**	NRA 53000/141/2
Contract Org	Mikros Traffic Monitoring (Pty) Ltd	**Station History Type**	Full Site
System Type	C1		

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To R335 Addo	1	To R335 Addo	East	2	1
2	To Kirkwood	2	To Kirkwood	West	1	1

NO PHOTO AVAILABLE.

Direction 1

NO DATA FOUND.

NO PHOTO AVAILABLE.

Direction 2

NO DATA FOUND.

PHOTO

As Built

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 1

Traffic Highlights of Site: R336 Sunland (8211)	
Site No	8211
Site Name	R336 Sunland
Site Description	Between Kirkwood & R335 Addo Intersection
Road Description	Route : R336 Section : 01E Distance : 34.98 km
GPS Position	Latitude: -33.48296 Longitude: 25.575787
Number of Lanes	2
Station Type	Permanent

Requested Data Period	01 Jan 2019 - 31 Dec 2019
First and Last Data Dates	01 Jan 2019 - 31 Oct 2019
Data Available for Requested Period as Percentage	83%

Last Full Day Count for ADT and ADTT	31 Oct 2019
Number of Full Days in Requested Period	304

Highlights per Stream		Str 1: To R335 Addo	Str 2: To Kirkwood	Value
1.1	Total Number of Vehicles	270,876	268,127	539,003
1.2	Average Daily Traffic (ADT)	891	882	1,773
1.3	Average Daily Truck Traffic (ADTT)	141	137	278
1.4	Percentage of Trucks	15.9 %	15.6 %	15.7 %
1.5	Truck Split % (Short : Medium : Long)	40 : 23 : 37	39 : 22 : 39	40 : 22 : 38
1.6	Percentage of Night Traffic [20h00 - 6h00)	6.5 %	6.7 %	6.6 %
2.1	Speed Limit			80
2.2	Average Speed (km/hr)	92.5	91.3	91.9
2.3	Average Speed - Light Vehicles (km/hr	95.4	94.1	94.8
2.4	Average Speed - Heavy Vehicles (km/hr)	78.2	77.4	77.8
2.5	Average Night Speed (km/hr)	91.5	89.9	90.7
2.6	15th Centile Speed (km/hr)	74.6	73.9	74.3
2.7	85th Centile Speed (km/hr)	111.9	110.8	111.4
2.8	Percentage of Vehicles in Excess of Speed Limit	85.9 %	85.4 %	85.6 %
3.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0 %	0 %	0.00%
3.2	Percentage of Vehicles less than 2s behind vehicle ahead	0 %	0 %	0 %

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 2

4.1	Total Number of Heavy Vehicles	42,945	41,748	84,693
4.2	Estimated Average Number of axles per Truck	4.5	4.6	4.6
4.3	Estimated Truck Mass (Ton/Truck)	26.3	26.7	26.5
4.4	Estimated Average E80 / Truck	2.1	2.2	2.15
4.5	Estimated Daily E80 on the Road			627.0
4.6	Estimated Daily E80 in the East Direction			953.0
4.7	Estimated Daily E80 in the West Direction			927.0
4.8	Estimated Daily E80 in the Worst East Lane			953.0
4.9	Estimated Daily E80 in the Worst West Lane			927.0
5.1	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
5.2	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
5.3	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

Traffic Volumes		Date and Time	Value
6.1	Highest Volume on the Road (vehs/hr)	29 Jun 2019 (09:00 - 10:00)	283
6.2	Highest Volume in the East (vehs/hr)	08 Aug 2019 (13:00 - 14:00)	157
6.3	Highest Volume in the West (vehs/hr)	29 Jun 2019 (10:00 - 11:00)	212
6.4	Highest Volume in a Lane (vehs/hr)	29 Jun 2019 (10:00 - 11:00)	212
6.5	15th Highest Volume on the Road (vehs/hr)	25 Jul 2019 (17:00 - 18:00)	226
6.6	15th Highest Volume in the East Direction (vehs/hr)	02 Aug 2019 (12:00 - 13:00)	118
6.7	15th Highest Volume in the West Direction (vehs/hr)	08 Aug 2019 (16:00 - 17:00)	122
6.8	30th Highest Volume on the Road (vehs/hr)	04 Jul 2019 (17:00 - 18:00)	215
6.9	30th Highest Volume in the East Direction (vehs/hr)	16 Aug 2019 (13:00 - 14:00)	115
6.10	30th Highest Volume in the West Direction (vehs/hr)	29 Jun 2019 (13:00 - 14:00)	114

SANRAL Yearbook

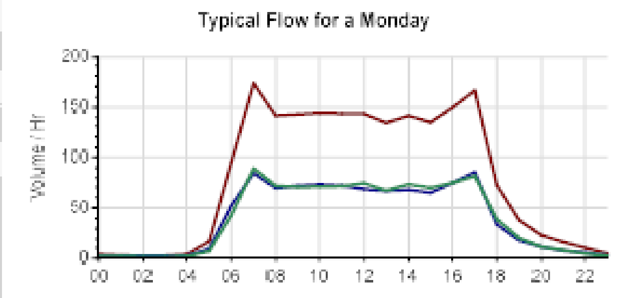
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

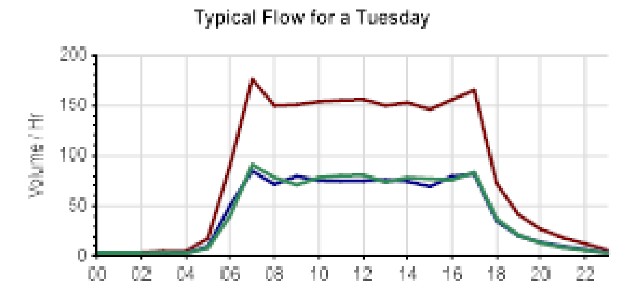
Station Data - 3

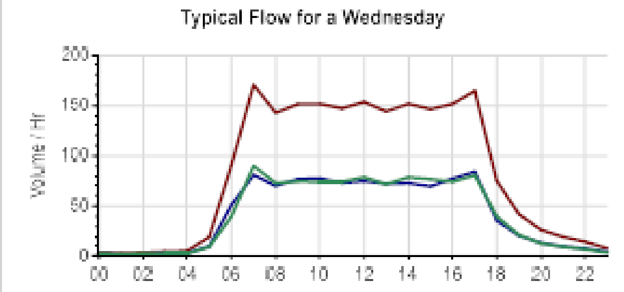
Station Typical Flow Graphs

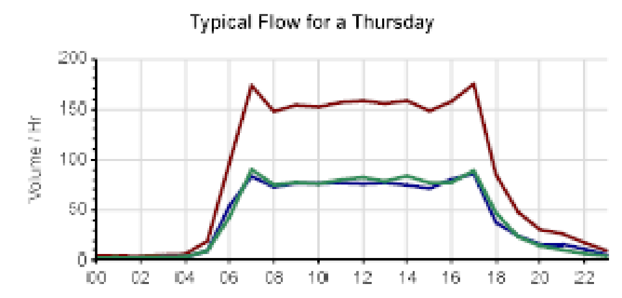
Site	8211 - R336 Sunland
Region	South
Actual Period	01 Jan 2019 - 31 Oct 2019
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

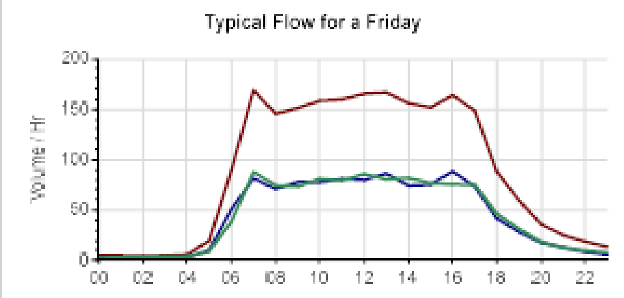
Total	Total
To Kirkwood	Light
To R335 Addo	Heavy

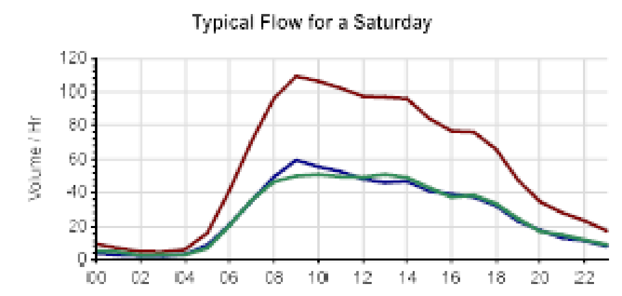


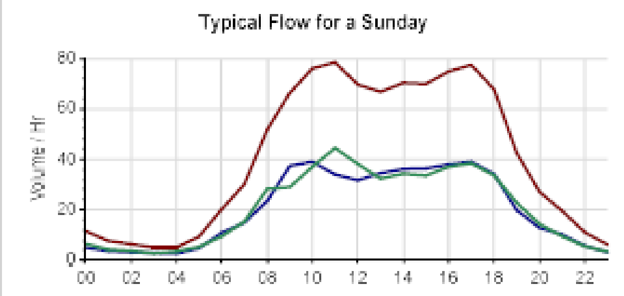


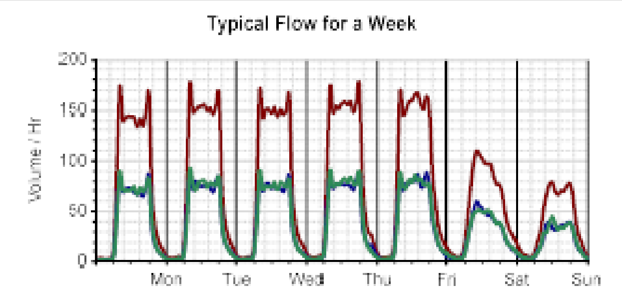


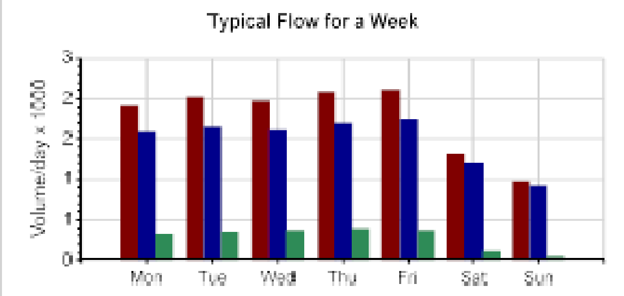












SANRAL

SANRAL Yearbook

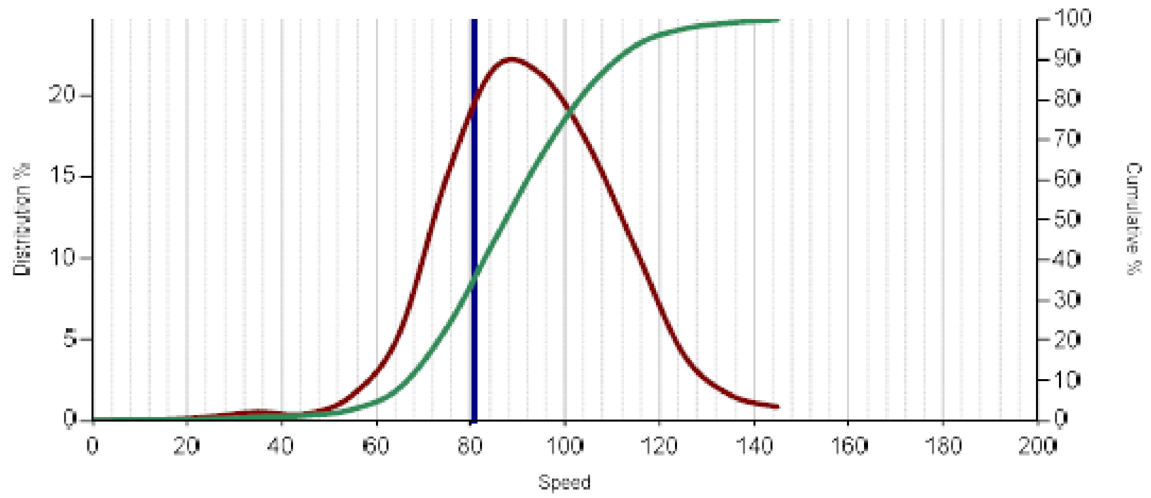
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 4

Station Speed Distribution

Site	8211 - R336 Sunland	Distribution
Speed Limit	80 km/hr	Cumulative
Period	01 Jan 2019 - 31 Dec 2019	Speed Limit

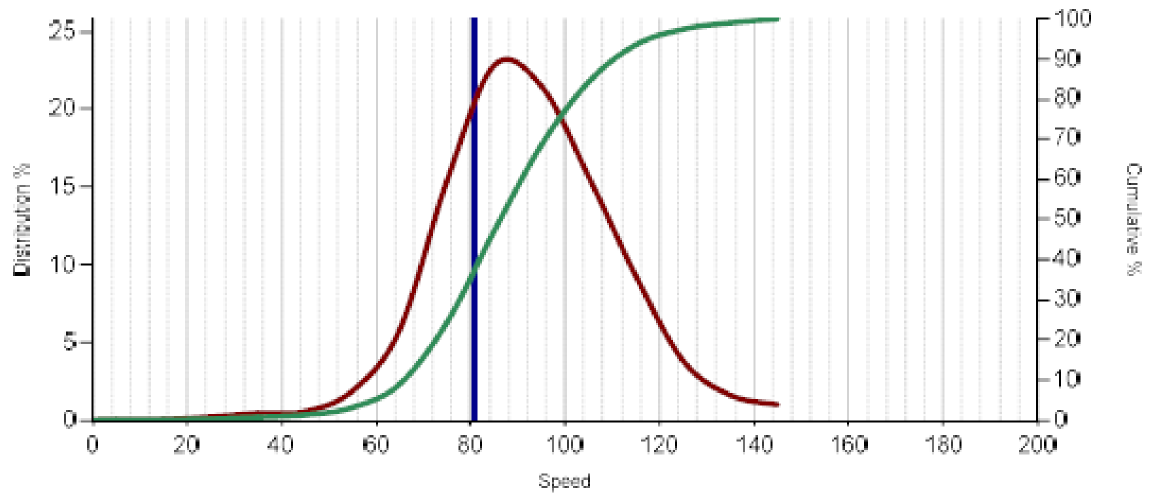
Lane 1 - To R335 Addo



Station Speed Distribution

Site	8211 - R336 Sunland	Distribution
Speed Limit	80 km/hr	Cumulative
Period	01 Jan 2019 - 31 Dec 2019	Speed Limit

Lane 2 - To Kirkwood



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 5

Station Information

Site Number	8211	**Site Identifier**	27127
Site Name	R336 Sunland		
Site Description	Between Kirkwood & R335 Addo Intersection		
Site Type	Permanent	**Owner**	SANRAL
Physical Lanes	2	**Responsibility**	NON-TOLL
Logical Lanes	2	**Installation Date**	2017-06-05
GPS Longitude	25.575787	**Termination Date**	
GPS Latitude	-33.48296	**Status**	In Use
Region	South	**Companion Site**	
Road	R336	**Speed Limit**	80
Route	R336	**Count Type**	Normal Traffic Counting Station
Section	01	**Distance**	34.98
Authority	SANRAL	**Contract No**	NRA 53000/2017/TOLL/2
Contract Org	Mikros Traffic Monitoring KZN	**Station History Type**	Full Site
System Type	C1		

Lane No	Lane Description	Stream No	Stream Description	Direction	Reverse Lane No	Pos
1	To R335 Addo	1	To R335 Addo	East	2	1
2	To Kirkwood	2	To Kirkwood	West	1	1

NO PHOTO AVAILABLE.

Direction 1

NO DATA FOUND.

NO PHOTO AVAILABLE.

Direction 2

NO DATA FOUND.

PHOTO

As Built

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 1

Traffic Highlights of Site: R336 Sunland (8211)	
Site No	8211
Site Name	R336 Sunland
Site Description	Between Kirkwood & R335 Addo Intersection
Road Description	Route : R336 Section : 01E Distance : 34.98 km
GPS Position	Latitude: -33.48296 Longitude: 25.575787
Number of Lanes	2
Station Type	Permanent
Requested Data Period	01 Jan 2020 - 31 Dec 2020
First and Last Data Dates	01 Jan 2020 - 23 Jun 2020
Data Available for Requested Period as Percentage	48%
Last Full Day Count for ADT and ADTT	22 Jun 2020
Number of Full Days in Requested Period	174

Highlights per Stream		Str 1: To R335 Addo	Str 2: To Kirkwood	Total
1.1	Total Number of Vehicles	133,485	131,064	264,549
1.2	Average Daily Traffic (ADT)	767	753	1,520
1.3	Average Daily Truck Traffic (ADTT)	120	115	235
1.4	Percentage of Trucks	15.6 %	15.2 %	15.4 %
1.5	Truck Split % (Short : Medium : Long)	42 : 20 : 38	41 : 19 : 40	42 : 20 : 39
1.6	Percentage of Night Traffic [20h00 - 6h00)	6.1 %	6.2 %	6.1 %
2.1	Speed Limit			80
2.2	Average Speed (km/hr)	92.6	91.8	92.2
2.3	Average Speed - Light Vehicles (km/hr	95.4	94.6	95.0
2.4	Average Speed - Heavy Vehicles (km/hr)	78.2	77.4	77.8
2.5	Average Night Speed (km/hr)	91.7	90.0	90.9
2.6	15th Centile Speed (km/hr)	74.3	73.9	74.1
2.7	85th Centile Speed (km/hr)	112.6	112.8	112.7
2.8	Percentage of Vehicles in Excess of Speed Limit	85.5 %	85.3 %	85.4 %
3.1	Percentage Vehicles in Flows Over 600 (vehs/hr)	0 %	0 %	0.00%
3.2	Percentage of Vehicles less than 2s behind vehicle ahead	0 %	0 %	0 %

SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 2

4.1	Total Number of Heavy Vehicles	20,810	19,972	40,782
4.2	Estimated Average Number of axles per Truck	4.5	4.6	4.6
4.3	Estimated Truck Mass (Ton/Truck)	26.0	26.4	26.2
4.4	Estimated Average E80 / Truck	2.1	2.2	2.15
4.5	Estimated Daily E80 on the Road			531.0
4.6	Estimated Daily E80 in the East Direction			812.0
4.7	Estimated Daily E80 in the West Direction			779.0
4.8	Estimated Daily E80 in the Worst East Lane			812.0
4.9	Estimated Daily E80 in the Worst West Lane			779.0
5.1	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
5.2	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
5.3	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.5 : 2.1 : 3.9)

Traffic Volumes		Date and Time	Total
6.1	Highest Volume on the Road (vehs/hr)	13 May 2020 (17:00 - 18:00)	218
6.2	Highest Volume in the East (vehs/hr)	05 Jun 2020 (17:00 - 18:00)	123
6.3	Highest Volume in the West (vehs/hr)	05 Jun 2020 (16:00 - 17:00)	129
6.4	Highest Volume in a Lane (vehs/hr)	05 Jun 2020 (16:00 - 17:00)	129
6.5	15th Highest Volume on the Road (vehs/hr)	26 May 2020 (17:00 - 18:00)	207
6.6	15th Highest Volume in the East Direction (vehs/hr)	03 Jun 2020 (16:00 - 17:00)	105
6.7	15th Highest Volume in the West Direction (vehs/hr)	04 Jun 2020 (16:00 - 17:00)	108
6.8	30th Highest Volume on the Road (vehs/hr)	03 Mar 2020 (14:00 - 15:00)	197
6.9	30th Highest Volume in the East Direction (vehs/hr)	10 Jun 2020 (08:00 - 09:00)	102
6.10	30th Highest Volume in the West Direction (vehs/hr)	01 Jun 2020 (17:00 - 18:00)	101

SANRAL Yearbook

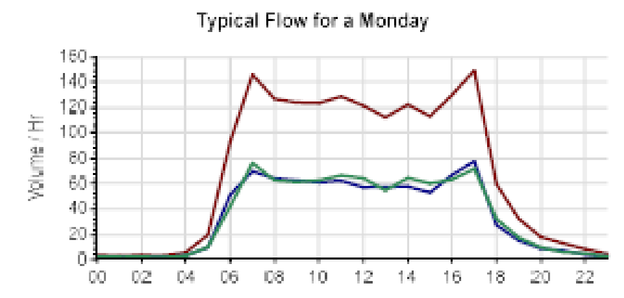
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

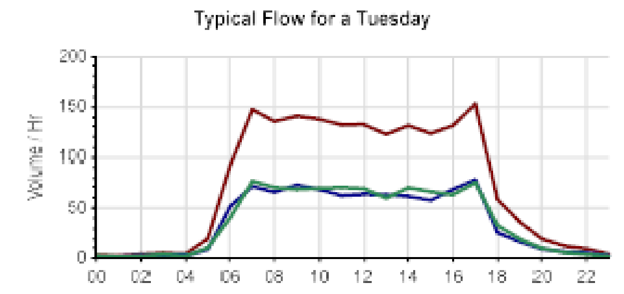
Station Data - 3

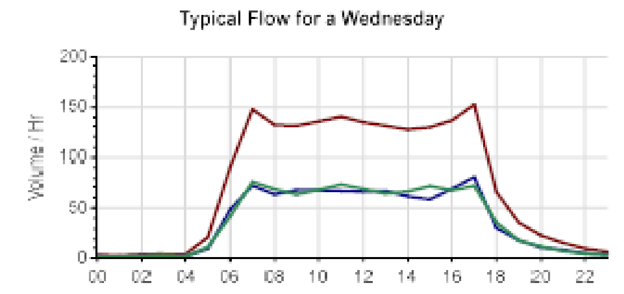
Station Typical Flow Graphs

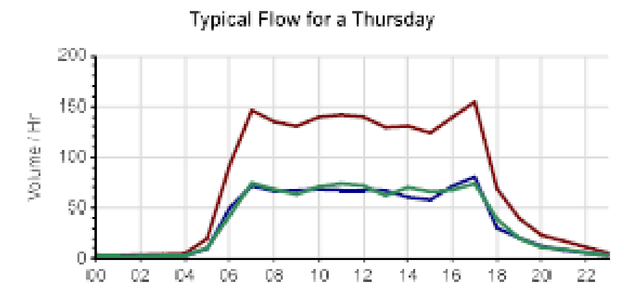
Site	8211 - R336 Sunland
Region	South
Actual Period	01 Jan 2020 - 23 Jun 2020
Classification	RSA Ext Lgt/Hvy
Day Type	Normal Day & Fixed Public Holiday+

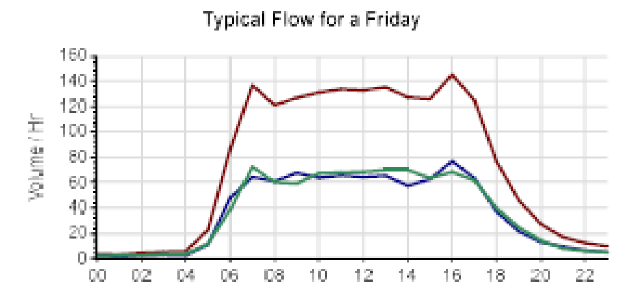
Total	Total		
To Kirkwood	Light		
To R335 Addo	Heavy		

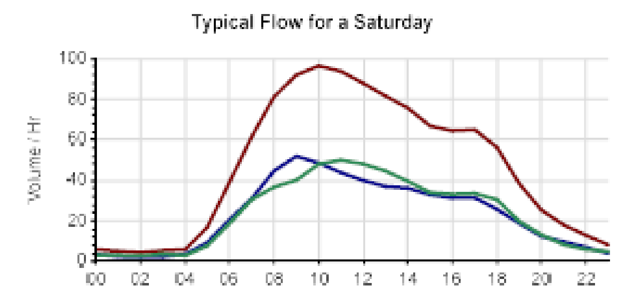


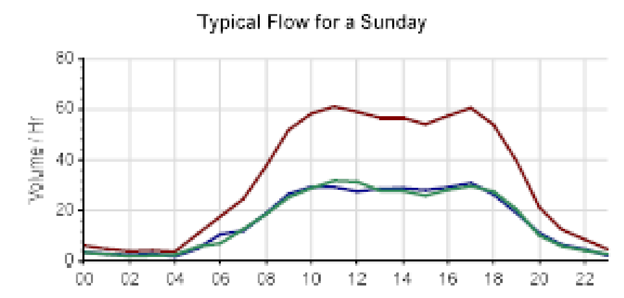


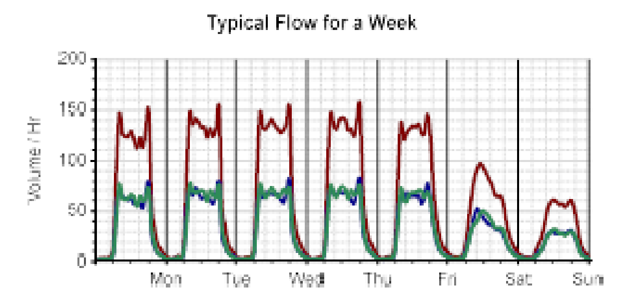


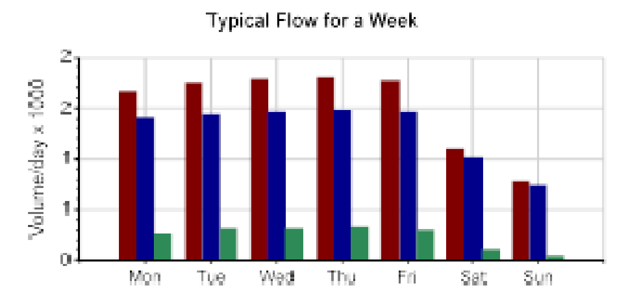












SANRAL Yearbook

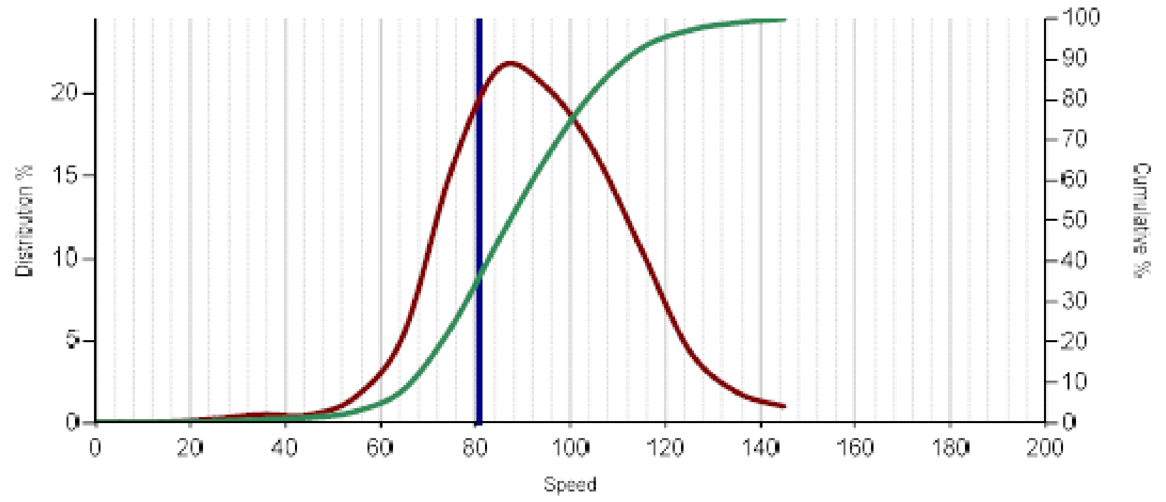
Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 4

Station Speed Distribution

Site	8211 - R336 Sunland	Distribution
Speed Limit	80 km/hr	Cumulative
Period	01 Jan 2020 - 31 Dec 2020	Speed Limit

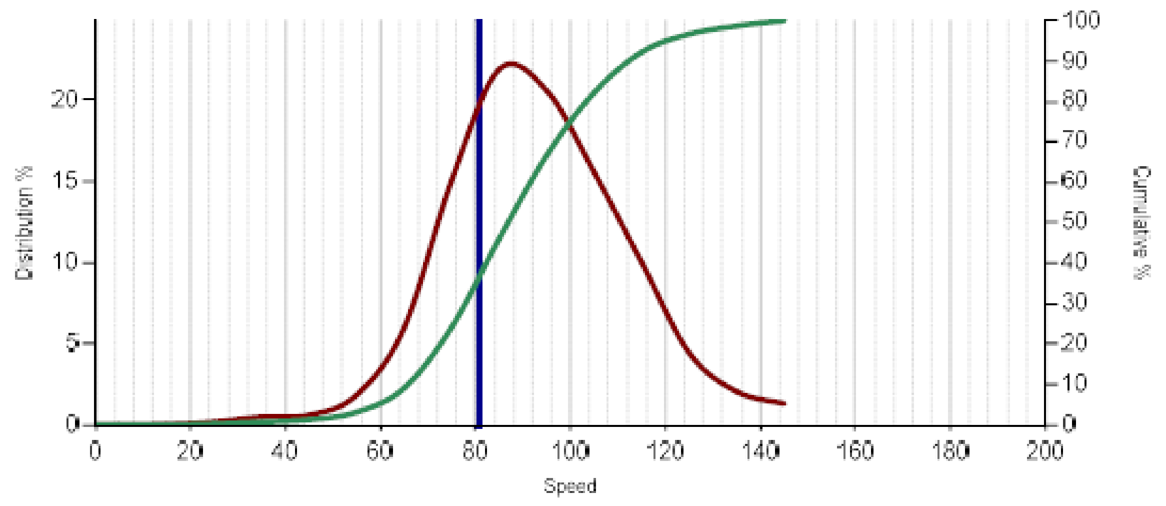
Lane 1 - To R335 Addo



Station Speed Distribution

Site	8211 - R336 Sunland	Distribution
Speed Limit	80 km/hr	Cumulative
Period	01 Jan 2020 - 31 Dec 2020	Speed Limit

Lane 2 - To Kirkwood



SANRAL Yearbook

Generated by The South African National Roads Agency SOC LTD
For queries, contact:
Michelle van der Walt (012) 844 8029 vdwaltm@nra.co.za

Station Data - 5