30 May 2014

KIMBERLEY STRENGTHENING PHASE 4 PROJECT – SOIL AND AGRICULTURAL POTENTIAL BASELINE STUDY FOR THE MANGANORE-FERRUM STUDY AREA

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BASELINE SOIL AND AGRICULTURAL POTENTIAL STUDY FOR THE PROPOSED ESKOM KIMBERLEY STRENGHTENING PHASE 4 PROJECT (MANGANORE-FERRUM STUDY AREA)

PREPARED FOR

LANDSCAPE DYNAMICS
ENVIRONMENTAL CONSULTANTS
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PREPARED BY

Prepared by:	***Terra-Africa Consult cc***
Report Author:	***Mariné Pienaar***
Professional Registration:	***SACNASP Reg. No. 400274/10***
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1. INTRODUCTION

Terra-Africa Consult cc. was appointed by Landscape Dynamics (Pty) Ltd. to conduct a baseline soil and agricultural potential assessment report for the proposed Eskom Kimberley Strengthening Phase 4 Project situated in the Northern Cape Province. The total project area has been divided into four development areas and the fourth of these are located between Eskom's Manganore and Ferrum Substations. The purpose of the baseline assessment is to evaluate the entire area for its suitability to the proposed project and to avoid areas with high potential agricultural soil where possible.

The objectives of this study are:

- to describe the soils present in the larger study area around the two proposed alternatives
- to determine the agricultural potential of the soil
- to determine land capabilities associated with the different soil types
- to make recommendations with regards to the most suitable alternative from the perspective of soil conservation

2. TERMS OF REFERENCE

The first phase consisted of a high level desktop assessment of the study area using spatial imagery on Google Earth before the site visit commenced. During this phase, the area was scanned to determine whether there is any large agricultural developments such as irrigation schemes that might be impact upon by the construction of the power lines.

The second phase consisted of flying along the proposed route and alternative routes between the Eskom Manganore-Ferrum substations. In addition to flying over the area, the alternative routes were also visited by road to evaluate soil profiles and to observe any agricultural activities.

The third phase included analysis of spatial data as was obtained from the Agricultural Research Council as well as the Environmental Potential Atlas Database.

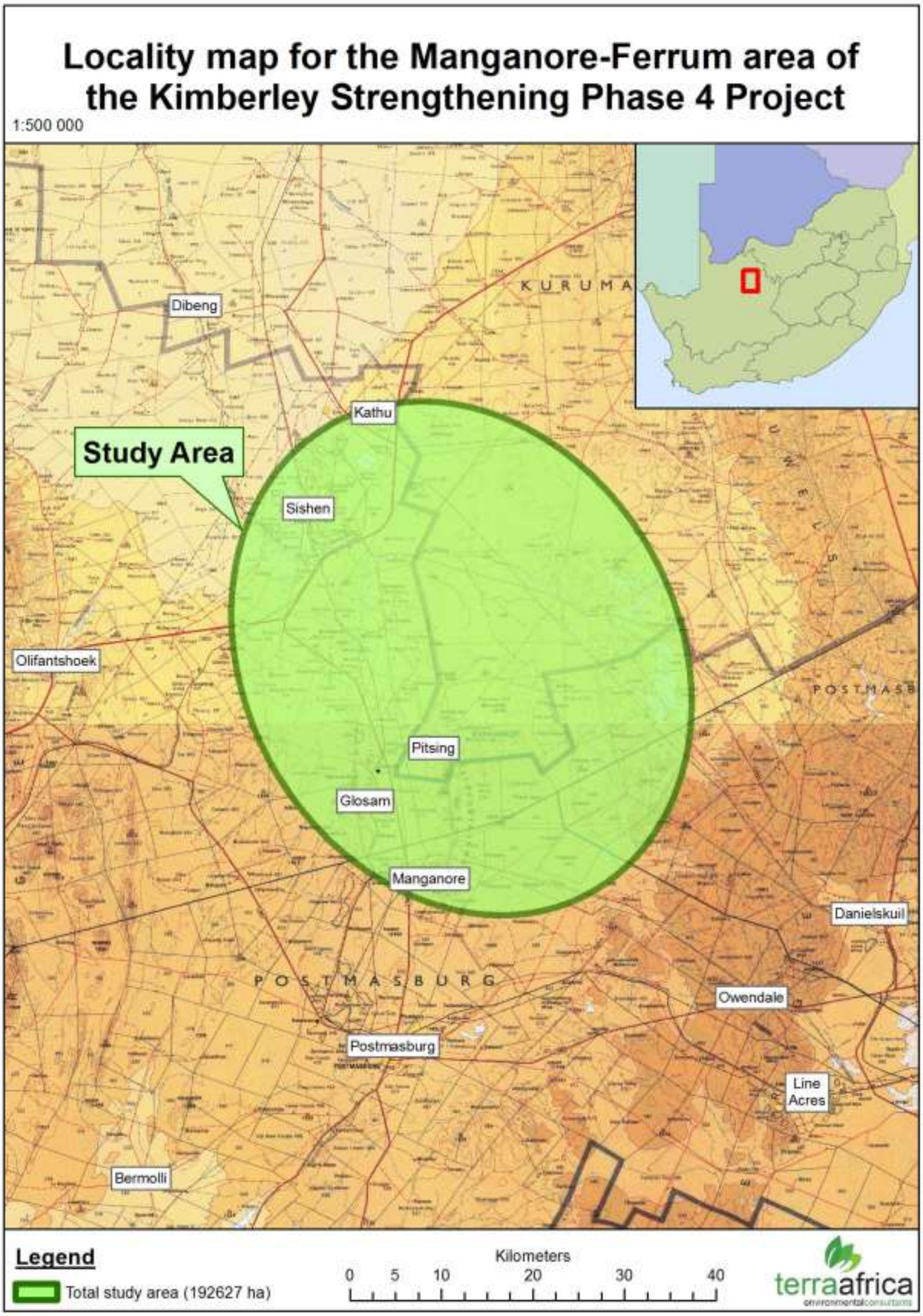

Figure 1: Locality map for the Manganore-Ferrum area of the Kimberley Strengthening Phase 4 Project

3. LOCALITY OF THE MANGANORE-FERRUM AREA OF THE KIMBERLEY STRENGTHENING PHASE 4 PROJECT

The two proposed Manganore-Ferrum alternatives are situated within the larger study area that is approximately 20 kilometres north of Postmasburg and directly south of Kathu. The Sishen Iron Ore mining area is located approximately 15 kilometres southwest of Kathu. The Manganore-Ferrum study area is located within the Northern Cape Province (Figure 1). The total study area for this assessment was 192,627 hectares (ha) and included assessment of three alternatives which are the first alternative (45 km), second alternative (49 km) (Figure 3). Both alternatives runs in an north-south direction within the study area and the first alternative aims to avoid crossing through pans and water bodies as far as possible.

4. CLIMATE OF THE STUDY AREA

The climate data was obtained from the New Local Climate Estimator, developed by the Food and Agricultural Organisation of the United Nations in 2005. The weather station where this data was obtained is the Kathu weather station located at longitude 23.65° and latitude -28.00°. The station is located at an altitude of 1127m.

The climate can be considered to be semi-arid with hot summers and cool to cold winter temperatures. Temperatures vary between –9°C and +42°C, with an average of 19.2°C. In spring, summer and autumn months, the average rainfall varies between 19mm (October) and 74mm per month (March), while potential evapo-transpiration will be between 145mm (October) to 130mm (March) per month. Rainfall during winter months is erratic and usually no or very little rain falls between June and September, while evapo-transpiration is never less than 60mm per month (Figure 2). This implies that the area has a precipitation deficit of 1075mm per year and a moisture index of -75% and can therefore be classified as a dry region (semi-arid) for agricultural purposes.

Mean monthly maximum temperatures range between 18°C and 32°C and can on some days be as high as 43°C while mean monthly minimum temperatures can be anything between

1°C and 17°C (Figure 3) and there is an average ground frost frequency of 7% during winter months.

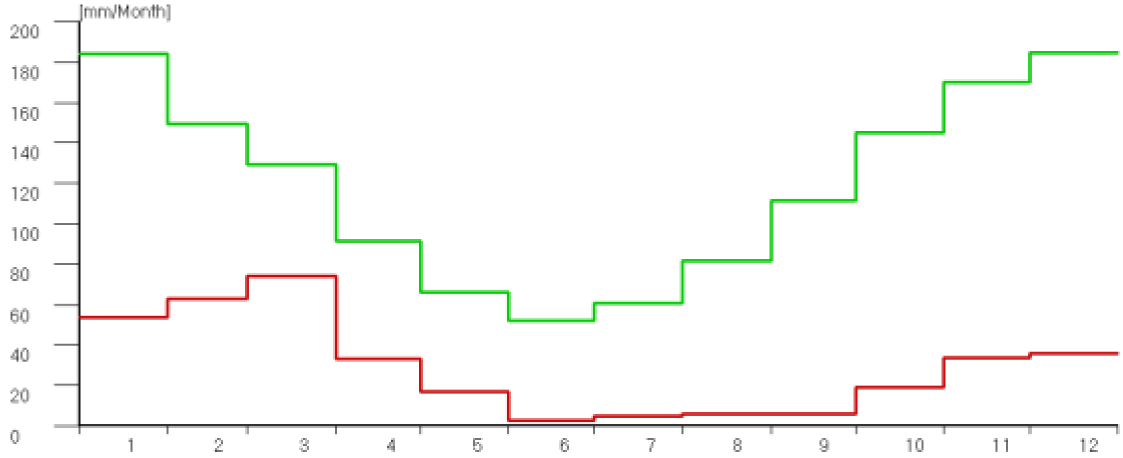

Figure 2: Annual rainfall (red) and Potential Evapo-transpiration (PET) (green) in mm/Month from month 1 (January) to month 12 (December)

Wind in the area has been recorded to blow at a maximum speed of up to 6.48 km/h (Figure 4). The highest vapour pressure recorded in this area is 15.10 hPa and this occurs during the months of February and March.

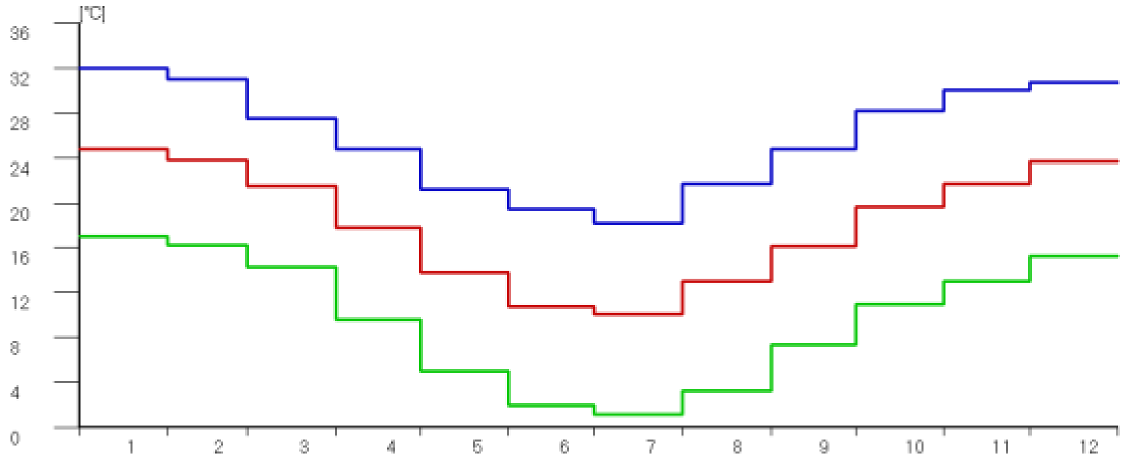

Figure 3: Average dail maximum temperature (blue), average daily mean temperature (red) and average daily minimum temperature (green) in °C from month 1 (January) to month 12 (December)

In the summer there is an average of 9.8 to 10.1 sunshine hours per day and average day lengths of 12 to 14 hours. The sunshine fraction is the percentage of time when bright sunshine is recorded during the day. It is directly linked to cloudiness, with full cloud cover being equal 0% of sunshine fraction. The highest sunshine fraction for the study area was measured in the month of August at 82% (Figure 5).

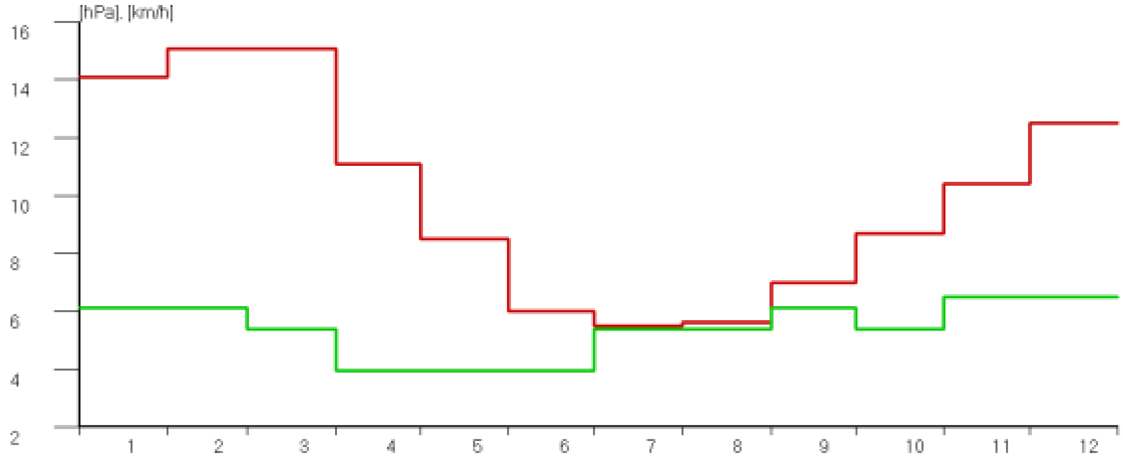

Figure 4: Average water vapour pressure (red) in hPa and average wind speed (green) in km/h from month 1 (January) to month 12 (December)

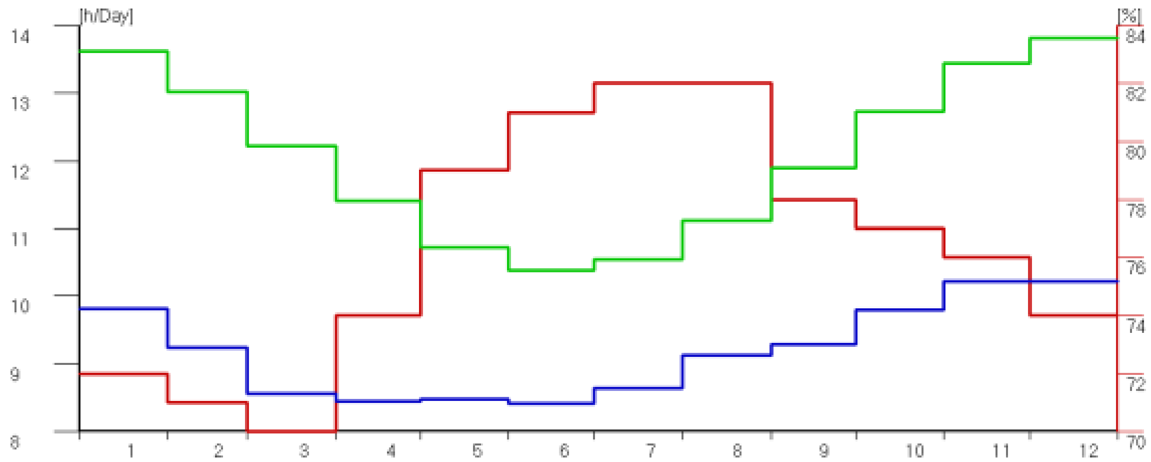

Figure 5: Sunshine fraction (red) in %, day length (green) in hours/Day and sunshine hours (blue) from month 1 (January) to month 12 (December)

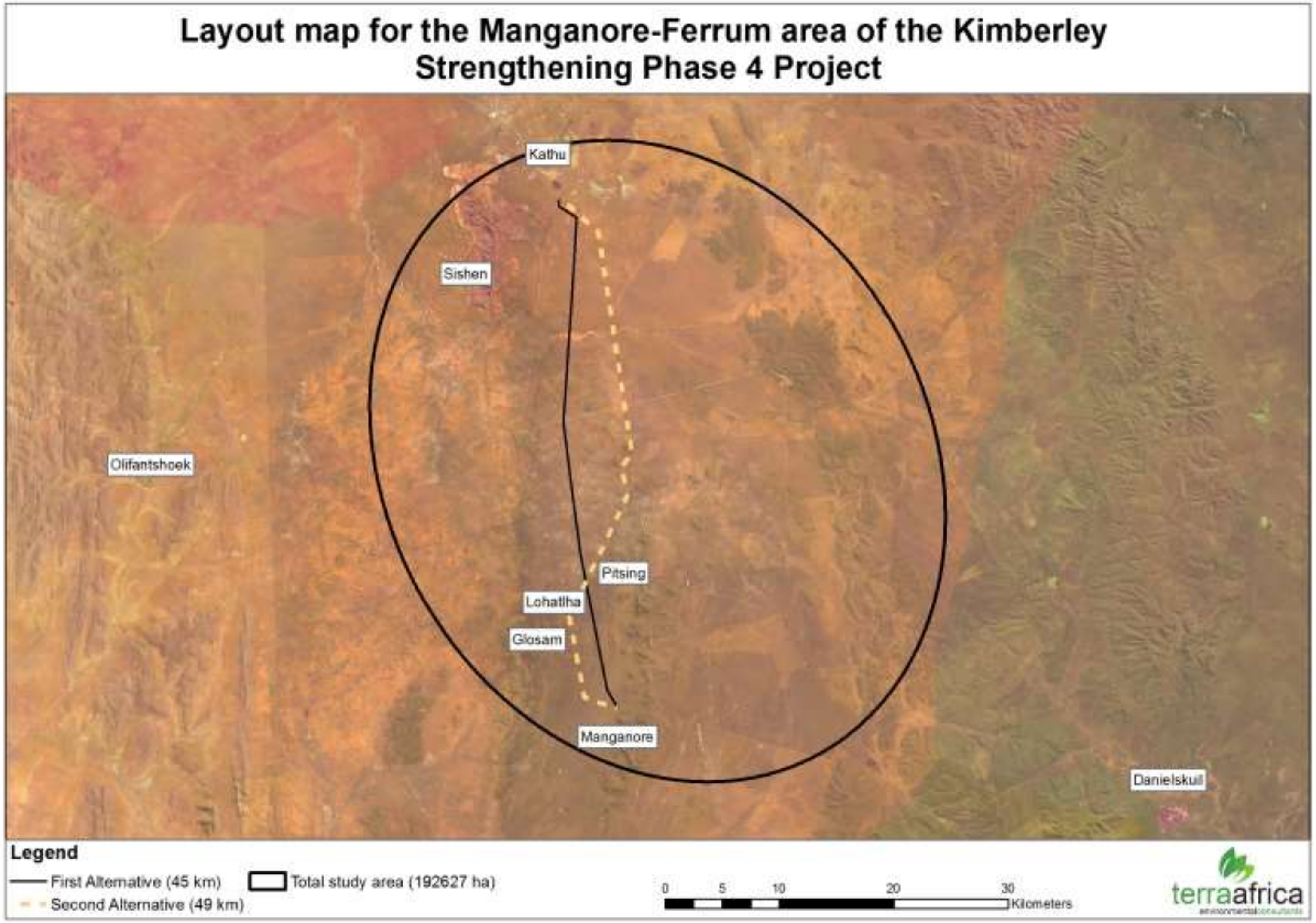

Figure 6: Layout map for the Manganore-Ferrum area of the Kimberley Strengthening Phase 4 Project

5. IDENTIFICATION OF ASSUMPTIONS AND LIMITATIONS

The study relies heavily on spatial data and imagery and has not been verified by a detailed soil survey. The photos were taken during the site visit and the purpose of this visit was to get a broad overview of the attributes of the landscape. However, taken the nature of the project into consideration and the very small areas where soil will be impacted upon, the study is sufficient to provide baseline information that can be used during the detailed planning and impact assessment phase of this project.

6. LAND TYPE DATA ASSESSMENT

6.1 Background information

The following abstract from Sililo et al. (2000) gives an introduction into the development and usefulness of a land type data system:

"In South Africa, land type maps were designed to assist in assessing agricultural potential. The procedure followed in mapping land types was described by the Institute of Soil, Climate and Water (Land type Survey Staff, 1987)."

Land type data was developed by superimposing broad soil groups developed from the Binomial Soil Classification System (MacVicar et al., 1977) with maps of climate zone. This resulted in the land type maps that indicated land type boundaries with an inventory for each land type that include clay percentage as well as other information regarding the area that can be used to interpret soil classification results more successfully.

6.2 Land type results

Twelve different land types were identified on within the larger Manganore-Ferrum study area. These land types are Ae1, Ae7, Ae8, Ae12, Ae215, Ag109, Ag110, Ag111, Ah9, Ib1, Ib237 and Ib238 (Figure 9). Below follows a description of each of the land types identified.

6.2.1 Land Type Ae1

The land type indicates only two landscape positions i.e. Position 4 that makes up 88% of the total land surface of this land type and Position 5 that makes up the remaining 12% of the land type surface area. The slope for Position 4 ranges between 0% and 3% with slope lengths of 500 and 3000 m and for Position 5 between of 0% and 2% and slope lengths between 30 and 300 m. The soil forms in this land type mainly consist of deep red apedal soil of the Hutton form (80% of the total land surface of this land type) as well as shallower soil of the Mispah form and rocky outcrops. The geology underlying this land type is red wind-blown sand and surface limestone of Tertiary to Recent age. Some outcrops of banded ironstone, jaspillite and crocidolite and fine and coarse-grained dolomite, chert and dolomitic limestone also occurs.

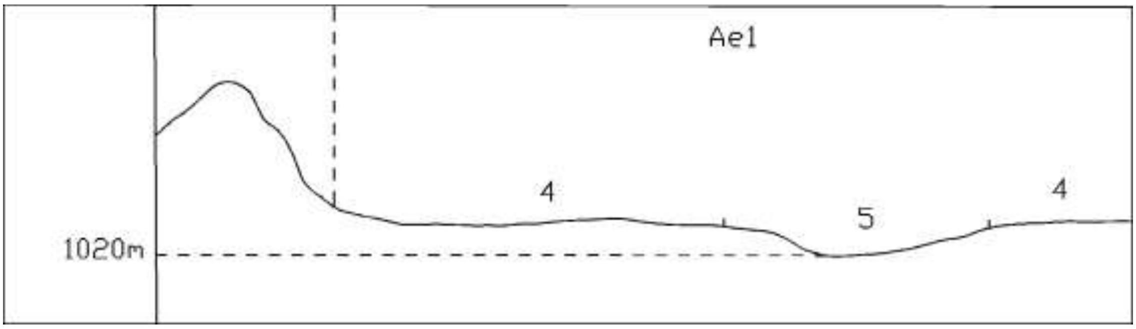

Figure 7: Terrain sketch for Land Type Ae1

6.2.2 Land Type Ae7

This land type consists of four different landscape positions where Positions 1 and 3 are associated with areas with slight hills and slopes of between 1% and 12% and slope lengths of 100 to 5000m. These positions are dominated by rock and shallow Hutton soils. For the flatter landscape positions (Positions 4 and 5), the slope is between 0 and 2% and slope length between and 50 and 1500 m for Landscape Position 4 and slope of 0 to 2% and slope length between 50 and 200 meters for Landscape Position 5. These landscape positions consits of red Hutton soils of varying depth and as well as smaller sections of Oakleaf and Valsrivier forms. The geology underlying this land type is amygdaloidal andesitic lava with interbedded tuff, agglomerate, chert and red jasper.

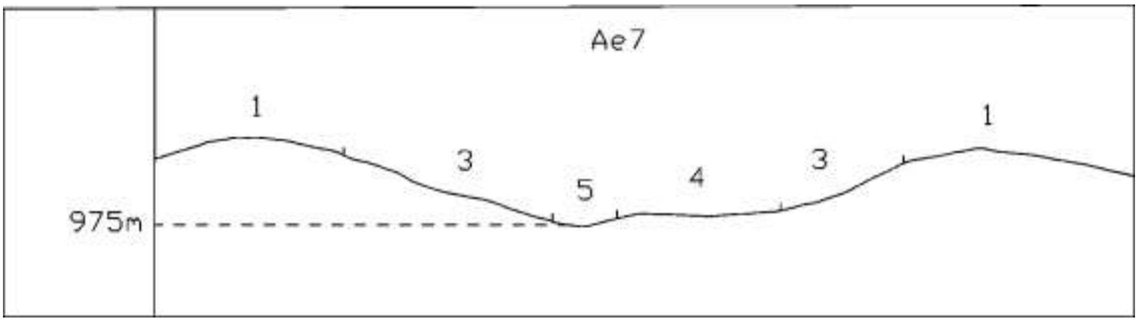

Figure 8: Terrain form sketch for Land Type Ae7

6.2.3 Land Type Ae8

This land type consists of four different landscape positions where Positions 1 is associated with areas with hill tops with slope of 0% to 7% and slope lengths of 50 to 800m while Position 3 indicates mid-slope landscape positions with slope between 6% and 30% and slope lengths of 200 to 1000 m. These positions are dominated by shallow Mispah soils with patches of shallow to medium-deep Hutton soils in between. Positions 1 and 3 is underlain mainly by volcanic rocks, banded ironstone and jaspillite with subordinate amphibolite and crocidolite. For the flatter landscape positions (Positions 4 and 5), the slope is between 1 and 6% and slope length between and 800 and 4000 m for Landscape Position 4 and slope of 0 to 2% and slope length between 50 and 1000 meters for Landscape Position 5. These landscape positions consits of red Hutton soils of varying depth. Positions 4 and 5 is underlain by red wind-blown sand with occurences of rubble river-terrace gravel and surface limstone of Tertiary to Recent age.

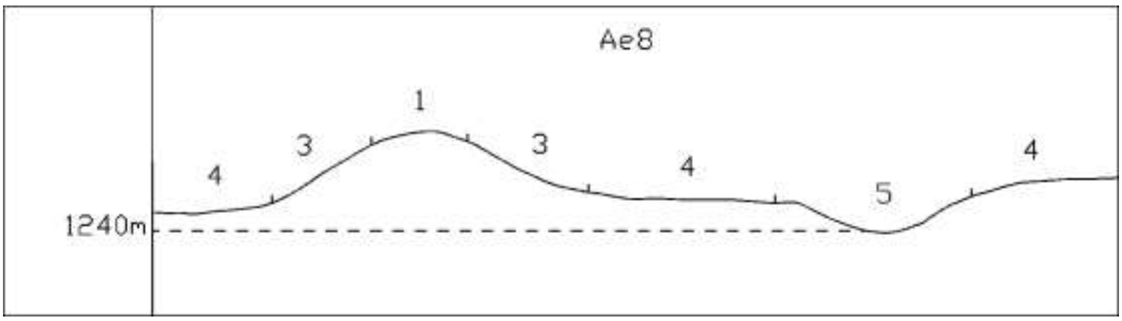

Figure 9: Terrain form sketch for Land Type Ae8

6.2.4 Land Type Ae12

This land type is found in four different landscape positions (terrain units) where Units 1 and 3 are associated with areas with slight hills and slopes of between 0 to 5% (Unit 1) and 4 to

8% (Unit 2) and shorter slope lengths of 50 to 400m. These positions consist mainly of rocky and shallow Mispah soil. For the flatter landscape positions, the slope is between 0 and 2% and slope length between and 1000 to 5000 m for Landscape Position 4 and slope of 0 to 2% and slope length between 50 and 500 meters for Landscape Position 5. These positions are dominated by red apedal Hutton soil of varying depth. The geology consists of red to flesh-coloured wind-blown sand with outcrops of shale, flagstone, quartzite and conglomerate.

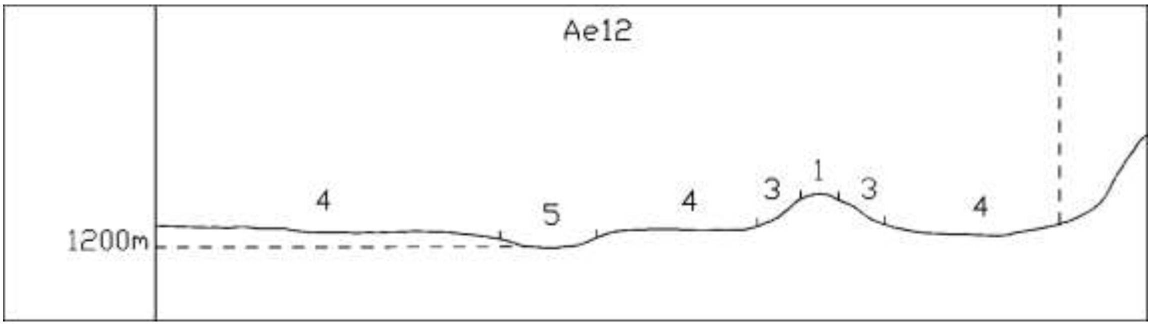

Figure 10: Terrain form sketch for Land Type Ae12

6.2.5 Land Type Ae215

The land type indicates only two landscape positions i.e. Position 4 that makes up 90% of the total land surface of this land type and Position 5 that makes up the remaining 10% of the land type surface area. The slope for Position 4 ranges between 0% and 3% with slope lengths of 300 and 2000 m and for Position 5 between of 1% and 2% and slope lengths between 20 and 150 m. The soil forms in this land type mainly consist of deep red apedal soil of the Hutton form as well as patches of yellow Clovelly soils and rocky outcrops. The geology underlying this mainly red to flesh-coloured wind-blown sand of Tertiary to Recent age.

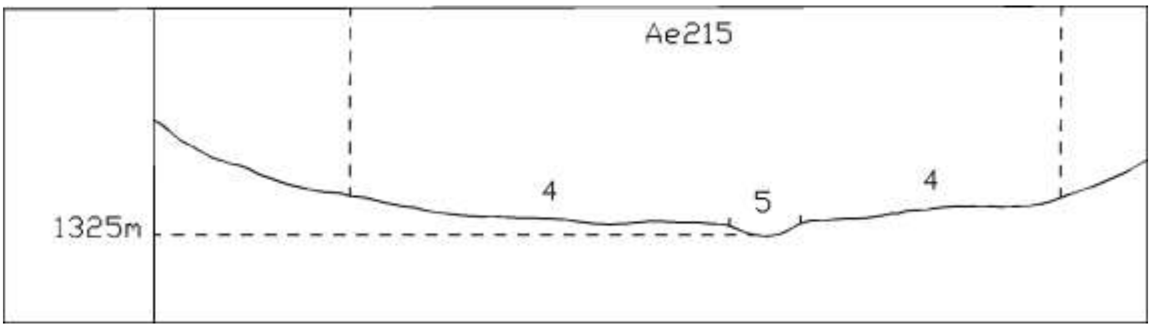

Figure 11: Terrain form sketch for Land Type Ae215

6.2.6 Land Type Ag109

This land type consists of four different landscape positions where Positions 1 is associated with areas with hill tops with slope of 0% to 7% and slope lengths of 50 to 600m while Position 3 indicates mid-slope landscape positions with slope between 6% and 30% and and slope lengths of 400 to 2000 m. These positions are dominated by rock and shallow Hutton soil. For the flatter landscape positions (Positions 4 and 5), the slope is between 1 and 3% and slope length between and 50 and 200 m for Landscape Position 4 and slope of 0 to 2% and slope length between 50 and 200 meters for Landscape Position 5. These landscape positions consits of red Hutton soils of varying depth. The geology of this land type consists of amygdaloidal andesitic lava with interbedded tuff, agglomerate, chert and red jasper.

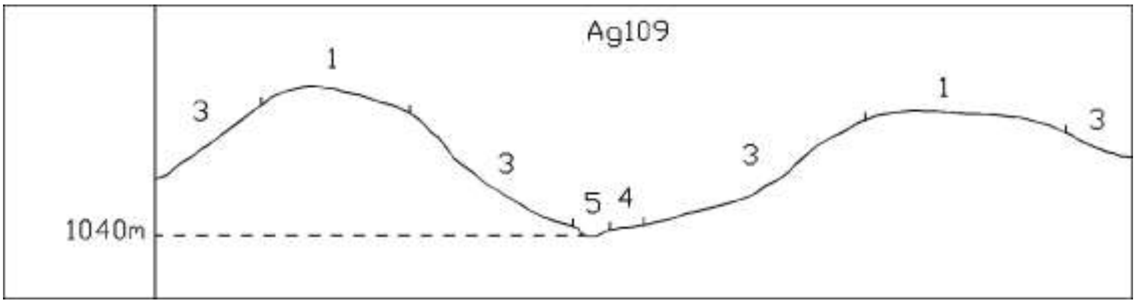

Figure 12: Terrain form sketch for Land Type Ag109

6.2.7 Land Type Ag110

The land type is found in landscapes where the slope is between 0 and 1% and slope length between and 1000 and 5000 m for Landscape Position 4 and slope of 0 to 2% and slope length between 50 and 5000 meters for Landscape Position 5. The soil forms in this land type mainly have high base status and are shallow, rocky and limestone rich red well drained soils. These soils in this area are derived from wind transported sands overlying hard rock. The geology underlying this land type is surface limestone, alluvium and red wind-blown sand of Tertiary to Recent age with a few occurrences of amygdaloidal andesitic lava (Ongeluk Formation). The clay percentages of the A-horizon range between 2 and 15%.

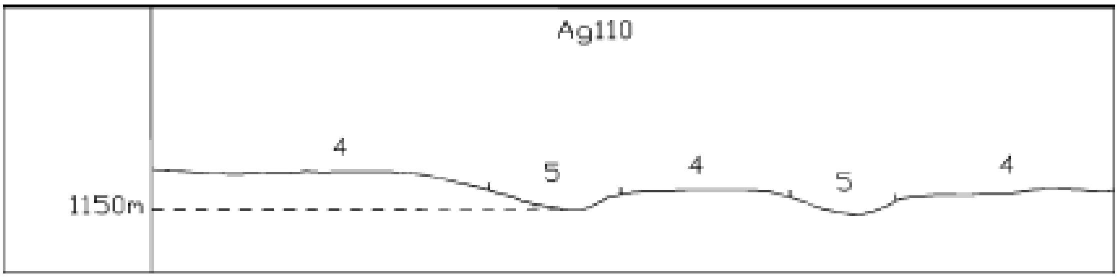

Figure 13: Terrain form sketch for Land Type Ag110

6.2.8 Land Type Ag111

This land type consists of four different landscape positions where Positions 1 is associated with areas with hill tops with slope of 1% to 4% and slope lengths of 50 to 500m while Position 3 indicates mid-slope landscape positions with slope between 6% and 30% and slope lengths of 100 to 700 m. These positions are dominated by rock and shallow Mispah and Hutton soil forms. For the flatter landscape positions (Positions 4 and 5), the slope is between 0% and 2% and slope length between and 500 and 5000 m for Landscape Position 4 and slope of 0 to 1% and slope length between 50 and 500 meters for Landscape Position 5. These landscape positions consists of red Hutton soils of varying depth as well as Mispah soil. The geology of this land type consists of fine and coarse-grained dolomite, chert and dolomitic limestone with prominent interbedded chert, limestone and banded ironstone.

6.2.9 Land Type Ah9

Land Type Ah9 indicates only two landscape positions i.e. Position 4 that makes up 95% of the total land surface of this land type and Position 5 that makes up the remaining 5% of the land type surface area. The slope for Position 4 ranges between 0% and 1% with slope lengths of 1000 and 10000 m and for Position 5 between of 1% and 3% and slope lengths between 200 and 1200 m. The soil forms in this land type mainly consist of deep yellow-brown apedal soil of the Clovelly forms as well as red apedal soil of the Hutton form. The geology underlying this land type is mainly aeolian sand of Recent age with a few outcrops of Tertiary Kalahari beds (surface limestone, silcrete and sandstone) in the riverbeds.

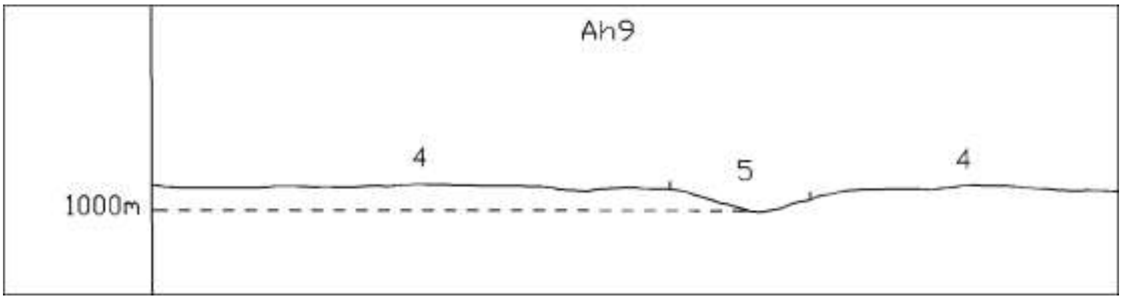

Figure 14: Terrain form sketch for Land Type Ah9

6.2.10 Land Type Ib1

Land Type Ib consist of three landscape positions i.e. Position 1 that is on the hill tops with 0 – 7% slope, slope length of 150 to 750 m that consist of 80% rock for the entire terrain unit. Position 3 that makes up 80% of the total land surface of this land type and Position 5 that makes up the remaining 5% of the land type surface area. The slope for Position 3 ranges between 3% and 30% with slope lengths of 500 and 2000 m and for Position 5 between of 2% and 4% and slope lengths between 50 and 200 m. The soil forms in this land type mainly consist of rock and shallow Hutton and Mispah forms. The geology underlying this land type is mainly yellow-brown banded or massive jaspilite with crocidolite; flat pebble conglomerate; banded ironstone with subordinate amphibolite and bron jaspilite and chert at the top.

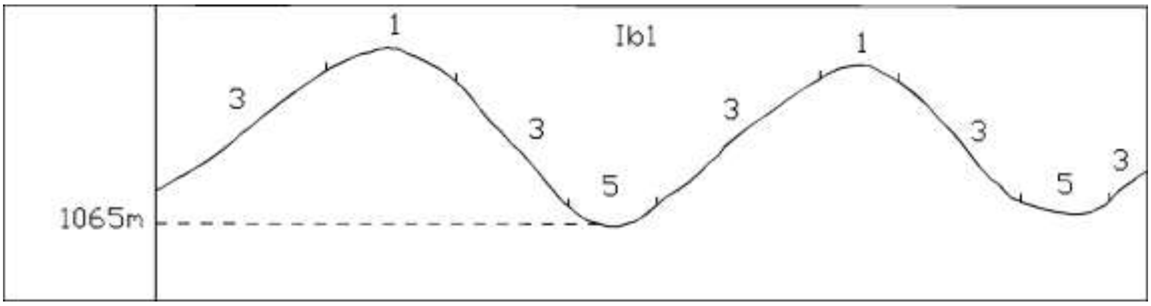

Figure 15: Terrain form sketch for Land Type Ib1

6.2.11 Land Type Ib237

This land type consists of four different landscape positions where Positions 1 is associated with areas with hill tops with slope of 1% to 7% and slope lengths of 100 to 800m while Position 3 indicates mid-slope landscape positions with slope between 6% and 45% and slope lengths of 200 to 2000 m. These positions are dominated by rock and shallow Hutton soil. For the flatter landscape positions (Positions 4 and 5), the slope is between 0 and 2%

and slope length between and 50 and 500 m for Landscape Position 4 and slope of 1 to 3% and slope length between 20 and 150 meters for Landscape Position 5. The soil forms in this land type mainly consist of shallow to deep Hutton soil. The geology underlying this land type is mainly yellow-brown banded or massive jaspilite with crocidolite; flat pebble conglomerate; banded ironstone with subordinate amphibolite and bron jaspilite and chert at the top.

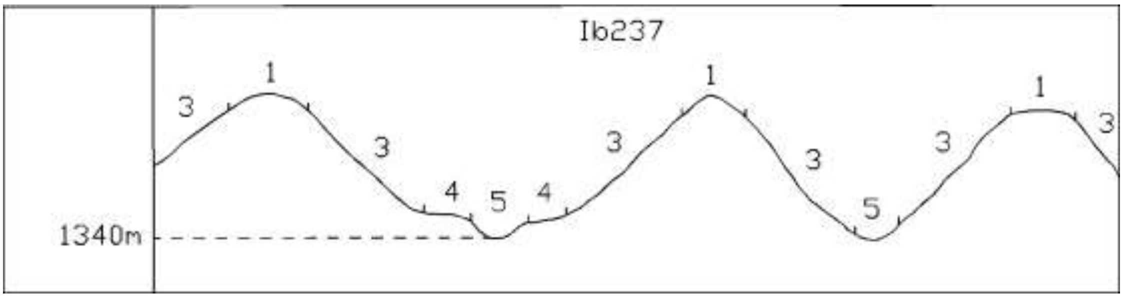

Figure 16: Terrain form sketch for Land Type Ib237

6.2.12 Land Type Ib238

Land Type Ib consist of three landscape positions i.e. Position 1 (25% of total land type surface area) that is on the hill tops with 2% to 7% slope, slope length of 50 to 250 m that consist of 80% rock for the entire terrain unit. Position 3 that makes up 70% of the total land surface of this land type and Position 5 that makes up the remaining 5% of the land type surface area. The slope for Position 3 ranges between 15% and 40% with slope lengths of 100 and 700 m and for Position 5 between of 1% and 4% and slope lengths between 50 and 150 m. The soil forms in this land type mainly consist of rock and shallow Hutton and Mispah forms. The geology underlying this land type is flagstone, quartzite, conglomerate and shale as well as outcrops of chert and chert breccia.

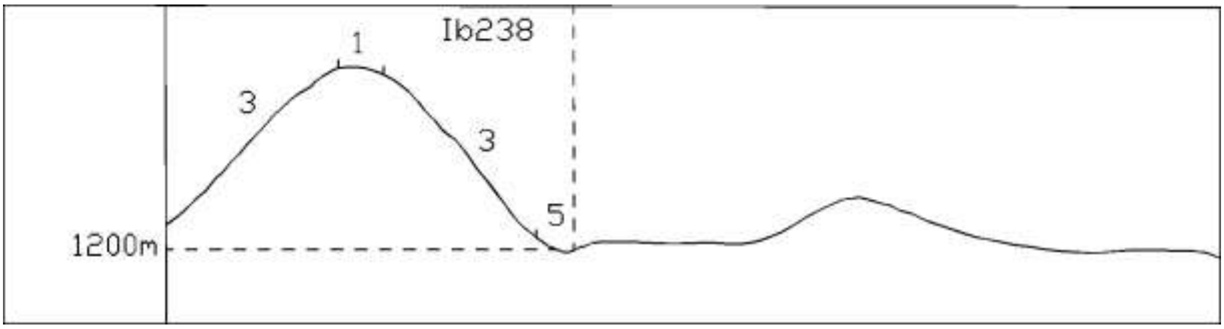

Figure 17: Terrain form sketch for Land Type Ib238

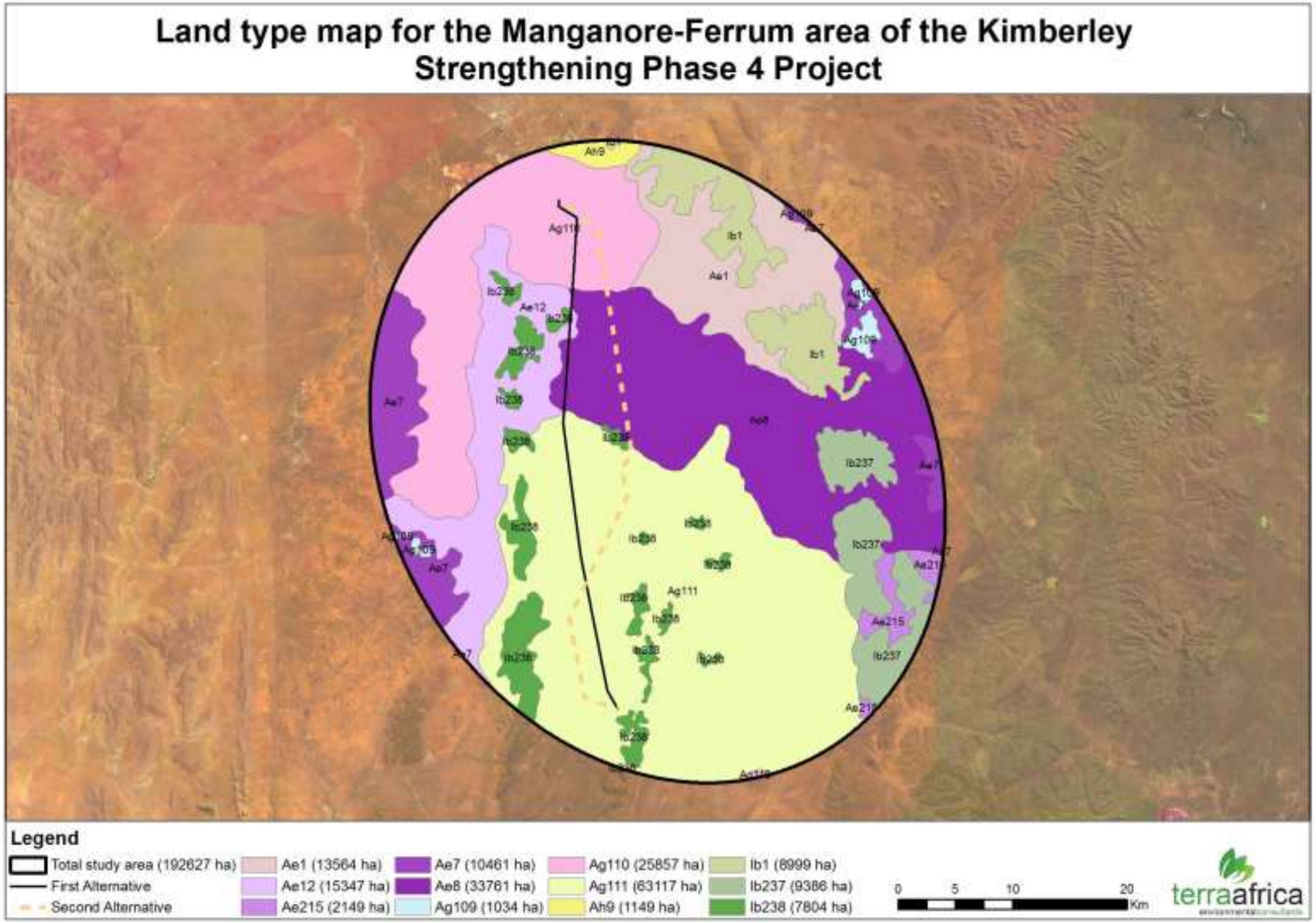

Figure 18: Land type map for the Manganore - Ferrum area of the Kimberley Strengthening Phase 4 Project

7. SOIL CLASSIFICATION

As the entire Kimberley Strengthening Phase 4 Project consist of four phases that are described in four different reports, soil description has been approached to be clear within each individual report as well as when all soil data are combined. Soils were classified into groups for the entire Phase 4 project area and only those relevant for each phase described within the phase's soil report.

Four different main soil groups are present in the entire Manganore-Ferrum baseline area as well as in the areas currently indicated as the proposed alternative corridors for the project.

7.1 Lithic soils (Group 2)

This group include shallow, rocky soils that are considered rather young in pedogenesis (soil formation processes). The lithic group is dominated by soils of the Mispah and Glenrosa forms and also include rocky outcrops (in this area more specifically dolerite outcrops). These soils have sandy texture, while topsoil structure is apedal and the profiles are very shallow (as shallow as 0.10 m of soil on a rocky layer). The orthic A-horizon of the lithic soil group is unsuitable for annual cropping or forage plants (poor rooting medium since the low total available moisture causes the soil to be drought prone). This soil group covers the smallest area of the three groups within the study area and is limited to the south-western part of the study site. Only alternative three has 4.2 kilometres of the proposed corridor that falls within the lithic soils.

The pans identified on site are endorheic pans that formed as a result of low infiltration rate of the soils present on site. These pans are underlain by rock and hardpan carbonate horizons where water accumulates during thunderstorms during the summer months. The water in the pans remains present until the high evaporation rate resulted in all the water evaporating. This leaves the soil surface barren and the lack vegetation on the soil surface cause sand to erode away as a result of wind erosion. The rock and/or carbonate horizon does not function as a conventional wetland and therefore the soils present in the pans are not considered sensitive. Sensitivity of these pans is more related to the ecosystems that are supported by the temporary water supply in the summer months.

7.2 Oxidic soils (Group 1)

The soil group consists of an orthic A horizon on a red or yellow-brown apedal B horizon overlying unspecified material. The B1-horizon has more or less uniform "red" or “yellow” soil colours in both the moist and dry states and has weak structure or is structureless in the moist state. The red and yellow apedal horizons are per definition non-calcareous within 1500mm of the soil surface, but may contain small lime nodules as was the case on site. Textures are coarse to medium sand to sandy-loam in the topsoil and medium to fine sandy-loam in the subsoil. Structure is weak blocky (dominant) or apedal in all horizons. These red-yellow apedal soils dominate the western half of the entire study area. The clay content for this soil group is less than 15%.

Figure 19: Example of red apedal soil that falls within Oxidic Soil Group 1

7.3 Oxidic soils (Group 2)

The soil group consists of an orthic A horizon on a red or yellow-brown apedal B horizon overlying unspecified material. The B1-horizon has more or less uniform "red" or “yellow” soil colours in both the moist and dry states and has weak structure or is structureless in the moist state. The red and yellow apedal horizons are per definition non-calcareous within 1500mm of the soil surface, but may contain small lime nodules as was the case on site. Textures are coarse to medium sand to sandy-loam in the topsoil and medium to fine sandy-loam in the subsoil. Structure is weak blocky (dominant) or apedal in all horizons. These red-yellow apedal soils dominate the western half of the entire study area. The clay content for this soil group is less than 15%.

7.4 Oxidic soils (Group 3)

The soil group consists of an orthic A horizon on a red or yellow-brown apedal B horizon overlying unspecified material. The B1-horizon has more or less uniform "red" or “yellow” soil colours in both the moist and dry states and has weak structure or is structureless in the moist state. The red and yellow apedal horizons are per definition non-calcareous within 1500mm of the soil surface, but may contain small lime nodules as was the case on site. Textures are coarse to medium sand to sandy-loam in the topsoil and medium to fine sandy-loam in the subsoil. Structure is weak blocky (dominant) or apedal in all horizons. These red-yellow apedal soils dominate the western half of the entire study area. The clay content for this soil group is less than 15%.

8. SOIL DEPTH

The Environmental Potential Atlas indicated that soil depths in the study area are divided into three groups i.e. soils shallower than 450mm; soils between 450 and 750mm and soils deeper than 750 mm(Figure 13). Deeper soils dominate the entire baseline area. The shallower soils are present on the western part of the side and are found in the areas associated with the oxidic soils as well as the lithic soil group.

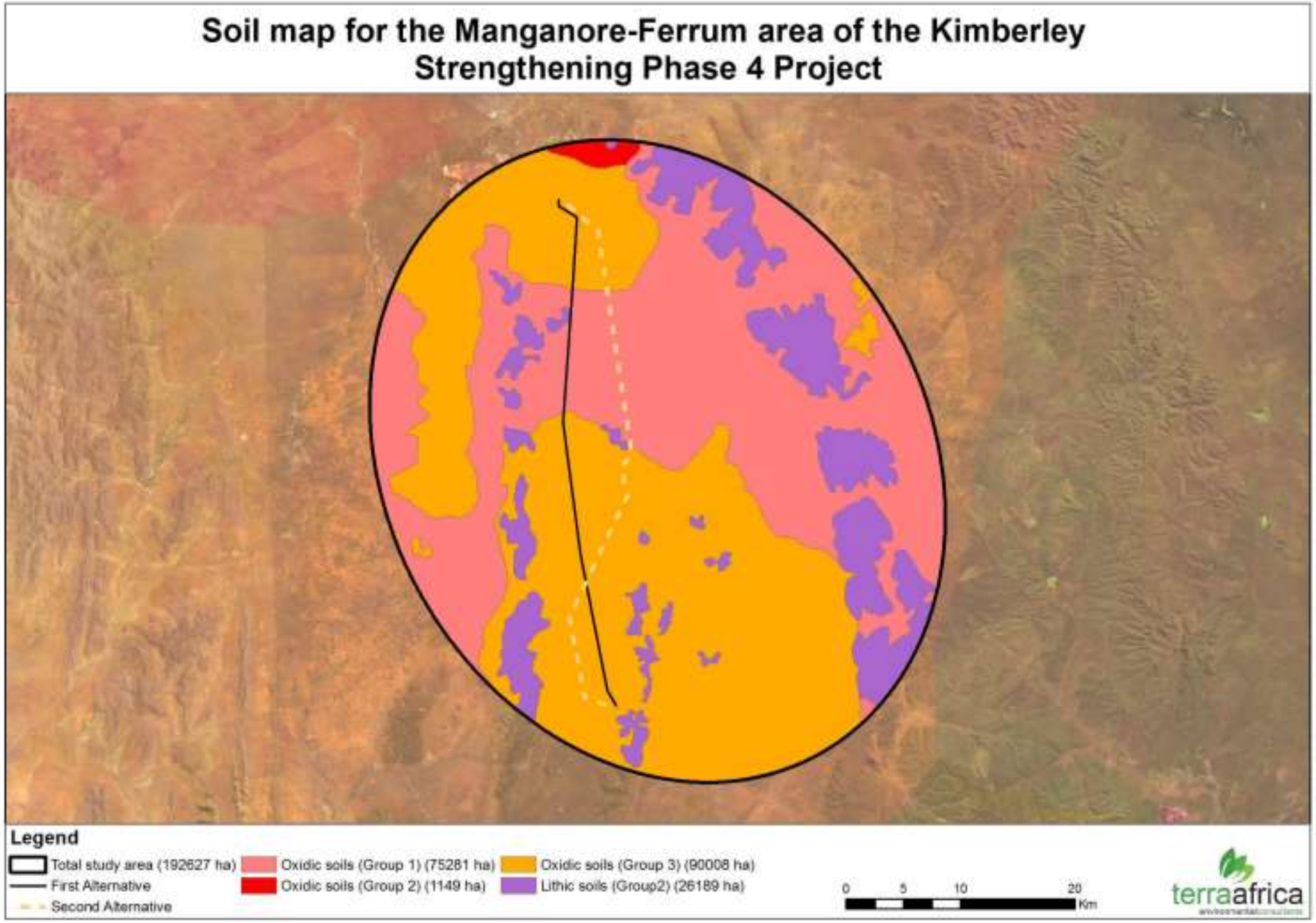

Figure 20: Soil map for the Manganore-Ferrum area of the Kimberley Strengthening Phase 4 Project

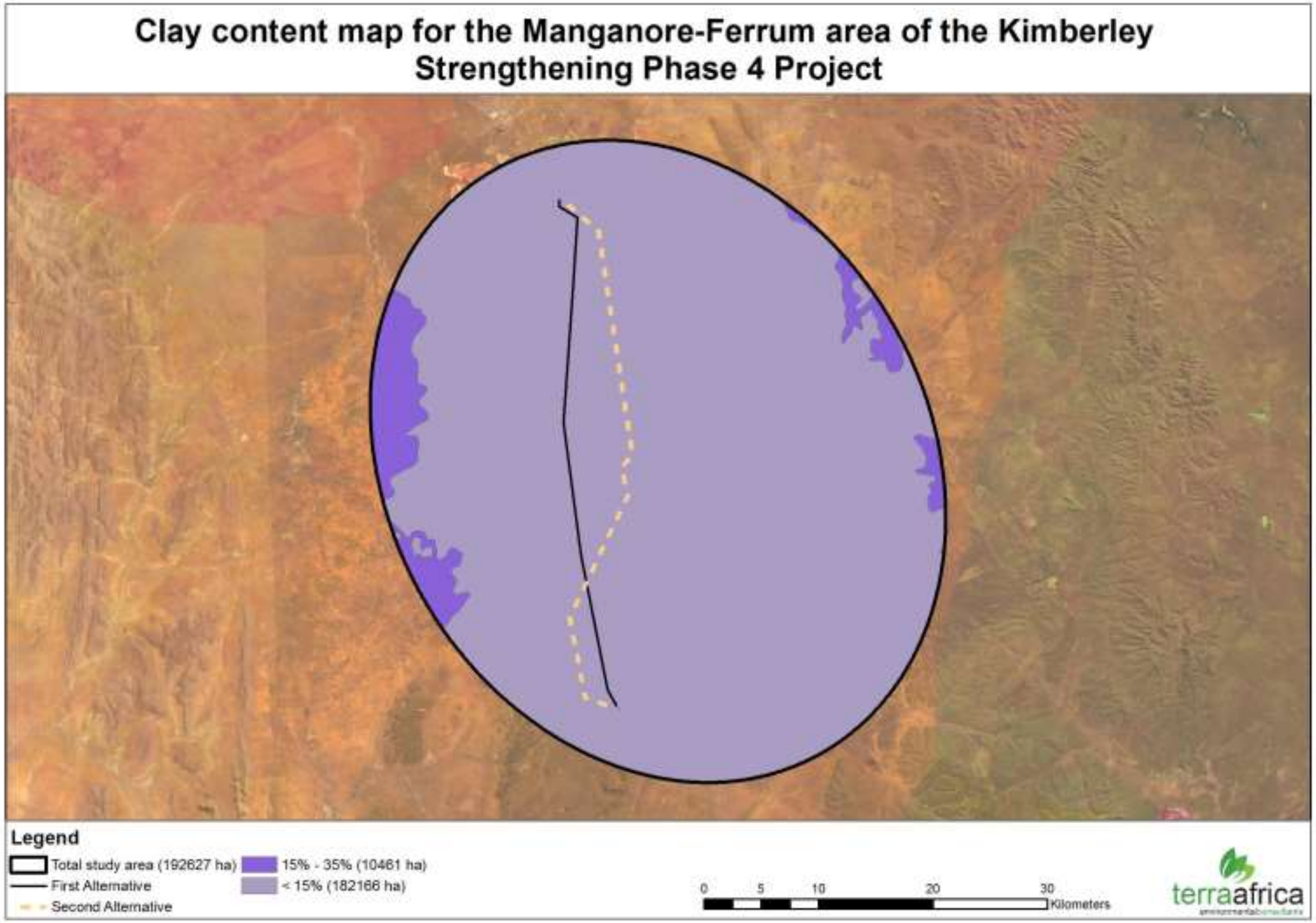

Figure 21: Clay content map for the Manganore-Ferrum area of the Kimberley Strengthening Phase 4 Project

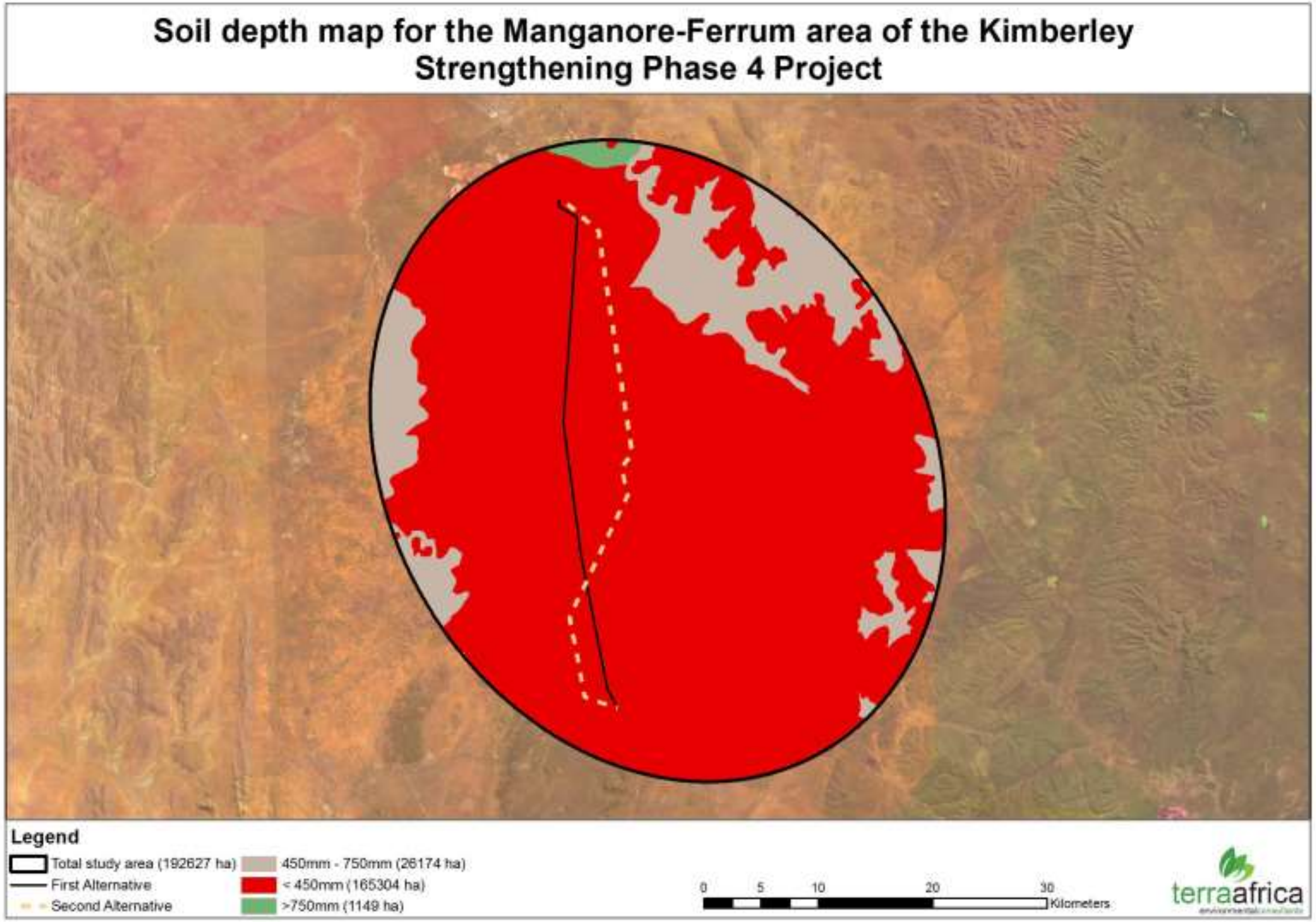

Figure 22: Soil depth map for the Manganore-Ferrum area of the Kimberley Strengthening Phase 4 Project

9. AGRICULTURAL POTENTIAL

The dominant land-use in the larger study area prior is cattle and small livestock farming. This included the commercial farming of cattle, goats and sheep. The average carrying capacity of the veldt is 14 ha per unit of large stock. Game farming is also present in the study area. This region is not suited to the production of dryland arable agricultural owing to the low rainfall. Irrigated crop production is practiced in very small areas that are limited by the availability of irrigation water and proximity to the water resource.

According to the ENPAT data, the western portion of the study area is dominated by land with no or very low arable agricultural potential due to the shallow nature of the topsoil present. The eastern portion is considered to have intermediate suitability as a result of the deeper soil profiles however the climate only permits successful production in the presence of irrigation systems as a result of the erratic rainfall and high evaporation rate that results in soilwater losses.

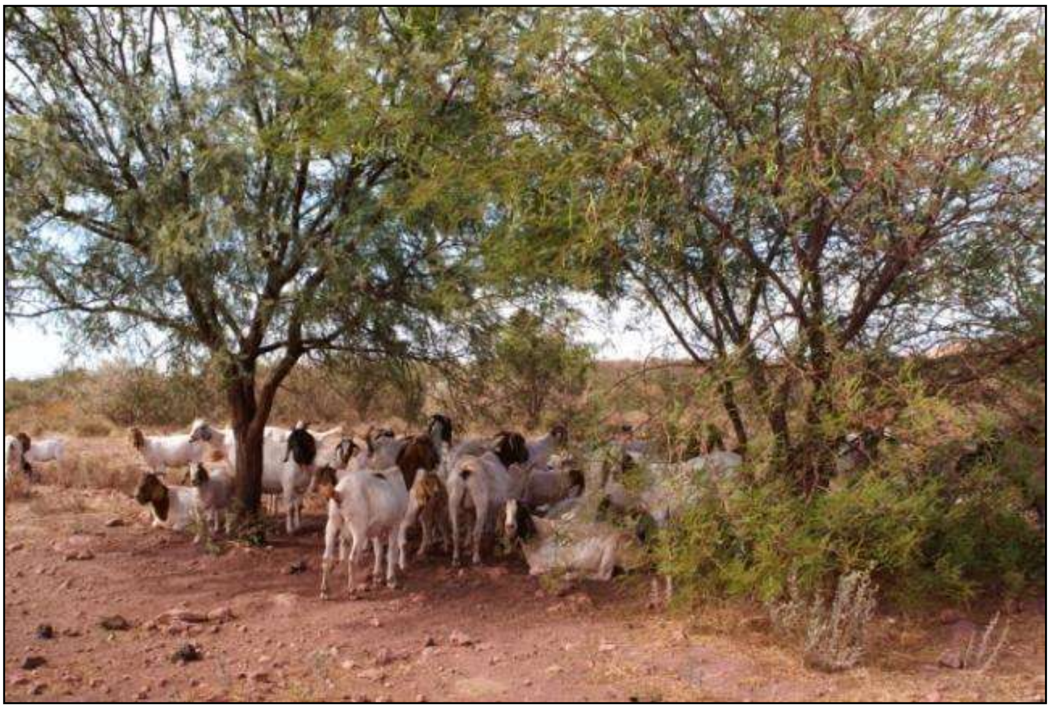

Figure 23: Goat farming identified in the study area

Suitability for arable agriculture	Map colour	First Alternative (km)	Second alternative (km)	Third alternative (km)
Not suitable		-	-	4,2
Poor suitability (where climate permits)		47,22	35,54	42,31
Intermediated suitability (where climate permits)		46,61	54,86	42,61

10. CONCLUSION

Based on the baseline soil and agricultural potential data gather for this study, it is the opinion of the soil scientist, from a soil conservation and land capability point of view, that the first alternative for the proposed development be considered favourably. Although the first alternative has a longer footprint than all other alternatives considered, it will avoid cutting through areas with endorheic pans that may have ecological value. However, it is not anticpated that the first alternative will have any detrimental impact on the crop production ability of the region or result in soil degradation. It is still important that due care is taken to minimise impacts on soils and land capability through good soil management principles.

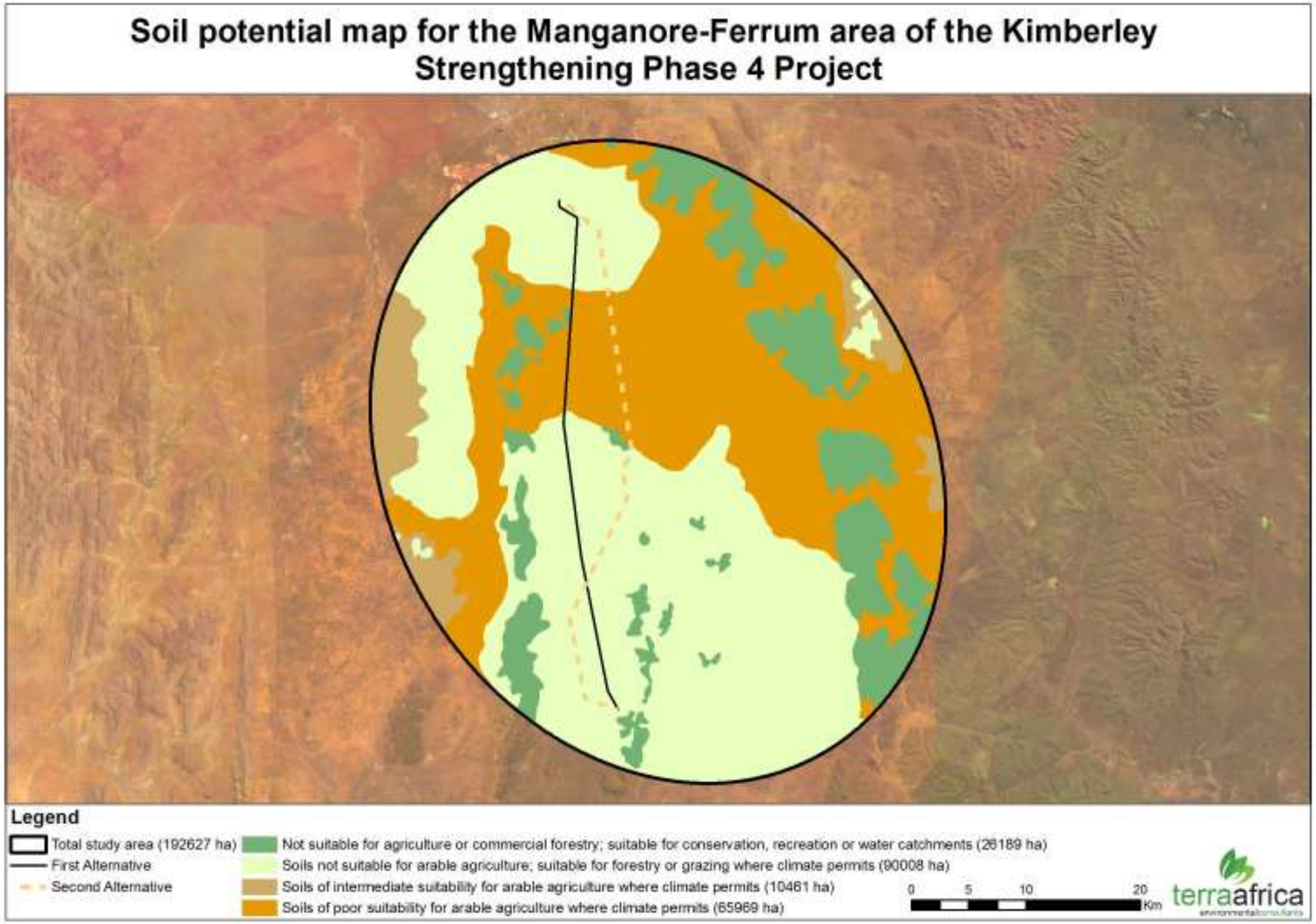

Figure 24: Soil potential map for the Manganore - Ferrum area of the Kimberley Strengthening Phase 4 Project