Soil, Land Use, Land Capability and Agricultural Potential Assessment for the Proposed Masetjaba Reservoir, Elevated Tower and associated infrastructure, Gauteng Province

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DEFINITIONS AND ACRONYMS

Base status: A qualitative expression of base saturation. See base saturation percentage. Base saturation refers to the proportion of the cation exchange sites in the soil that are occupied by the various cations (hydrogen, calcium, magnesium, potassium). The surfaces of soil minerals and organic matter have negative charges that attract and hold the positively charged cations. Cations with one positive charge (hydrogen, potassium, sodium) will occupy one negatively charged site. Cations with two positive charges (calcium, magnesium) will occupy two sites.

Calcareous: Containing calcium carbonate or magnesium carbonate.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0,25-0,1mm in diameter. (2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction.

Gleying: The process whereby the iron in soils and sediments is bacterially reduced under anaerobic conditions and concentrated in a restricted horizon within the soil profile. Gleying usually occurs where there is a high water table or where an iron pan forms low down in the soil profile and prevents run-off, with the result that the upper horizons remain wet. Gleyed soils are typically green, blue, or grey in colour.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, map able at 1:250000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Orthic A horizon: A surface horizon that does not qualify as organic, humic, vertic or melanic topsoil although it may have been darkened by organic matter.

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Saline, soil: Soils that have an electrical conductivity of the saturation soil extract of more than 400 mS/m at 25°C.

Slickensides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickensides. They occur in clayey materials with a high smectite content.

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand sub-separates.

Vertic, diagnostic A-horizon: A-horizons that have both, high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

Declaration of EAP

Details of practitioner

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Declaration of Independence

I, Mariné Pienaar, hereby declare that TerraAfrica Consult, an independent consulting firm, has no interest or personal gains in this project whatsoever, except receiving fair payment for rendering an independent professional service.

I further declare that I was responsible for collecting data and compiling this report. All assumptions, assessments and recommendations are made in good faith and are considered to be correct to the best of my knowledge and the information available at this stage.

TerraAfrica Consult cc represented by M Pienaar
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1. Introduction

Savannah Environmental (Pty) Ltd appointed Terra Africa Consult to conduct the soil, land use, land capability and agricultural potential study as part of the Basic Assessment process for the proposed Masetjaba Reservoir, Elevated Tower and associated infrastructure, Gauteng Province. The proposed project will be located on Portion 107 of the Farm Spaarwater 171 (from here onwards referred to as the project site) within the management area of the City of Ekurhuleni. The project site is located north-west of Nigel and south of Tsakane (Figure **1**). The project site can be accessed via the R550 (also known as Springs Road) that also forms the northern boundary of the project site.

The purpose of the study is to determine and describe the baseline soil properties and the land capabilities and land uses associated with it within the proposed project's direct and indirect areas of influence from on-site investigations and data currently available. This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 326 of 2014 as amended).

2. Objective of the study

The objective of the Soil, Land Use and Land Capability study is to fulfill the requirements of the most recent South African Environmental Legislation with reference to the assessment and management of these natural resource aspects (stipulated in Section 3 below). The key components of assessment are to determine and describe the baseline soil properties and the land capabilities and land uses associated with it within the proposed project's direct and indirect areas of influence from on-site investigations and data currently available. It also assists with the identification of gaps in information. Once these conditions have been established, the anticipated impacts of the project on these properties can be determined. Mitigation and management measures can be recommended to minimise negative impacts and maximise land rehabilitation success towards successful closure at the end of the project life.

3. Environmental legislation applicable to study

The following South African Environmental Legislation needs to be considered for any new or expanding developments with reference to the management of soil and land use:

- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal. This act requires the protection of land against soil erosion and the prevention of water logging and salinisation of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and watercourses are also addressed.

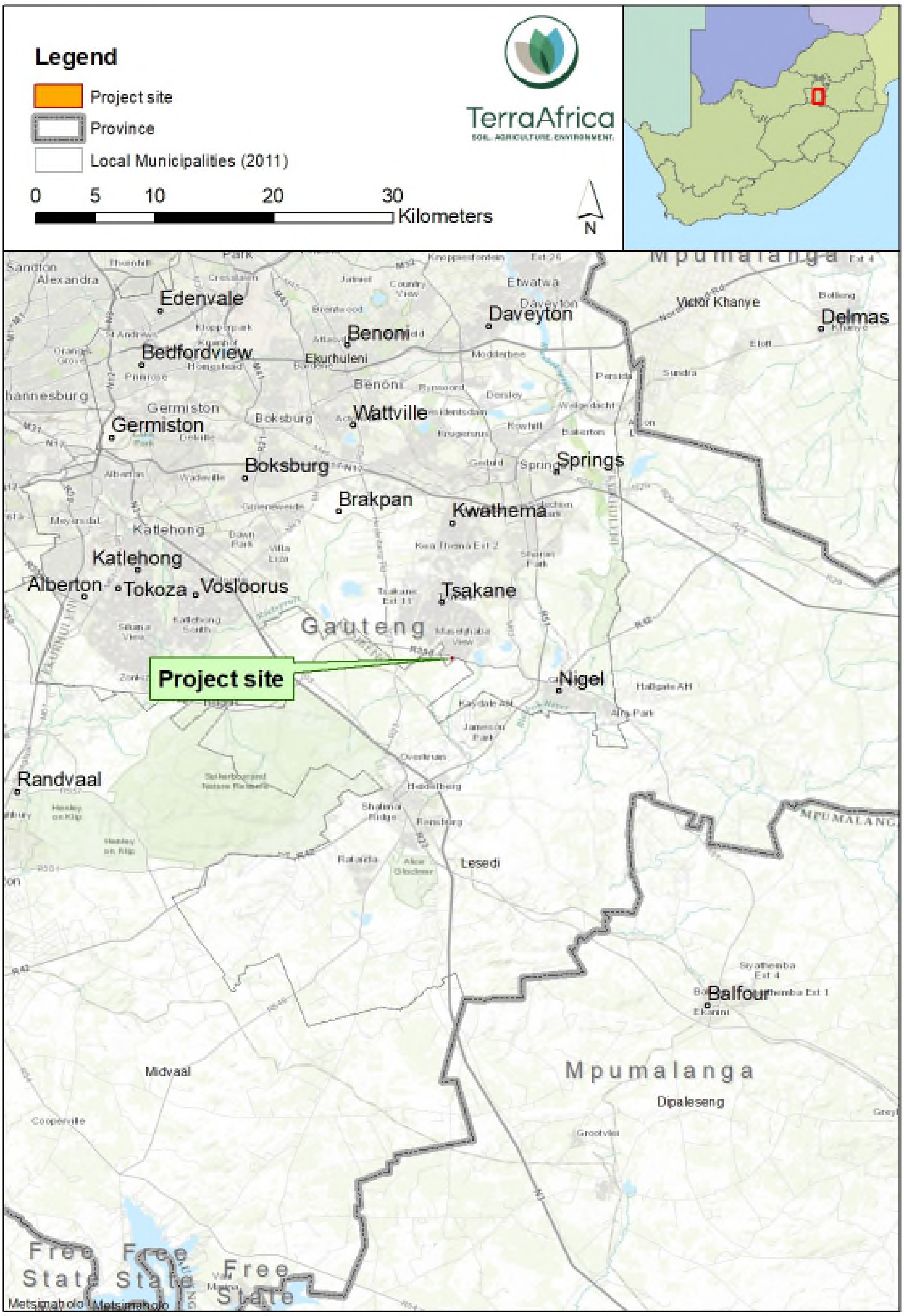

Figure 1: Locality map of the proposed project site for the Masetjaba Reservoir, Elevated Tower and associated infrastructure

- In addition to this, the National Water Act (Act 36 of 1998) deals with the protection of wetlands. This Act defines wetlands as “land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.” This Act therefore makes it necessary to also assess soil for its hydropedological properties.
- Section 3 of the National Environmental Management Act, the EIA Regulations, 2014 (as amended) and the Subdivision of Agricultural Land Act is also relevant to the development.

4. Terms of reference

The following Terms of Reference as stipulated by Savannah Environmental (Pty) Ltd applies to the soil, land use and land capability study:

- Undertake a soil survey of the proposed subject property area focusing on all landscape features including areas with potentially wetland land capability;
- Describe soils in terms of soil texture, depth, structure, moisture content, organic matter content, slope and land capability of the area;
- Classify and describe soils using the South African Soil Classification: A Natural and Anthropogenic System for South Africa;
- Identify and assess potential soil, land use and land capability impacts resulting from the proposed Masetjaba Reservoir and Elevated Tower Project;
- Identify and describe potential cumulative soil, land use and land capability impacts resulting from the proposed development in relation to proposed and existing developments in the surrounding area;
- Recommend mitigation, management and monitoring measures to minimise impacts and/or optimise benefits associated with the proposed project.

5. Assumptions

No assumptions were made in the assessment and report.

6. Uncertainties, limitations and gaps

The following uncertainties, limitations and gaps exists with regards to the study methodology followed and conclusions derived from it:

- Soil profiles were observed using a 1.5m hand-held soil auger. A description of the soil characteristics deeper than 1.5m cannot be given.
- The study does not include a land contamination assessment to determine pre-construction soil pollution levels (should there be any present).

7. Response to concerns raised by I&APs

Thus far, no concerns were raised by I & APs during the Public Participation Process pertaining to the continuation of existing land uses in the surrounding area. Should any comments be received during the public review period, it will be adequately addressed in this report.

8. Methodology

8.1 Desktop study

The following data was obtained and studied for the desktop study:

- The Field Boundaries Metadata Layer for Gauteng Province as released by the Department of Agriculture, Forestry and Fisheries (DAFF) in 2017 was evaluated to determine the extent of crop fields in the larger area around the study site. This data layer includes categories for rainfed annual crops, non-pivot irrigated annual crops, horticulture, old fields, pivot irrigation, smallholdings, shade-netting and subsistence farming. DAFF still recommends that the data be verified by field observations for accuracy.
- The most recent aerial photography of the area available from Google Earth was obtained. The aerial photography analysis was used to determine areas of existing impact, land uses within the project area as well as the larger landscape, wetland areas and preferential flow paths.

8.2 Study area survey

A one-day systematic soil survey was undertaken on 19 November 2018. The season in which the site visit took place has no influence on the results of the survey. The soil profiles were examined to a maximum depth of 1.5m using a hand-held auger. Detailed soil surveys are usually conducted on a 1 ha survey grid but as a result of the small size of the site (1,6 ha), soil profiles were classified at much higher density and ten survey points were observed (Figure 2). Observations were made regarding soil texture, structure, colour and soil depth at each survey point. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. The soils are described using the South African Soil Classification: A Natural and Anthropogenic System for South Africa. For soil mapping, the soils were grouped into classes with relatively similar soil characteristics.

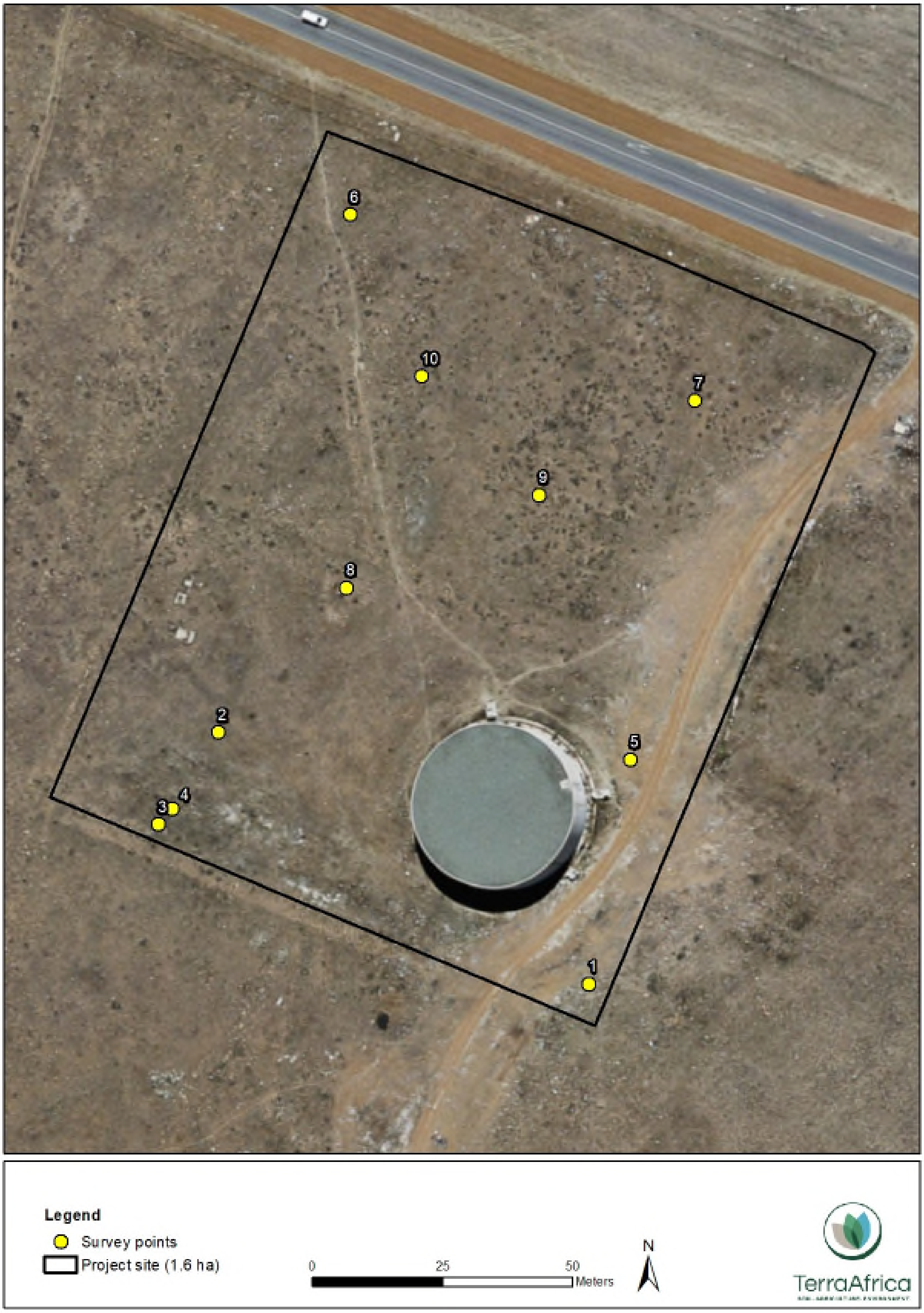

Figure 2 Survey points map of the project site of the Masetjaba Reservoir, Elevated Tower and associated infrastructure

8.3 Analysis of samples at soil laboratory

Two topsoil and one subsoil sample were collected at the project site. One topsoil sample (Mas01) is representative of the Mispah soil form that has such shallow soil profiles that only topsoil can be collected between 0 and 20 cm from the surface. The other two samples are representative of the Glencoe soil form. The samples were sealed in soil sampling plastic bags and sent to Eco Analytica Laboratory that is part of North West University for analyses. Samples taken to determine baseline soil fertility were analysed for pH (KCl), plant-available phosphorus (Bray1) and exchangeable cations (calcium, magnesium, potassium, sodium).

8.4 Land capability classification

Agricultural potential is described through the term land capability. Land capability means “the most intensive long term use of land for purposes of rainfed farming, determined by the interaction of climate, soil and terrain and makes provision for eight land capability classes”. The newly developed land capability classification system that was released by the Department of Agriculture, Forestry and Fisheries (DAFF) was used to combine different soil forms into land capability units. The new system has a few strong departures from the old system developed by Schoeman et al. (2002). The new system has fifteen land capability classes as opposed to the initial eight classes. In the new system, Classes 1 to 7 are considered to be of very low land capability making it only suitable for wilderness and grazing with a variety of management measures. The remaining classes (Class 8 to 15) is considered to have arable land capability with the potential for high yields increasing with the number of the land capability class. It should be noted that this land capability classification system does not indicate wetland land capability (soils with hydromorphic properties) as a class. The possible wetland potential of soils are discussed in Section 9.3.

8.5 Impact assessment methodology

Following the methodology prescribed by Savannah Environmental (Pty) Ltd., the direct, indirect and cumulative impacts associated with the project have been assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
    - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
    - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
    - medium-term (5–15 years) – assigned a score of 3;
    - long term (> 15 years) - assigned a score of 4; or

- o permanent - assigned a score of 5;

- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

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

S=(E+D+M)P

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

The **significance weightings** for each potential impact are as follows:

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

9. Baseline conditions

9.1 Soil forms present within the project site

Four different soil forms were identified within the project site. The soil depths of the ten profiles surveyed range between very shallow to shallow (the deepest Glencoe profile are 50cm deep).

A portion (0,2 ha) of the project site have been anthropogenically affected by previous construction activities (most probably for the construction of the existing Masetjaba reservoir). In this area, the in situ profiles have been disturbed to the extent that the original horizon organisation is not visible anymore and building rubble is present on the surface. Even though the new South African Soil Classification System (released February 2018) provides guidelines for more detailed classification of different anthropogenic soil forms, the historical processes and the nature of the materials present are not known and the soil in this area are therefore classified as “Anthropogenic” following the predominant characteristic of human disturbance.

Of the three in situ soil forms within the project site, the area is dominated by the rocky, shallow Mispah form (1,1 ha). This soil form has a bleached orthic A horizon of between 5 and 20 cm overlying solid rocky, parent material in combination with smaller loose stones.

The two remaining soil forms are the Dresden form (0,1 ha) and the Glencoe form (0,2 ha). For both these soil forms, the soil depth is limited by a hard plinthic B-horizon. While the Glencoe form consists of an orthic A horizon that overlies a yellow-brown apedal horizon (30cm in thickness) above the hard plinthite, the Dresden form consists of only an orthic A-horizon overlying the hard plinthite.

While both the Dresden and Glencoe forms are considered soil forms that indicate that indicate zones of temporary wetness and therefore wetland potential, these soil forms showed very limited mottling (less than 5% of total horizon volume) above the hard plinthic horizon. It may therefore historically have been part of a wetter area but not in recent years as the area may have dried out as a result of changing rainfall patterns and large settlement developments in the area.

9.2 Soil chemical conditions

The purpose of establishing baseline chemical composition of soil on a site before development commences, is to determine whether there is any deterioration in soil fertility and what the nutrient status of the soil is associated with the natural vegetation. Should the chemical content of the soil be drastically different once rehabilitation commences, the chemical composition might have to be amended by the addition of fertilizers or organic matter. The analyses results obtained from the laboratory is attached as Appendix 2.

9.2.1 pH

The pH of the soil is measured potentiometrically in a supernatant suspension of a 1:2.5 soil to liquid mixture. For this assessment potassium chloride (KCl) was used. The pH levels will be described using the scale of general descriptive terminology as was defined by the United States Department of Agriculture Natural Resources Conservation Service (NRCS).

Figure 3: Soil map of the project site

Table 1 - Descriptive terminology for pH ranges (NRCS, USDA)

Description/Denomination	pH range
Ultra-acidic	<3,5
Extremely acidic	3,5 – 4,4
Very strongly acidic	4,5 – 5,0
Strongly acidic	5,1 – 5,5
Moderately acidic	5,6 – 6,0
Slightly acidic	6,1 – 6,5
Neutral	6,6 – 7,3
Slightly alkaline	7,4 – 7,8
Moderately alkaline	7,9 – 8,4
Strongly alkaline	8,5 – 9,0
Very strongly alkaline	>9,0

The pH values of the three samples ranges between 3,82 and 3,94 and are therefore extremely acidic. pH values below 5 result in high solubility of aluminium that results in aluminium toxicity symptoms such as stunted root growth and minimum lateral root development (Mengel and Kirkby, 2001). Should the site ever be considered for agricultural production, it will require amelioration with agricultural lime to increase the pH levels.

9.2.2 Plant-available phosphorus

Plant-available phosphorus are extracted with a Bray 1 solution for soils with a neutral to low pH. The plant-available phosphorus levels are 7,9 mg/kg, 9,8 mg/kg and 10,2 mg/kg respectively. Although these levels are low, it is rather common for undisturbed soil profiles in South Africa and higher levels are usually found in crop fields where phosphorus is supplemented with fertilizer or in forested areas where much of the higher soil organic matter content is linked with higher P levels. At the low pH levels present (discussed in Section 9.2.1), phosphate fixation will occur that will result in lower availability of phosphorus to plant roots.

9.2.3 Major cationic plant nutrients

The exchangeable complexed fraction of the major cationic plant nutrients (magnesium, calcium, potassium and sodium) were determined by percolation of the samples with ammonium acetate and measurement of bases in the percolate. The levels of all four cations were rather low. Low sodium levels are preferred and indicates that future sodification of the soil is highly unlikely (unless it is anthropogenically affected by the addition of high levels of sodium to the environment). The calcium, magnesium and potassium levels will have to be supplemented should crop production ever be considered in this area. The levels of each of the cations are indicated in the analysis results in Appendix 1.

9.3 Land capability

Land capability can be defined as “the extent to which land can meet the needs of one or more uses under defined conditions of management” (Schoeman, 2002). The land capability of an area is the combination of the inherent soil properties and the climatic conditions as well as other landscape properties such as slope and drainage patterns that may inhibit agricultural land use or result in the development of specific land functionality such as wetlands. Land capability affects the socio-economic aspects of human settlements and determine the livelihood possibilities of an area. Baseline land capabilities are also used as a benchmark for rehabilitation of land in the case of project decommissioning.

Following the newly launched land capability classification systems as released by DAFF (2017) that consists of fifteen land capability classes, the area has low-moderate (Class 6) land capability (Figure **4**). This is as a result of the shallow soil depth and rocky nature of the underlying material that restricts soil depth. From a land capability perspective, the area is suitable for grazing at low density. No areas with wetland capability have been identified within the project site.

9.4 Agricultural potential

As a results of the rocky nature of the largest portion of the site and the shallow soil depth of the project site, the site is considered to be unsuitable for rain-fed crop production. While irrigated crop production may be possible in the slightly deeper soil of the Glencoe form (0,2 ha), it is also not considered a viable option as there is currently no irrigation infrastructure on site. In addition, the underlying hard plinthic horizon will restrict water infiltration and that will result in waterlogged soil conditions that are problematic for crop roots.

From a land capability perspective, the possible viable option for the project site, is livestock farming. The grazing capacity of a specified area for domestic herbivores is given either in large animal unit per hectare or in hectares per large animal unit. One large animal unit is regarded as a steer of 450kg whose weight increases by 500g per day on veld with a mean energy digestibility of 55%. The grazing capacity of the veld in the project site is 6 to 8 hectares per large animal unit or large stock unit (LSU) (Morgenthal et al., 2005). Since the project site is only 1,6 ha in extent, it will not even be suitable to sustain the grazing of one head of cattle.

9.5 Land use and surrounding land use

The project site is fenced off as the existing Masetjaba View Reservoir is located here. Apart from this existing reservoir, the site is currently not used for anything else. The larger area around the project site consist of residential areas to the north that include the associated services such as roads and sewer pipelines. Crop fields are located south-east and south-west of the project site (Figure **5**). These crop fields consist of pivot irrigation areas as rainfed crops and planted pastures.

Figure 4: Land capability map of the project site

Figure 5: Land use and surrounding land use (agricultural field boundaries data sourced from DAFF, 2017)

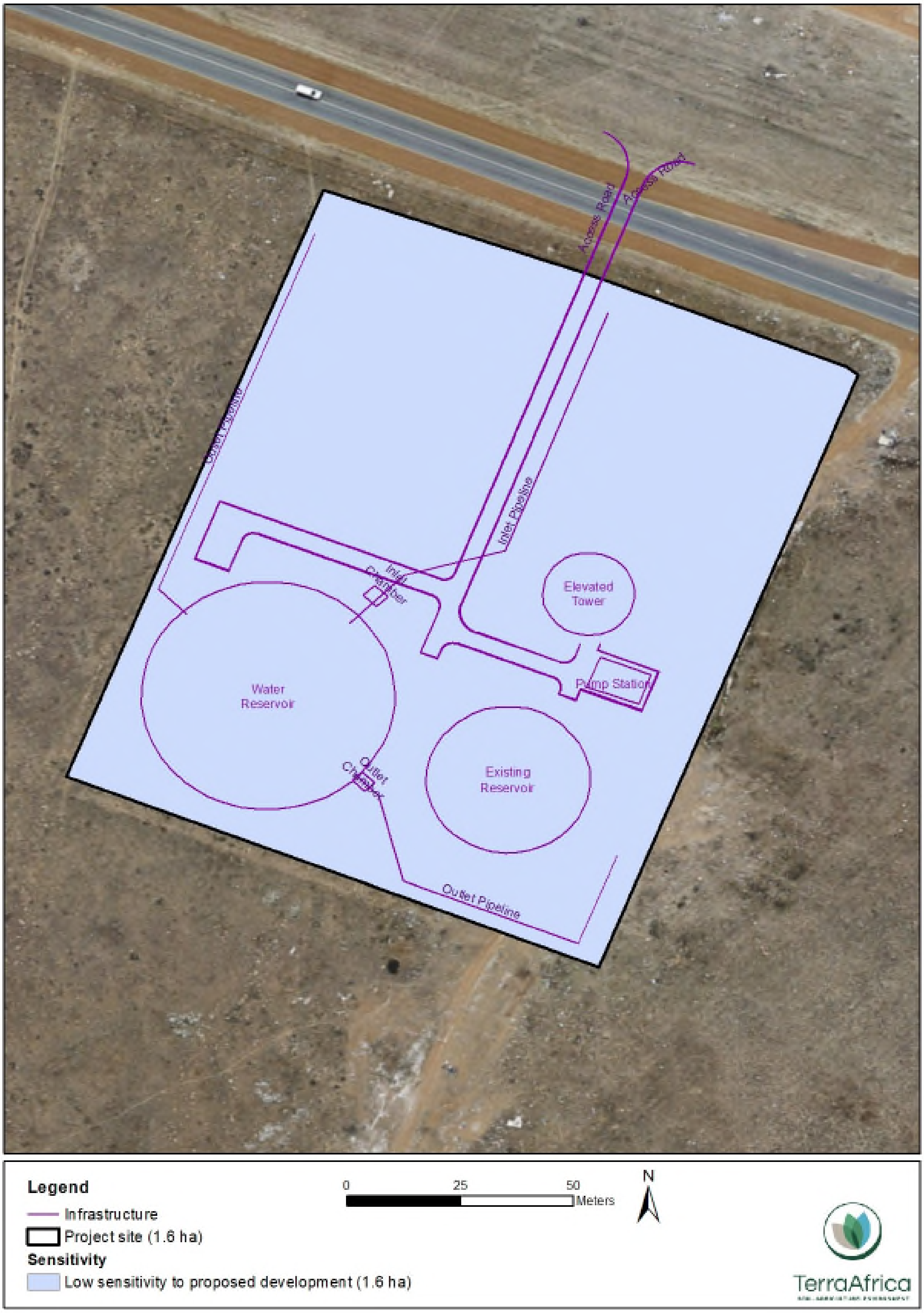

Figure 6: Sensitivity analysis of the proposed project site

9.5 Sensitivity analysis of the project site

Following the analysis of the baseline properties of the project site, it can be classified as having low sensitivity to the proposed project from the perspective of soil, land capability and agricultural potential (Figure **6**). The area is already fenced off and not used for any form of food production. The soil of the project site is shallow and underlying material is rocky with rock outcrops visible on the surface where the Mispah soil form is present. There are no prominent hydromorphic soil units that expresses pronounced hydromorphic properties.

10. Impact Assessment

10.1 Project description

The project consists of the establishment of a 15ML concrete reservoir, 2ML elevated tower, pump station and associated infrastructure at the existing Masetjaba View reservoir. The facility is proposed to include the following infrastructure:

- 15ML Water Reservoir approximately 8m in height
- 2ML concrete water tower approximately 32m in height
- Pump Station
- Standby Generator
- Interconnecting pipework and chambers
- Stormwater provisions
- Access road approximately 170m in length

10.2 Description of the impacts anticipated for the project phases

All infrastructure and activities required for the operational phase will be established during the construction phase. Once construction has ceased, a number of impacts remain during the operational phase (as described below). The main envisaged activities include the following:

- site establishment which will require the clearance of vegetation and site levelling;

- construction of permanent access routes which entails the stripping of topsoil, dynamic compaction and the importation of gravel;

- construction of the reservoir, elevated tower and pump station;

- construction of access road and interconnecting pipework and chambers;

- construction of campsite and laydown area including:

- workshops and maintenance area;
- stores (for handling and storage of fuel, lubricants, solvents, paints and construction material);
- contractor laydown areas;
- mobile site offices;
- temporary waste collection and storage area; and
- parking area for cars and equipment.

The site preparation activities are disruptive to natural soil horizon distribution and will impact on the current soil hydrological properties and functionality of soil.

The following anticipated impacts have been assessed.

* The sandy nature of the soil forms on site are prone to erosion. Soil erosion is anticipated due to slope correction and vegetation clearance. The impacts of soil erosion are both direct and indirect. The direct impacts are the reduction in soil quality which results from the loss of nutrient-rich upper layers of the soil and the reduced water-holding capacity of severely eroded soils. The off-site indirect impacts of soil erosion include the sedimentation of surrounding areas.

* Soil chemical pollution as a result of storage of hazardous chemicals, concrete mixing, temporary sanitary facilities and potential oil and fuel spillages from vehicles. This impact will be localised within the site boundary.

* Soil compaction will occur as a result of construction activities that will require soil compaction and as a result of vehicles traversing on site. This impact will be localised within the site boundary.

* In areas of permanent changes such as roads and the erection of infrastructure, rock spoil material discard site and topsoil stockpiles, the current land capability will be lost permanently. This impact will also be localised within the site boundary.

During the operation phase the impacts related to loss of land capability will stay the same. Areas under infrastructure such as the reservoir, and pump station as well as other covered surfaces are no longer susceptible to erosion, but hard surfaces around these will increase run-off during rain storms onto bare soil surfaces.

Soil chemical pollution during the operation phase will be minimal. Possible sources are oil that need to be replaced and oil and fuel spillage from maintenance vehicles. This impact will be localised within the site boundary.

Soil compaction will remain during this phase as a result of the structures erected during the construction phase. Vehicle traffic for maintenance visits may slightly increase the compaction around the infrastructure.

Although wind erosion may have an impact before revegetation on adjacent areas, the loss of soil as a resource is restricted to the actual footprint of the project site. The only impact that may have effects beyond the footprint area is erosion which may cause the sedimentation of the adjacent areas.

10.3 Susceptibility to soil erosion due to construction and operation of the Masetjaba Reservoir and Elevated Tower

Table 2 Summary of soil erosion impact assessment

Nature: The construction of the reservoir, elevated tower, pump station, access road and pipeline network will require the clearing and levelling of a limited area of land. The following construction activities will result in bare soil surfaces that will be at risk of erosion:

1. vegetation removal during site clearing;
2. creating impenetrable surfaces during the construction phase that will increase run-off onto bare soil surfaces; and
3. leaving soil surfaces uncovered during the rainy season during the construction phase.

During the operation phase the impenetrable surfaces such as the reservoir, elevated tower and pump station stay intact, however, the impact of increased run-off persists on surrounding areas.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	

Mitigation:

- Land clearance must only be undertaken immediately prior to construction activities;
- Unnecessary land clearance must be avoided;
- Soil stockpiles must be dampened with dust suppressant or equivalent;
- Geo-textiles must be used to stabilise soil stockpiles and uncovered soil surfaces during the construction phase and to serve as a sediment trap to contain as much soil as possible that might erode away;
- Storm water must be managed according to the Storm Water Management Plan for the site to prevent erosion. This includes provisions for storm water run-off from the roof and overflow from the reservoir weir and the scour wedge gate valve draining the reservoir.; and
- Revegetate cleared areas as soon as possible after construction activities.

Residual Impacts:

The residual impact from the construction and operation of the Masetjaba Reservoir and associated infrastructure on the susceptibility to erosion will be negligible.

10.4 Soil compaction caused by the construction and operation of the Masetjaba Reservoir and Elevated Tower

Table 3 Summary of soil compaction impact assessment

Nature: The construction of the reservoir, elevated tower, pump station, access road and pipeline network will require compaction of the soil surface and vehicles traversing over the surface that will also cause compaction. During the operation phase the compaction underneath the reservoir, elevated tower and pump station stay intact but traffic from maintenance vehicles may slightly increase compaction during the operational phase.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	

Mitigation:

- Areas of deliberate soil compaction for construction purposes must be kept as as small as possible;
- Restrict movement and parking of vehicles and construction plant to a designated area;
- Restrict vehicle movement associated with maintenance during the operational phase to the access road.

Residual Impacts:

The residual soil compaction impact from the construction and operation of the Masetjaba Reservoir and associated infrastructure will be negligible.

10.5 Chemical pollution due to construction and maintenance of the Masetjaba Reservoir, Elevated Tower and associated infrastructure

Table 4 Summary of soil chemical pollution impact assessment

Nature: The following construction activities can result in the chemical pollution of the soil:

1. Hydro-carbon spills by machinery and vehicles during earthworks and the mechanical removal of vegetation during site clearing.
2. Spills from vehicles transporting workers, equipment and construction material to and from the construction site.
3. The accidental spills from temporary chemical toilets used by construction workers.
4. The generation of domestic waste by construction and operational workers.
5. Accidental spills of other hazardous chemicals used and stored on site.
6. Pollution from concrete mixing.

The operation of the Masetjaba Reservoir and Elevated Tower can result in the chemical pollution of the soil:

1. Spills from maintenance vehicles.
2. The generation of domestic waste by personnel that visit the project site for maintenance work.

	Without mitigation	**With mitigation**
Extent	Local to Regional (3)	Local (1)
Duration	Medium-term (3)	Short-term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (36)**	**Low (14)**

Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- High level maintenance must be undertaken on all vehicles and construction machinery to prevent hydrocarbon spills;
- The washing of vehicles or construction machinery on site must be prohibited in order to avoid any possible soil chemical pollution;
- Should water be used on site for concrete mixing, any run-off water from this process or any spill of ready-mixed concrete should be contained and stored and removed from site to a municipal waste treatment facility;
- Spills of fuel and lubricants from vehicles and equipment must be contained using a drip tray with plastic sheeting filled with adsorbent material;
- Waste disposal at the construction site must be avoided by separating, trucking out and recycling of waste;
- Potentially contaminating fluids and other wastes must be contained in containers stored on hard surface levels in bunded locations; and
- Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately by trained staff with the correct equipment and protocols as outlined in the EMPr.

Residual Impacts:

The residual impact from the construction and operation of the proposed project will be low to negligible

10.5 Loss of land capability as a result of the project development

Table 5 Summary of land capability impact assessment

Nature: The land capability of the project site where soil layers are changed and construction of infrastructure is done, will be lost. The impact remains present through the operational phase. The following activities can result in the loss of land capability within the project site:

1. The removal of vegetation during site clearing;
2. Earthworks which destroy the natural layers of the soil profiles; and
3. The construction of access roads and photovoltaic power plant (frame structures and installation of modules onto frames) and infrastructure which will cover soil surfaces.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Minor (2)	Minor (2)
Probability	Definite (4)	Definite (4)
Significance	**Low (28)**	**Low (28)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- Keep the project footprint as small as possible.

Residual Impacts:

The residual impact from the construction and operation of the Masetjaba Reservoir and Elevated Tower will be negligible.

11. Assessment of cumulative impacts

11.1 Assessment rationale

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[1].

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

- Unacceptable risk
- Unacceptable loss
- Complete or whole-scale changes to the environment or sense of place
- Unacceptable increase in impact

11.2 Other projects in the area

The larger area to the north, north-west and north-east of the project site already consist of large residential and human settlements. In addition to this, the town of Nigel has several businesses, industries and mining areas within its municipal boundaries. In close proximity there are other infrastructure already present such as Masetjaba View, roads, powerlines and the existing Masetjaba View Reservoir (located within the project site).

The proposed Masetjaba Reservoir and Elevated tower will be within the confines of the fenced-off area of the existing Masetjaba View Reservoir. It is not considered to add any significant cumulative impacts to the area.

The cumulative impact will be a reduction in the area with grazing land capability (although it is currently not used for grazing purposes). In addition to this, cumulative impacts will be an increased risk for soil erosion when vegetation is removed and possible pollution of soil resources.

Table 6 Assessment of cumulative impact of decrease in areas with grazing land capability

Nature:

[1] Unless otherwise stated, all definitions are from the 2014 EIA Regulations (GNR 326).

Decrease in areas with grazing land capability. However, since the area is not currently used for grazing purposes and that so small that it doesn't consist of a financially viable unit for livestock form, both the project impact in isolation as well as the cumulative impact is considered to be of low significance.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Local (1)
Duration	Permanent (3)	Permanent (3)
Magnitude	Minor (2)	Minor (2)
Probability	Definite (4)	Definite (4)
Significance	**Low (24)**	**Low (24)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: The only mitigation measures for this impact is to keep the footprints as small as possible.		

Table 7 Assessment of cumulative impact of increased areas with compacted soil

Nature: Increase in areas with compacted soil as soil compaction is required underneath the permanent structures (as per engineering specifications) and traffic by construction vehicles will compact the soil surface around the infrastructure. This adds to other project sites in the region where soil compaction occurs as a result of similar activities (for example, road construction).		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Medium (33)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: The only mitigation measures for this impact is to keep the footprints as small as possible and to avoid vehicle traffic on unsurfaced areas.		

Table 8 Assessment of cumulative impact of areas susceptible to soil erosion

Nature:

Increase in areas susceptible to soil erosion as a result of an increase in the number of projects where construction is preceded by vegetation removal that increases the size of exposed surfaces from which soil can erode.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Medium-term (3)	Permanent (5)
Magnitude	Moderate (6)	Moderate (3)
Probability	Probable (3)	Probable (4)
Significance	**Medium (30)**	**Medium (40)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil erosion prevention and management as defined in Section 10.4 above.		

Table 9 Assessment of cumulative impact of increased risk of soil pollution

Nature: Increase in areas susceptible to soil pollution as a result of an increase in areas where construction activities will expose the natural resource (soil) to pollutants. The project area adds a site with potential pollution risk to the region where other construction projects may also result in soil pollution risk.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Medium-term (3)	Permanent (5)
Magnitude	Moderate (6)	Moderate (3)
Probability	Probable (3)	Probable (4)
Significance	**Medium (30)**	**Medium (40)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil pollution prevention and management as defined in Section 10.5 above.		

12. Soil, land use and land capability management plan

The management plan for the management of the impacts described in Section 10.

Table 10 Measures to mitigate, manage and monitor soil for susceptibility to erosion

OBJECTIVE: To construct the facility in a manner that ensures the protection of soils against erosion caused by the removal of vegetation cover and compaction of soil, and to maintain and monitor the terrain of the Masetjaba Reservoir and associated infrastructure.		
Project Component/s	Construction and Operation Phases	
Potential Impact	Susceptibility to erosion.	
Activity / Risk source	• Vegetation removal during site clearing; • Creating impenetrable surfaces; • Leaving soil surfaces uncovered by vegetation.	
Mitigation: Target / Objective	Revegetate, maintain and monitor the project site.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Soil stockpiles must be dampened with dust suppressant or equivalent to prevent erosion by wind. • Land clearance must only be undertaken immediately prior to construction activities. • Unnecessary land clearance must be avoided. • All graded or disturbed areas which will not be covered by permanent infrastructure such as paving, buildings or roads must be stabilised with erosion control mats (geo-textiles) and revegetated. • Ensure vegetation is re-established on disturbed surfaces as soon as construction has been completed in an area.	» Contractor » ECO	Ongoing during construction. Revegetate as soon as possible after construction is completed.
Performance indicator	Prevent, minimise and manage any visible erosion on the project site during construction and operation of Masetjaba Reservoir and associated infrastructure.	
Monitoring	• On-going visual assessment of compliance with erosion prevention by Contractor and ECO. • Monitor visual signs of erosion such as the formation of gullies after rainstorms and the presence of dust emissions during wind storms. • Any signs of soil erosion on site should be documented (including photographic evidence and coordinates of the problem areas) and submitted to the management team of the Masetjaba Reservoir project.	

	• Monitor compliance of construction workers to restrict construction work to the clearly defined limits of the construction site to keep footprint as small as possible. • Where vegetation is not re-establishing itself in areas where surface disturbance occurred, soil samples must be collected, analysed for pH levels, electrical conductivity (EC) and major plant nutrient levels (calcium, magnesium, potassium) and sodium. • When vegetation re-establishment still remains unsatisfactory, the bulk density of the soil should be measured with a penetrometer to determine whether compaction is an issue. • The results must be submitted to a professional soil or agricultural scientist for recommendations on the amendment of the issue to ensure that the vegetation cover is established and erosion prevented.

Table 11 Measures to mitigate, manage and monitor soil for susceptibility to soil pollution

OBJECTIVE: To construct and operate the Masetjaba Reservoir and associated infrastructure in a manner that minimise the pollution of soil by hydrocarbon spills from vehicles and machinery, and resultant waste material and pollution that may result from waste generation and fuel and oil spills whenever maintenance work is required at the project site. To store and use fuel, lubricants and other hazardous chemicals safely, and to prevent spills and contamination of the soil resource.		
Project Component/s	Construction and Operation Phases	
Potential Impact	Soil pollution	
Activity / Risk source	• Hydrocarbon spills by vehicles and machinery during leveling, vegetation clearance and transport of workers, materials and equipment and fuel storage tanks; • Accidental spills of hazardous chemicals; • Generation of domestic waste by construction workers; • Pollution from concrete mixing during construction.	
Mitigation: **Target / Objective**	Prevent and contain hydrocarbon leaks. Undertake proper waste management during construction and maintenance. Store hazardous chemicals safely in a bunded area.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Losses of fuel and lubricants from the oil sumps and steering racks of vehicles and equipment must be contained using a drip tray with plastic sheeting filled with absorbent material when not parked on hard standing. • Waste disposal at the construction site must be avoided by separating and trucking out of waste. • Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately in line	» Contractor » ECO	On-going visual assessment during the construction phase and maintenance to detect polluted areas and the application of clean-up and preventative procedures. .

with procedures by trained people with the appropriate equipment.		
Performance indicator	Check vehicles and machinery daily for oil, fuel and hydraulic fluid leaks; Undertake high standard maintenance on vehicles; Proper waste management; Safe storage of hazardous chemicals.	

Monitoring	• On-going visual assessment to detect polluted areas and the application of clean-up and preventative procedures during the construction phase. • Monitor hydrocarbon spills from vehicles and machinery during construction continuously and record volume and nature of spill, location and clean-up actions. • Monitor maintenance of drains and intercept drains weekly. • Analyse soil samples for pollution in areas of known spills or where a breach of containment is evident when it occurs. • Gaps must be identified and procedures must be amended if necessary by the Masetjaba Project Management Team. • Visual assessment of the project site after any maintenance work conducted to detect whether any soil pollution from waste or fuel and oil spills has occurred as a result of maintenance. Any such events must be addressed immediately as described for the construction phase.

Table 12 Measures to mitigate, manage and monitor loss of land capability

OBJECTIVE: To keep the Masetjaba Reservoir and Elevated Tower footprint as small as possible and minimise the loss of land capability.		
Project Component/s	Construction and Operation Phases	
Potential Impact	Loss of Land Capability	
Activity / Risk source	• The removal of vegetation during site clearing; • Earthworks which destroy the natural layers of the soil profiles; and • The construction of access roads and infrastructure which will cover soil surfaces.	
Mitigation: **Target / Objective**	Keep the project footprint as small as possible	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Keep the project footprint as small as possible	» Contractor » ECO	On-going visual assessment of compliance by EPC Contractor to stay within the design footprint.
Performance indicator	Stay within the boundary of the project site as designed and agreed upon.	
Monitoring	• Monitor compliance of construction workers to restrict construction work to the clearly defined limits of the construction site by ECO. • Reporting by ECO to the Masetjaba Project Management team if any impacts outside the project fence take place. • If any transgressions occur, corrective actions should be taken.	

13. Consideration of alternatives

No alternative layouts were provided for consideration.

14. Reasoned opinion

The proposed Masetjaba Reservoir and Elevated Tower project infrastructure will be located on a small portion of shallow, rocky soils with low-moderate land capability. While the site has grazing land capability it is too small (1,6 ha) to be a viable unit for livestock farming. The project site is already fenced-off and not currently used for any agricultural production. The soil of the project site is not suitable for rain-fed agriculture and even though it may have some suitability for irrigated crop production, there is no irrigation water or infrastructure available. The soil chemistry indicates low pH and low inherent fertility that will require amendment should crop production ever be considered in this soil.

The proposed project with the associated infrastructure will have medium to minor impacts on soil and land capability properties in the areas where the footprint will result in surface disturbance. Cumulative impacts are related to an increase in the loss of land with grazing land capability as well as increased areas of soil compaction, soil pollution risk and soil erosion risk. These impacts can be reduced by keeping the footprints minimised where possible and strictly following soil management measures pertaining to erosion control and management and monitoring of any possible soil pollution sources such as vehicles traversing over the sites. No layout alternatives were provided for consideration.

The proposed Masetjaba Reservoir and Elevated Tower falls within an area where there is an existing Masetjaba View Reservoir, powerlines, roads and housing developments and human settlements. The purpose of the project is to improve water supply to certain parts of the community which do not have adequate water supply during peak usage periods. The proposed reservoir will also supply the reservoir zone located on the southern boundary of Brakpan and will include most future developments in Tsakane and its extensions excluding Tsakane X17.

It is therefore of my opinion that the proposed project is acceptable within the context and that it will have no impact on food production in the area. It is also my opinion that the activity should be authorised. It follows that the recommendations and monitoring requirements as set out in this report should form part of the conditions of the environmental authorisation for the proposed project.

Figure 7 Project layout superimposed on the soil forms of the area

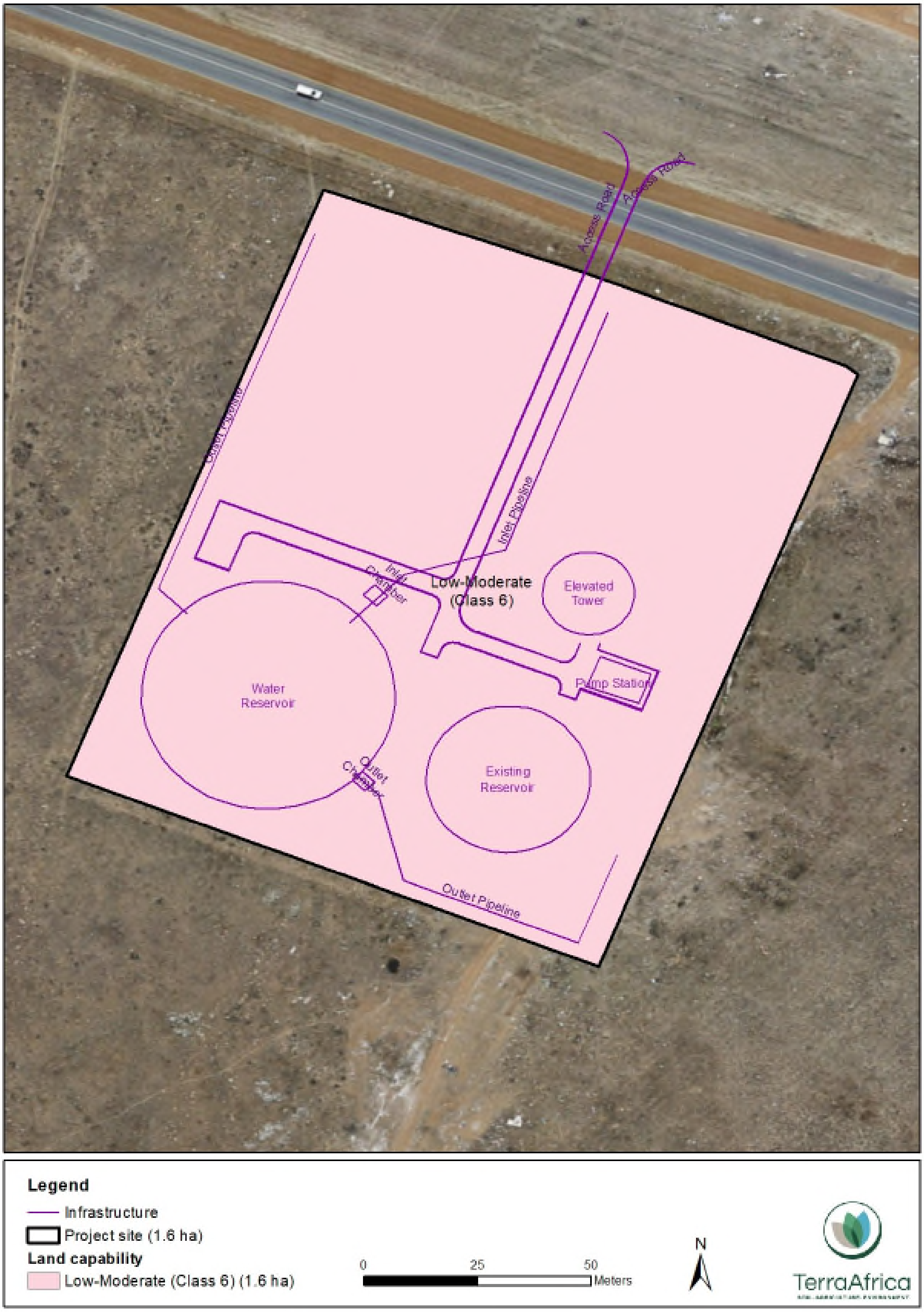

Figure 8 Project layout superimposed on the land capabilities of the area

15. Reference list

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Crop Estimates Consortium (2017). *Field Crop Boundary data layer (Gauteng province), 2017*. Pretoria. Department of Agriculture, Forestry and Fisheries

The Soil Classification Working Group (1991). *Soil Classification – Taxonomic System for South Africa.* Dept. of Agric., Pretoria.

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Appendix 1 – Laboratory analyses sheet

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ECO-ANALYTICA

Eco Analytica
PO Box 19140
NOORDBRUG 2522
Tel: 018-285 2732/3/4

MASETJABA RESERVOIR PROJECT - TERRA-AFRICA

Plant Nutrients

Sample no.	Ca	Mg	K	Na	P	pH(KCl)
	(mg/kg)					
MAS 01	137,2	10,1	58,7	8,5	9,8	3,92
MAS 02	43,8	1,0	56,1	9,1	10,2	3,82
MAS 03	119,0	17,3	20,5	11,2	7,9	3,94

Exchangeable Cations

Sample no.	Ca	Mg	K	Na	S-value
	(cmol(+)/kg)				
MAS 01	0,68	0,08	0,15	0,04	0,96
MAS 02	0,22	0,01	0,14	0,04	0,41
MAS 03	0,59	0,14	0,05	0,05	0,84

"HANDBOOK OF STANDARD SOIL TESTING METHODS FOR ADVISORY PURPOSES

EXCHANGEABLE CATIONS	1 M NH_4-asetaat pH=7	PHOSPHATE:	Bray 1 Extra
CEC:	1 M NH_4-asetaat pH=7	pH H_2O/KCl:	1:2,5 - Extra

Ten einde betroubaarheid van analises te verseker, neem Eco-Analytica deel aan die volgende instansies se kontroleske
International Soil-Analytical Exchange (ISE), Wageningen, Nederland

Geen verantwoordelikheid word egter deur Noordwes Universiteit aanvaar vir enige verliese wat uit die gebruik van hierdie data ma

APPENDIX 2 - CURRICULUM VITAE OF SPECIALIST (Mariné Pienaar)

- **Personal Details**

  Last name: **Pienaar**
  First name: **Mariné**
  Nationality: **South African**
  Employment: **Self-employed (Consultant)**

- **Contact Details**

  Email address: mpienaar@terraafrica.co.za
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  Mailing address: **PO Box 433, Ottosdal, 2610**
  Telephone: **+27828283587**
  Address: **57 Kruger Street, Wolmaransstad, 2630, Republic of South Africa**
  Current Job: **Lead Consultant and Owner of Terra Africa Consult**

- **Concise biography**

Mariné Pienaar is a professionally registered soil- and agricultural scientist (SACNASP) who has consulted extensively for the past eleven years in the fields of soil, land use and agriculture in several African countries. These countries include South Africa, Liberia, Ghana, DRC, Mozambique, Botswana, Angola, Swaziland and Malawi. She has worked with mining houses, environmental consulting companies, Eskom, government departments as well as legal and engineering firms. She conducted more than three hundred specialist studies that included baseline soil assessment and rehabilitation planning for new projects or expansion of existing projects, soil quality monitoring, land rehabilitation assessment and monitoring, natural resource assessment as part of agricultural project planning, evaluation and development of sustainable agriculture practices, land use assessment and livelihood restoration planning as part of resettlement projects and land contamination risk assessments. She holds a BSc. Agriculture degree with specialisation in Plant Production and Soil Science from the University of Pretoria and a MSc in Environmental Science from the University of the Witwatersrand. In addition to this, she has attended a number of courses in Europe, the USA and Israel in addition to those attended in South Africa. Mariné is a contributing author of a report on the balance of natural resources between the mining industry and agriculture in South Africa (published by the Bureau for Food and Agricultural Policy, 2015).

- **Qualifications**

  Academic Qualifications:

  - **MSc Environmental Science**; University of Witwatersrand, South Africa, 2017
  - **BSc (Agric) Plant Production and Soil Science;** University of Pretoria, South Africa, 2004

- **Senior Certificate / Matric;** Wolmaransstad High School, South Africa, 2000

Courses Completed:

- **World Soils and their Assessment;** ISRIC – World Soil Information, Wageningen, 2015
- **Intensive Agriculture in Arid- and Semi-Arid Environments** – Gilat Research Centre, Israel, 2015
- **Hydrus Modelling of Soil-Water-Leachate Movement;** University of KwaZulu-Natal, South Africa, 2010
- **Global Sustainability Summer School 2012;** Institute for Advanced Sustainability Studies, Potsdam, Germany, 2012
- **Wetland Rehabilitation;** University of Pretoria, South Africa, 2008
- **Enviropreneurship Institute;** Property and Environment Research Centre [PERC], Montana, U.S.A., 2011
- **Youth Encounter on Sustainability;** ACTIS Education [official spin-off of ETH Zürich], Switzerland, 2011
- **Environmental Impact Assessment │Environmental Management Systems – ISO 14001:2004 │Environmental Law;** University of Potchefstroom, South Africa, 2008
- **Carbon Footprint Analyst Level 1;** Global Carbon Exchange Assessed, 2011
- **Negotiation of Financial Transactions;** United Nations Institute for Training and Research, 2011
- **Food Security: Can Trade and Investment Improve it?** United Nations Institute for Training and Research, 2011

- **Language ability**

Perfectly fluent in English and Afrikaans (native speaker of both) and conversant in French.

- **Professional Experience**

Name of firm	Terra Africa Environmental Consultants
Designation	Owner | Principal Consultant
Period of work	December 2008 to Date

- **Prior Tenures**

Integrated Development Expertise (Pty) Ltd; **Junior Land Use Consultant** [July 2006 to October 2008]
Omnia Fertilizer (Pty) Ltd; **Horticulturist and Extension Specialist** [January 2005 to June 2006]

- **Professional Affiliations**

- South African Council for Natural Scientific Professions [SACNASP]
- Soil Science Society of South Africa [SSSA]
- Soil Science Society of America
- South African Soil Surveyors' Organisation [SASSO]
- International Society for Sustainability Professionals [ISSP]

Summary of a selected number of projects completed successfully:

[Comprehensive project dossier available on request]

1. *Sekoko Railway Alignment and Siding Soil, Land Use and Capability Study* in close proximity to the Medupi Power Station in the Lephalale area, Limpopo Province.

2. *Italthai Rail and Port Projects, Mozambique* – The study included a thorough assessment of the current land use practices in the proposed development areas including subsistence crop production and fishing as well as livestock farming and forestry activities. All the land uses were mapped and intrinsically linked to the different soil types and associated land capabilities. This study was used to develop Livelihood Restoration Planning from.

3. *Bomi Hills Railway Alignment Project, Liberia:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, as well as associated infrastructure upgrades of the port, road and railway.

4. *Kingston Vale Waste Facility, Mpumalanga Province, South Africa*: Soil and vegetation monitoring to determine the risk of manganese pollution resulting from activities at the waste facility.

5. *Keaton Mining's Vanggatfontein Colliery, Mpumalanga*: Assessment of soil contamination levels in the mining area, stockpiles as well as surrounding areas as part of a long-term monitoring strategy and rehabilitation plan.

6. *Richards Bay Minerals, KwaZulu-Natal*: Contaminated land assessment of community vegetable gardens outside Richards Bay as a result of spillages from pipelines of Rio Tinto's Richards Bay Minerals Mine.

7. *Buffelsfontein Gold Mine, Northwest Province, South Africa:* Soil and land contamination risk assessment for as part of a mine closure application. Propose soil restoration strategies.

8. Glenover Phosphate Mining Project near Steenbokpan in the Lephalale area – Soil, Land Use and Land Capability Study as part of the environmental authorisation process.

9. *Waterberg Coal 3 and 4 Soil, Land Use and Land Capability Study* on 23 000 ha of land around Steenbokpan in the Lephalale area.

10. *Lesotho Highlands Development Agency, development of Phase II (Polihali Dam and associated infrastructure)*: External review and editing of the initial Soil, Land Use and Land Capability Assessment as requested by ERM Southern Africa.

11. *Tina Falls Hydropower Project, Eastern Cape , South Africa*: Soil, land use and land capability assessment as part of the ESIA for the construction of a hydropower plant at the Tina Falls.
12. *Graveyard relocation as part of Exxaro Coal's Belfast Resettlement Action Plan*: Soil assessment to determine pedohydrological properties of the relocation area in order to minimise soil pollution caused by graveyards.

13. *Rhino Oil Resources: Strategic high-level soil, land use and land capability assessment of five proposed regions to be explored for shale gas resources in the KwaZulu-Natal, Eastern Cape, North-West and Free State provinces of South Africa.*

14. *Eskom Kimberley Strengthening Phase 4 Projec*t, Northern Cape & Free State, South Africa: soil, agricultural potential and land capability assessment.

15. *Mocuba Solar Project, Mozambique* – The study included a land use assessment together with that of the soil and land capabilities of the study area. All current land uses were documented and mapped and the land productivity was determined. This study advocated the resettlement and livelihood restoration planning.

16. *Botswana (Limpopo-Lipadi Game Reserve).* Soil research study on 36 000 ha on the banks of the Limpopo River. This soil study forms part of an environmental management plan for the Limpopo-Lipadi Game Reserve situated here as well as the basis for the Environmental Impact Assessment for the development of lodges and Land Use Management in this area.

17. *TFM Mining Operations [proposed] Integrated Development Zone, Katanga, DRC* [part of mining concession between Tenke and Fungurume]: soil and agricultural impact assessment study.

18. *Closure Strategy Development for Techmina Mining Company – Lucapa, Angola.* Conducted an analysis of the natural resources (soil, water) to determine the existing environmental conditions on an opencast diamond mine in Angola. The mine currently experience severe problems with kimberlite sediment flowing into the river. A plan is currently being developed to change the mining area into a sustainable bamboo farming operation.

19. *Closure of sand mining operations, Zeerust District.* Succesfully conducted the closure application of the Roos Family Sand Mine in the Zeerust District. Land Use Management Plans for rehabilitated soil were developed. The mine has closed now and the financial provision has been paid out to the applicant.

20. *ESIA for [proposed] Musonoi Mine, Kolwezi area, Katanga, DRC:* soil, land use and land capability assessment.

21. *Bauba A Hlabirwa Moeijelik Platinum mine [proposed] project, Mpumalanga, South Africa:* soil, land use and land capability assessment and impact on agricultural potential of soil.

22. *Commissiekraal Coal Mine [proposed] project, KwaZulu*-Natal, South Africa: sustainable soil management plans, assessment of natural resource and agricultural potential and study of the possible impacts of the proposed project on current land use. Soil conservation strategies included in soil management plan.

23. *Cronimet Chrome Mine [proposed] project, Limpopo Province, South Africa:* soil, land use and land capability of project area and assessment of the impacts of the proposed project.
24. *Moonlight Iron Ore Land Use Assessment, South Africa* – Conducted a comprehensive land use assessment that included interviews with land users in the direct and indirect project zones of influence. The study considered all other anticipated social and environmental impacts such as water, air quality and noise and this was incorporated into a sensitivity analysis of all land users to the proposed project.

25. *Project Fairway Land Use Assessment, South Africa* – The study included an analysis of all land users that will directly and indirectly be influenced by the project. It analysed the components of their land uses and how this components will be affected by the proposed project. Part of the study was to develop mitigation measures to reduce the impact on the land users.

26. *Bekkersdal Urban Renewal Project – Farmer Support Programme,* Independent consultation on the farmer support programme that forms part of Bekkersdal Renewal Project. This entailed the production of short and long term business plans based on soil and water research conducted. Part of responsibilities were the evaluation of current irrigation systems and calculation of potential water needs, etc. as well as determining quantities and prices of all project items to facilitate the formalisation of tender documents.

27. *Area-based agricultural business plans for municipalities in Dr. Kenneth Kaunda Municipal District.* Evaluation of the agricultural and environmental status of the total district as well as for each municipality within the district. This included the critical evaluation of current agricultural projects in the area. The writing of sustainable, executable agricultural business plans for different agricultural enterprises to form part of the land reform plans of each Municipality within the district.

28. *Batsamaya Mmogo, Hartswater.* Conducted a soil and water assessment for the farm and compiled management and farming plans for boergoats grazing on *Sericea lespedeza* with pecan nuts and lucerne under irrigation.

29. *Anglo Platinum Twickenham Mine – Irrigated Cotton Project.* Project management of an irrigated cotton production project for Twickenham Platinum Mine. This project will ensure that the community benefit from the excess water that is available from the mine activities.

30. *Grasvally Chrome (Pty) Ltd Sylvania Platinum [proposed] Project, Limpopo Province, South Africa:* Soil, land use and agricultural potential assessment.

31. *Jeanette Gold mine project [reviving of historical mine], Free State, South Africa:* Soil, land use and agricultural potential assessment.

32. *Kangra Coal Project, Mpumalanga, South Africa:* Soil conservation strategies proposed to mitigate the impact of the project on the soil and agricultural potential.

33. *Richards Bay Integrated Development Zone Project, South Africa* [future development includes an additional 1500 ha of land into industrial areas on the fringes of Richards Bay]: natural resource and agricultural potential assessment, including soil, water and vegetation.

34. *Exxaro Belfast Coal Mine [proposed] infrastructure development projects* [linear: road and railway upgrade | site-specific coal loading facilities]: soil, land capability and agricultural potential assessment.

35. *Marikana In-Pit Rehabilitation Project of Aquarius Platinum, South Africa:* soil, land capability and land use assessment.
36. *Eskom Bighorn Substation proposed upgrades, South Africa:* soil, land capability and agricultural potential assessment.

37. *Exxaro Leeuwpan Coal Mining Right Area, South Africa:* consolidation of all existing soil and agricultural potential data. Conducted new surveys and identified and updated gaps in historic data sets.

38. *Banro Namoya Mining Operation, DRC:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, including proposed project extension areas and progressive soil and land use rehabilitation plan.

39. *Kumba Iron Ore's Sishen Mine, Northern Cape, South Africa: soil, land use and agricultural scientist* | *Western Waste Rock Dumps [proposed] Project:* soil, land use and agricultural potential assessment, including recommendations regarding stripping/stockpiling and alternative uses for the large calcrete resources available.

40. *Vetlaagte Solar Development Project, De Aar, South Africa:* soil, land use and agricultural scientist. Soil, land use and agricultural potential assessment for proposed new 1500 ha solar development project, including soil management plan.