Phase 1 Heritage Impact Assessment for the proposed new Good Hope Solar PV facility near Dealesville, Free State Province.

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Summary

A phase 1 Heritage Impact Assessment was carried out for the establishment of a proposed new solar PV facility on the farms Goede Hoop 1028, Epsom Downs 1216 and Gedenksrust 1029 near Dealesville in the Free State province. Good Hope 1 largely covers "degraded" farmland terrain (in the sense that it has either been ploughed or used for pasture or both in the past) and is underlain by palaeontologically insignificant dolerite intrusions, covered by a well-developed and calcrete-rich aeolian sand overburden. Good Hope 2 largely covers "degraded" farmland terrain (in the sense that it has either been ploughed or used for pasture or both in the past) and is partially underlain by Permian shales and siltstones of the Tierberg Formation (Ecca Group), that are covered by a well-developed and calcrete-rich aeolian sand overburden. There is no aboveground evidence of historically significant building structures older than 60 years, intact Stone Age archaeological remains, graves or material of cultural significance within the confines of the two development footprints. Proposed development at Good Hope 1 will primarily affect superficial Quaternary sediments and intrusive dolerite bedrock, which has no palaeontological potential. The likelihood of negative impact on palaeontological heritage in superficial Quaternary sediments (aeolian sand & residual soils) is considered negligible. Proposed development at Good Hope 2 will primarily affect superficial Quaternary sediments and potentially fossil-bearing rock units of the Tierberg Formation. In addition, Quaternary pan dune (lunette) deposits, as found in the northern boundary of the site, are potentially highly sensitive in terms of palaeontological as well as archaeological finds. It is advised that development at Good Hope 2 may proceed, provided that extensive excavations into intact Ecca sediments should be avoided where possible; or alternatively it is recommended that palaeontological monitoring is allowed at the start of and for duration of (1) linear excavations exceeding 3 m in length and > 60cm in depth into Ecca bedrock or (2) the mechanical exposure of unweathered Ecca bedrock surfaces exceeding 4 m^2 in size, while fresh, potentially fossiliferous strata is still exposed for study and recording. It is also recommended that the pan dune deposits bordering the northern boundary of the site should be strictly avoided by a ≥ 50 m no-go zone.

Contents

Introduction

A phase 1 Heritage Impact Assessment was conducted for the establishment of a proposed new solar PV facility on the farms Goede Hoop 1028, Epsom Downs 1216 and Gedenksrust 1029 near Dealesville in the Free State province (**Fig 1 & 2**). The extent of the proposed development (over 5000 m2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African National Heritage Resources Act (Act No. 25 of 1999). As a prerequisite for new development in terms of the National Heritage Resources Act, the study was also triggered by possible need for extensive ground moving activities and excavations into potentially vulnerable fossiliferous sediments of Quaternary and Paleozoic age. The task involved an assessment of possible impact by the proposed development on potential fossil heritage, an assessment of their significance and recommendations for mitigation where relevant.

Terms of Reference

- Identify and map possible heritage sites and occurrences using published and database resources;
- Determine and assess the potential impacts of the proposed development on potential heritage resources;
- Recommend mitigation measures to minimize potential impacts associated with the proposed development.

Approach and Methodology

The heritage significance of the affected area was based on existing field data, database information and published literature. A field assessment, using a Garmin Etrex Vista GPS hand model (set to the WGS 84 map datum) and a digital camera for recording purposes followed this. Geological maps, aerial photographs and site records were integrated with data acquired during the on-site inspection. The study area is rated according to field rating categories as prescribed by SAHRA (**Table 1**).

Assumptions and Limitations

The assessment provided within this report is based upon a desktop study without the benefit of a site visit. As such, the presentation of geological units present within the study area is derived from 1:250 000 geological maps that may vary in their accuracy. It is also assumed, for the sake of prudence, that fossil remains are always uniformly distributed in fossil-bearing rock units, although in reality their distribution may vary significantly.

Locality data

Relevant 1:50 000 topographic map: 2825 DB Dealesville

Relevant geological map: 2824 Kimberley

Site Coordinates (**Fig 3**):

Good Hope 1

A) 28°38'14.84"S 25°45'7.26"E
B) 28°38'42.90"S 25°46'20.27"E
C) 28°39'6.13"S 25°46'8.80"E
D) 28°39'0.40"S 25°45'32.13"E
E) 28°39'7.32"S 25°45'27.53"E
F) 28°38'57.73"S 25°45'21.64"E
G) 28°38'59.34"S 25°45'13.63"E
H) 28°38'35.59"S 25°45'0.10"E

Good Hope 2

A) 28°37'57.46"S 25°46'42.66"E
B) 28°37'44.82"S 25°47'8.84"E
C) 28°39'1.12"S 25°47'21.74"E
D) 28°38'38.66"S 25°46'23.07"E

Two areas designated Good Hope 1 and Good Hope 2 are located on the farms Goede Hoop 1028, Epsom Downs 1216 and Gedenksrust 1029, covering 207 ha and 215 ha of open farmland respectively (**Fig. 3**). The study areas are located about 3 km due north of the Dealesville CBD and close to the eastern margin of the Free State pan veld (**Fig. 2**). Numerous shallow and usually waterless depressions, underlain by a shale substrate, cover the western Free State and these pans are often archaeologically as well as palaeontologically significant.

Background

Geology

The geology of the area has been described by Bosch (1993). The area in question is underlain by sediments of widely different geological ages (**Fig. 4,** portion of 1: 250 000 scale geological map 2824 Kimberley, Council for Geoscience, Pretoria, 1991). From oldest to youngest, the geology in and around the affected area is made up of Permian Ecca shales (Tierberg Formation., *Pt*), Jurassic dolerite intrusions (*Jd*, Karoo Dolerite Suite), Quaternary calcretes, surface limestones, calcified pandunes (*Qc*) and aeolian sands (*Qs*) (Kalahari Group). The wind-blown sands represent the latest geological phase and are made up of the characteristically red-brown

Kalahari sands (Hutton sands). The geological map indicates that, accept for dolerite intrusions, the affected area is mainly covered by Quaternary-age surface deposits made up of surface limestones (*Qc*) and a thick mantle of aeolian sand (*Qs*). Unconsolidated sediments like sheet wash, alluvium, spring accumulations and aeolian sand generally occur as thin to well-developed deposits in the region, while consolidated regolith largely preserve as pedocretes (**Fig. 5**).

Karoo Fossils

The affected areas lie within the outcrop belt of the Tierberg Formation (Ecca Group). Deposition of the Tierberg shales took place under reducing conditions in an inland sea, through suspension settling of fine mud and silt, during the Middle Permian. Fossils from the Tierberg Formation are generally poorly represented. They largely occur as sparsely distributed and generally not diverse assemblages of trace fossils (Anderson 1976; De Beer et al. 2002; Viljoen 2005; Johnson *et al.* 2006). These ichnoassemblages include arthropod trackways and associated resting impressions, fish swimming trails, horizontal epichnial furrows often attributed to gastropods, as well as a variety of different kinds of small burrows. Plant remains, including fossilized wood becomes more abundant in the upper layers of the formation (Ryan 1967; Wickens 1996). Impressions of *Gondwanidium validum* and pieces of *Dadoxylon* have been discovered between Douglas and Belmont, south of Kimberley (McLaren 1976). Sponge spicules, fish scales and disarticulated microvertebrate remains from calcareous concretions have also been recorded (Zawada 1992, Bosch 1993).

Karoo Dolerites

Dolerite, in the form of dykes and sills, is common throughout the study area. Regarded as feeders of Drakensberg lavas, dolerites are not palaeontologically significant and can be excluded from further consideration in the present evaluation.

Superficial Deposits & Archaeology

Quaternary-age surface deposits in the region can be highly fossiliferous in places, especially those that are directly related to fluvial environments along major river courses. Fossil assemblages (including an assortment of mammalian bones and teeth, coprolites, freshwater molluscs and plant microfossils), individual specimens and fossilized hyena burrows have been found preserved in Late Pleistocene alluvial sediments of the nearby Modder River (Broom 1909 a, b; Cooke 1955; Churchill *et al.* 2000; Rossouw 2006). Intrusive features such as fossilized hyena lairs or fossilized bone accumulations are sometimes located outside the present river valleys along calcified pan dunes and localized spring deposits (Horowitz *et al*. 1978; Scott and Klein 1981; Butzer 1984; Scott & Brink 1991). When these types of pans were formed, the prevailing winds blew unconsolidated material (aeolian sands) into newly formed lunettes on the lee side of the deflation hollows which occasionally provided a locus for hyena activities

(burrows) and prehistoric human habitation in the past (**Fig. 6**). Spring and associated pan dune deposits, such as at Baden Baden north of Dealesville, Florisbad northwest of Bloemfontein, and Liebenbergspan (Voigts Post) and Deelpan between Bloemfontein and Petrusburg, may contain Pleistocene vertebrate fossils and plant microfossils (Brink 1987, 1988; Scott & Rossouw 2005) (**Fig**. **7**). In addition, spring deposits occasionally found in the vicinity of pans, such as at Florisbad northwest of Bloemfontein and Baden Baden north of Dealesville are renowned for their intact stone tool assemblages and archaeozoological remains (**Fig**. **8**).

In addition to pans and spring localities, Stone Age archaeological sites in the region largely occur as Middle Stone Age (MSA) and Later Stone Age (LSA) open-site assemblages with ESA assemblages increasing towards the west closer to the confines of the Vaal River drainage. There are no records of rock engravings in the vicinity of the survey area. Dealesville is situated outside the periphery of distribution of Late Iron Age settlements in the Free State. Ruins of Late Iron Age settlements are found on several farms about 150 km to the east and northeast of Bultfontein, such as the stone kraal settlements at Doornpoort near Winburg and the large settlement complex at Strydfontein between Hennenman and Ventersburg (Maggs 1976).

Field Assessment

Good Hope 1

The site mainly covers “degraded” farmland terrain (in the sense that it has either been ploughed or used for pasture or both in the past) and is underlain by palaeontologically insignificant dolerite intrusions, covered by a well-developed and calcrete-rich aeolian sand overburden (**Fig. 9 - 11**). There is no aboveground evidence of historically significant building structures older than 60 years, intact Stone Age archaeological remains, graves or material of cultural significance within the confines of the development footprint.

Good Hope 2

The site mainly covers “degraded” farmland terrain (in the sense that it has either been ploughed or used for pasture or both in the past) and is partially underlain by Permian shales and siltstones of the Tierberg Formation (Ecca Group), that are covered by a well-developed and calcrete-rich aeolian sand overburden **(Fig. 12 - 13**). There is no aboveground evidence of historically significant building structures older than 60 years, intact Stone Age archaeological remains, graves or material of cultural significance within the confines of the development footprint. A cluster of dilapidated farm structures covering about 1.6 ha, and recorded near the south eastern boundary of the footprint is not considered to be historically significant (GPS coordinates 28°38'36.77"S 25°47'10.73"E, **Fig. 14).**

Impact Statement & Recommendations

The proposed development is considered **long-term** with the possible consequence that any damage or destruction to potential palaeontological and archaeological material within the affected areas will be permanent and irreversible.

Good Hope 1

It is expected that infrastructure development will involve installation of multiple photovoltaic panels and associated underground cables and wiring, as well as access roads that will extend over a relatively large surface area. The assessment indicates that the proposed developments will primarily affect superficial Quaternary sediments (*Qs*) and intrusive dolerite bedrock (*Jd*), which has no palaeontological potential. The insignificant (for dolerites) to moderate (for aeolian sand) palaeontological sensitivity rating for the area according to the SAHRIS palaeosensitivity map (**Fig. 15**) is changed to low for the unconsolidated overburden (*Qs,* see **Fig. 4**). Construction occurring on intrusive dolerite bedrock (*Jd*), will not result in any palaeontological impact (**Fig. 16**). The likelihood of negative impact on palaeontological heritage in dolerite is considered non-existant. The likelihood of negative impact on palaeontological heritage in superficial Quaternary sediments (aeolian sand & residual soils, *Qs*) is considered negligible.

The archaeological and cultural component at Good Hope 1 are assigned a site rating of General Protection C (**Table 1**). It is recommended that the development may proceed, provided that all construction activities are restricted to within the boundaries of each demarcated footprint.

Good Hope 2

It is expected that infrastructure development will involve installation of multiple photovoltaic panels and associated underground cables and wiring, as well as access roads that will extend over a relatively large surface area. The assessment indicates that the proposed developments will primarily affect superficial Quaternary sediments (*Qs*) and potentially fossil-bearing rock units of the Tierberg Formation (Ecca Group, *Pt*).

The moderate to high palaeontological sensitivity rating of the area according to the SAHRIS palaeosensitivity map (**Fig. 15**) is changed to low for the unconsolidated overburden (*Qs*, see **Fig. 4**) and moderate for the underlying sedimentary strata (Ecca Group, *Pt*, **Fig. 16**). The Permian shales and siltstones of the Ecca Group Tierberg Formation are fairly to poorly fossiliferous. However, these fossils are generally not evenly distributed in their occurrence in sedimentary strata. As such, the probability of fossils occurring within the Tierfontein Formation strata being impacted by activities during the construction phase of the project is considered *low to moderate*.

In addition, Quaternary pan dune (lunette) deposits, as found in the northern boundary of the site, are potentially highly sensitive in terms of palaeontological as well as archaeological finds (**Fig. 16 - 18**). Probability of impact are considered *moderate to high* in this case.

Possible impact on moderate to highly sensitive sedimentary strata usually requires monitoring by a professional palaeontologist, since most detrimental impacts on palaeontological heritage usually occur during the construction phase when fossils may be disturbed or destroyed during excavations and subsequent construction activities. It is advised that the development may proceed, given the following recommendations:

- extensive excavations into intact Ecca sediments should be avoided where possible.
- alternatively it is recommended that palaeontological monitoring is allowed at the start of and for duration of (1) linear excavations exceeding 3 m in length and > 60cm in depth into Ecca bedrock or (2) the mechanical exposure of unweathered Ecca bedrock surfaces exceeding 4 m^2 in size, while fresh, potentially fossiliferous strata is still exposed for study and recording.
- The pan dune deposits bordering the northern boundary of the site should be strictly avoided by a ≥ 50 m no-go zone (**Fig. 19**).

The archaeological and cultural component at Good Hope 2 are assigned a site rating of General Protection C (**Table 1**). It is recommended that the development may proceed, provided that all construction activities are restricted to within the boundaries of each demarcated footprint.

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DECLARATION OF INDEPENDENCE

October 2021

I, Lloyd Rossouw, declare that I act as an independent specialist consultant. I do not have or will not have any financial interest in the undertaking of the activity other than remuneration for work as stipulated in the terms of reference and have no interest in secondary or downstream developments resulting from the authorization of this project.

Tables & Figures

Table1. Field rating categories as prescribed by SAHRA

Field Rating	**Grade**	**Significance**	**Mitigation**
National Significance (NS)	Grade 1	-	Conservation; national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation; mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A (GP.A)	-	High/medium significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium significance	Recording before destruction
Generally Protected C (GP.C)	-	Low significance	Destruction

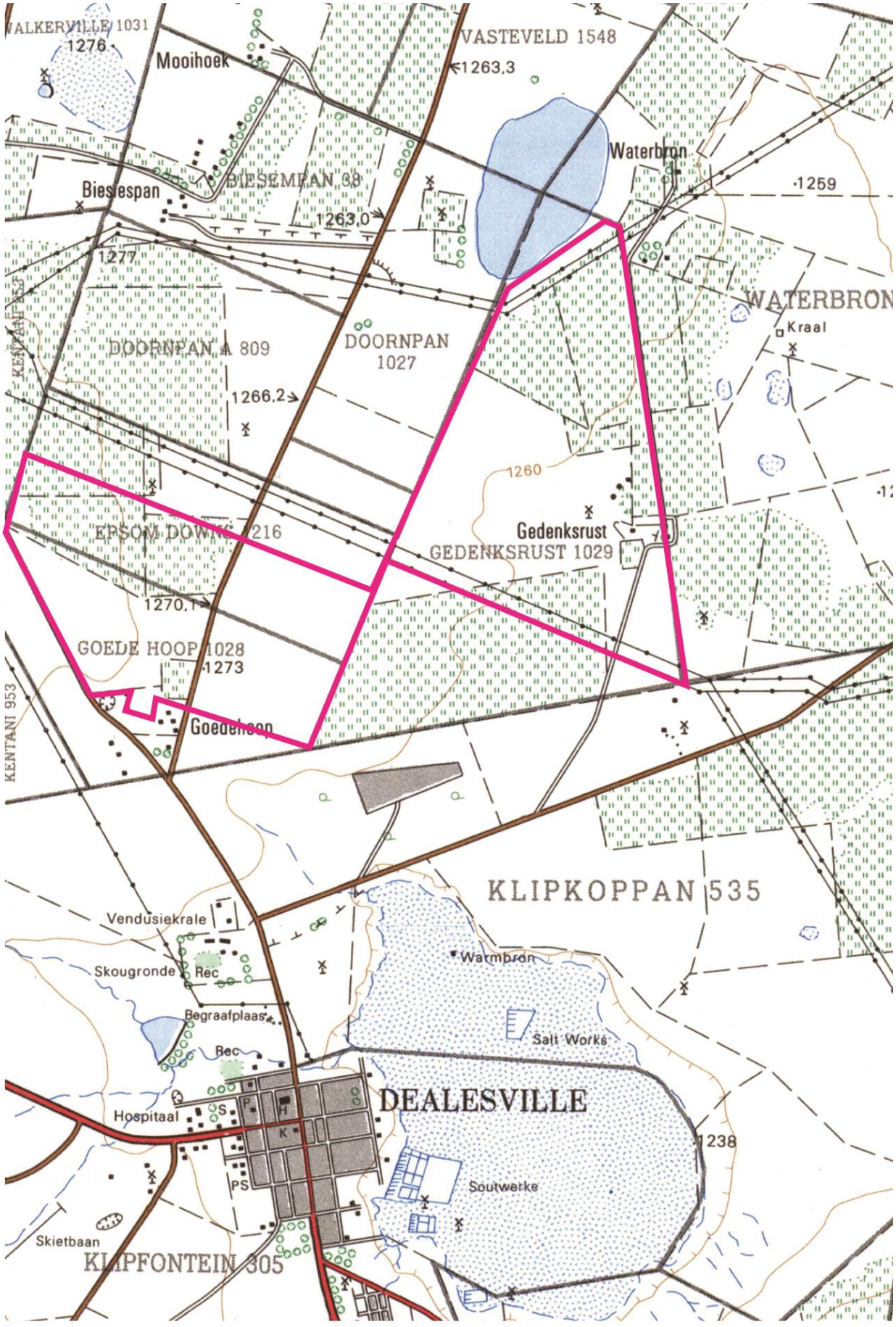

Figure 1. Map of the proposed solar PV footprint (portion of 1:50 000 scale topographic map 2825 DB Dealesville).

Figure 2. Aerial view of the proposed development.

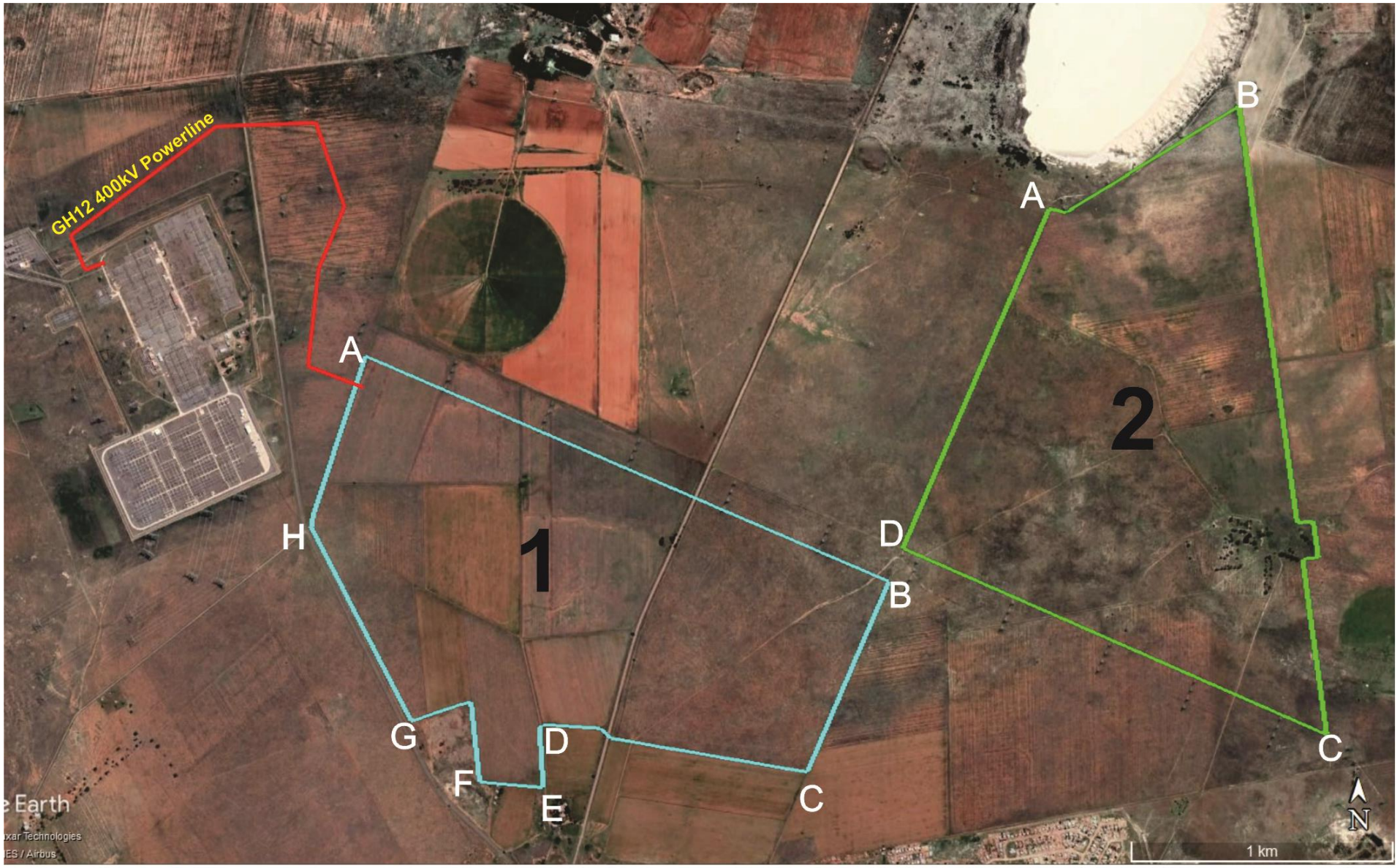

Figure 3. Layout of the proposed development.

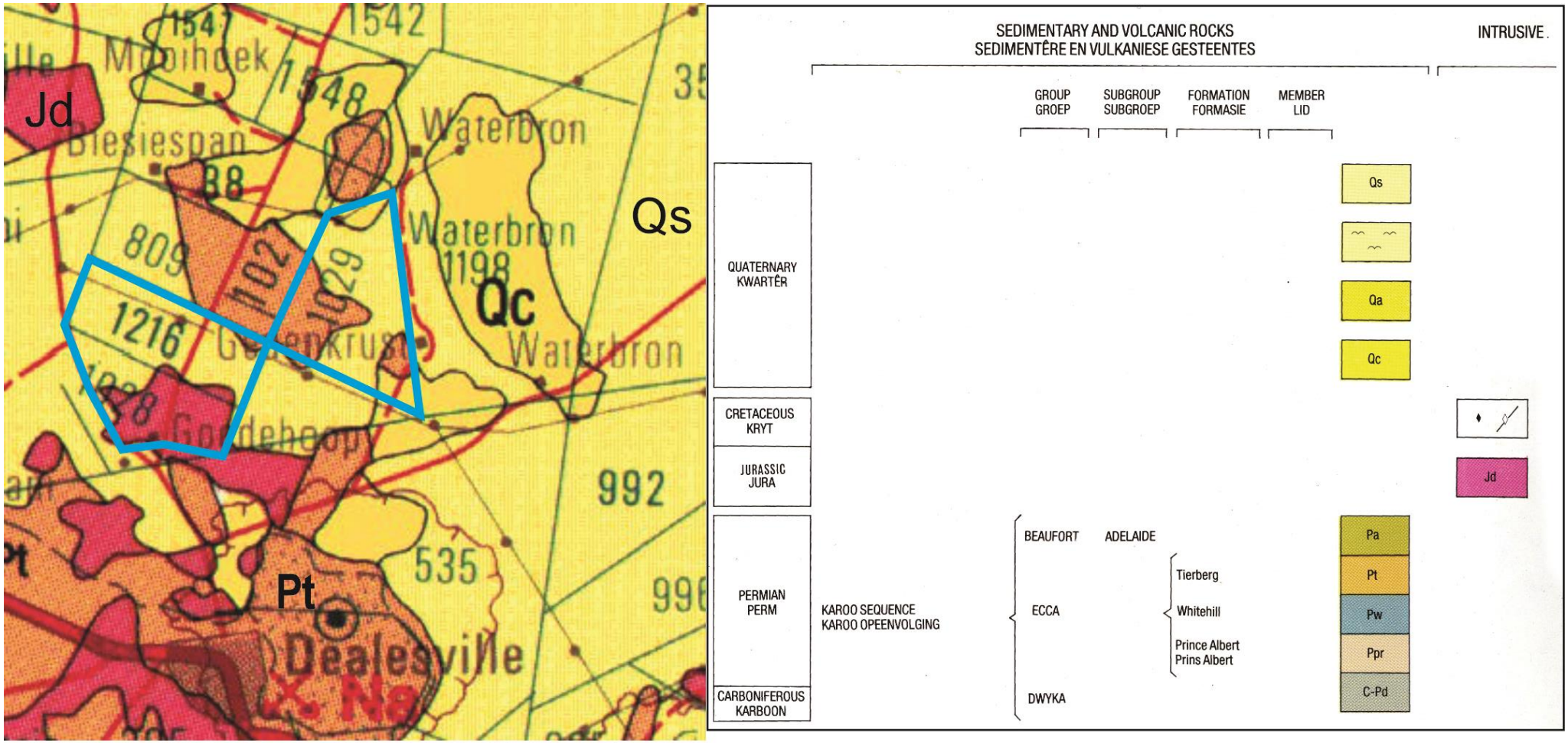

Figure 4. Portion of 1 : 250 000 scale geological map 2824 Kimberley of the study area. From oldest to youngest, the geology in and around the affected area is made up of Permian Ecca shales (Tierfontein Formation, *Pt*), Jurassic dolerite intrusions (*Jd*, Karoo Dolerite Suite), Quaternary calcretes, surface limestones, calcified pandunes (*Qc*) and aeolian sands (*Qs*) (Kalahari Group).

Figure 5. Example of pedocrete diagenesis: massive hardpan calcrete exposure west of Good Hope 1

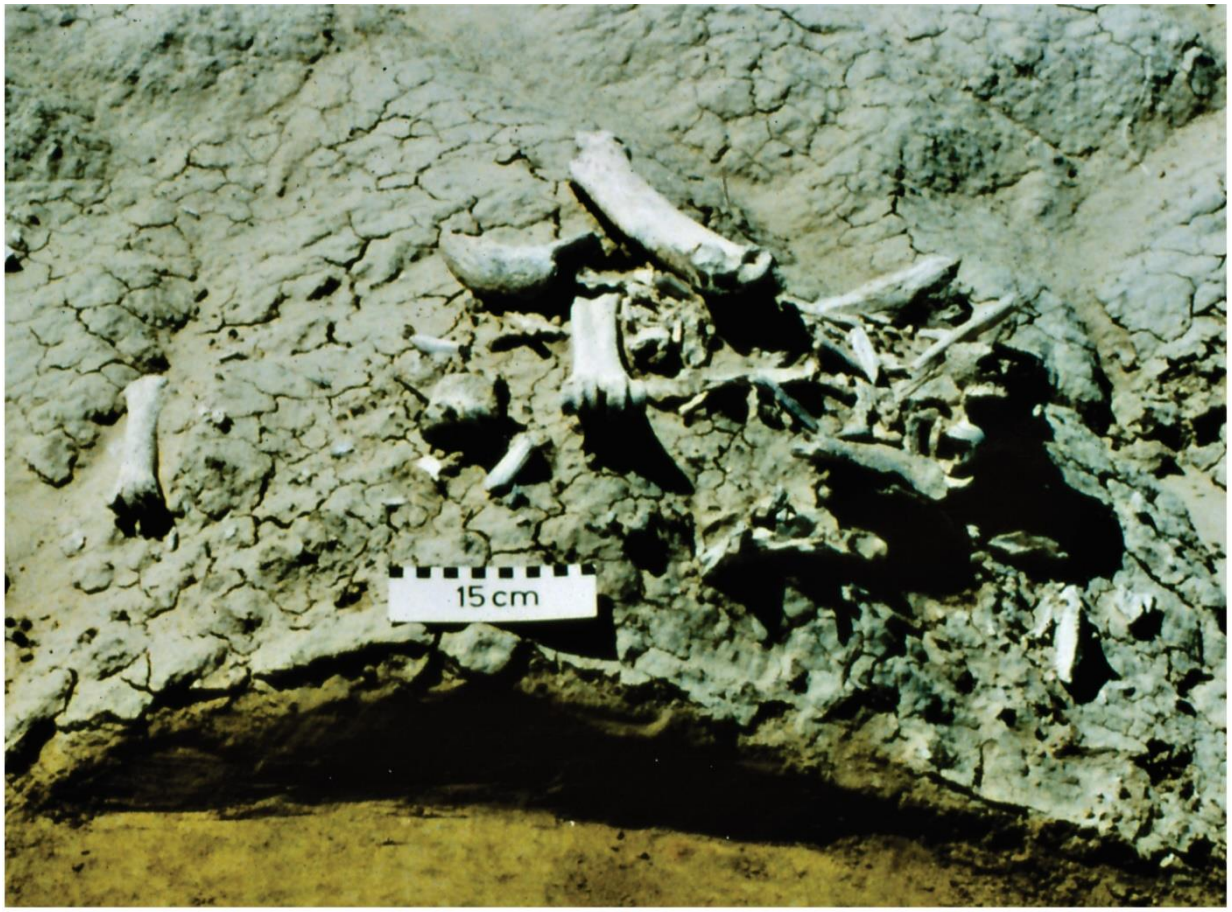

Figure 6. Fossil exposure (top) in pan lunette (below), Western FS Panveld.

Figure 7. Important fossil and Stone Age archaeological localities in the region between Dealesville, Petrusburg and Bloemfontein.

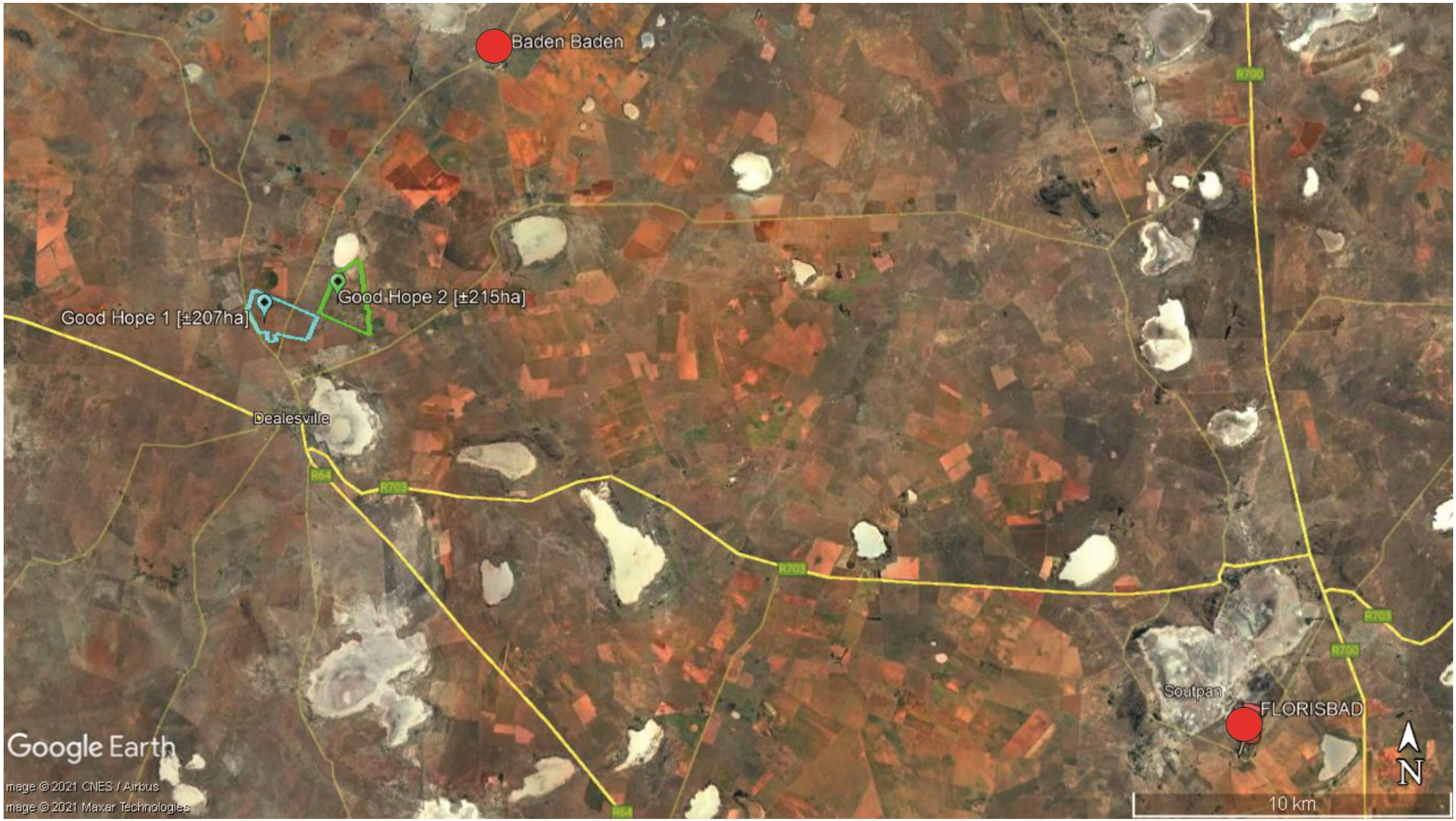

Figure 8. Position of fossil-bearing and archaeologically rich spring deposits at Baden Baden and Florisbad in relation to the localities of the proposed new developments.

Figure 9. General view of Good Hope 1 footprint, looking west (above) and east (below).

Figure 10. Good Hope 1 is largely covered by “degraded” farmland terrain (in the sense that it has either been ploughed or used for pasture or both in the past).

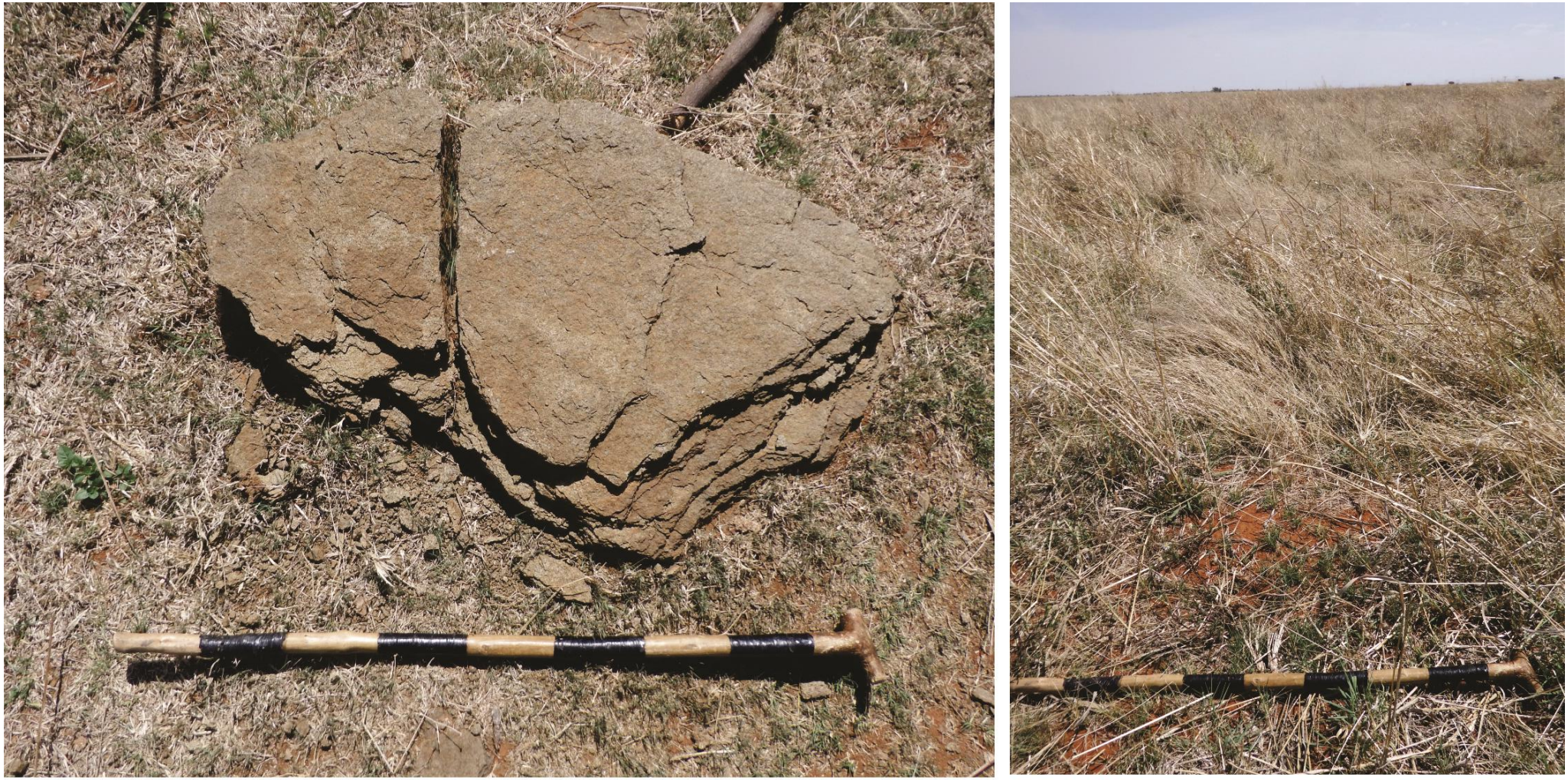

Figure 11. Weathered dolerite (left) covered by a well-developed and calcrete-rich aeolian sand overburden (right).
Scale 1 = 10 cm.

Figure 12. General view of Good Hope 2 footprint, looking north (above) and south (below). The site is largely covered by "degraded" farmland terrain (in the sense that it has either been ploughed or used for pasture or both in the past).

Figure 13. Tierberg Formation shale (above) covered by a well-developed and calcrete-rich aeolian sand overburden (below).
Scale 1 = 10 cm

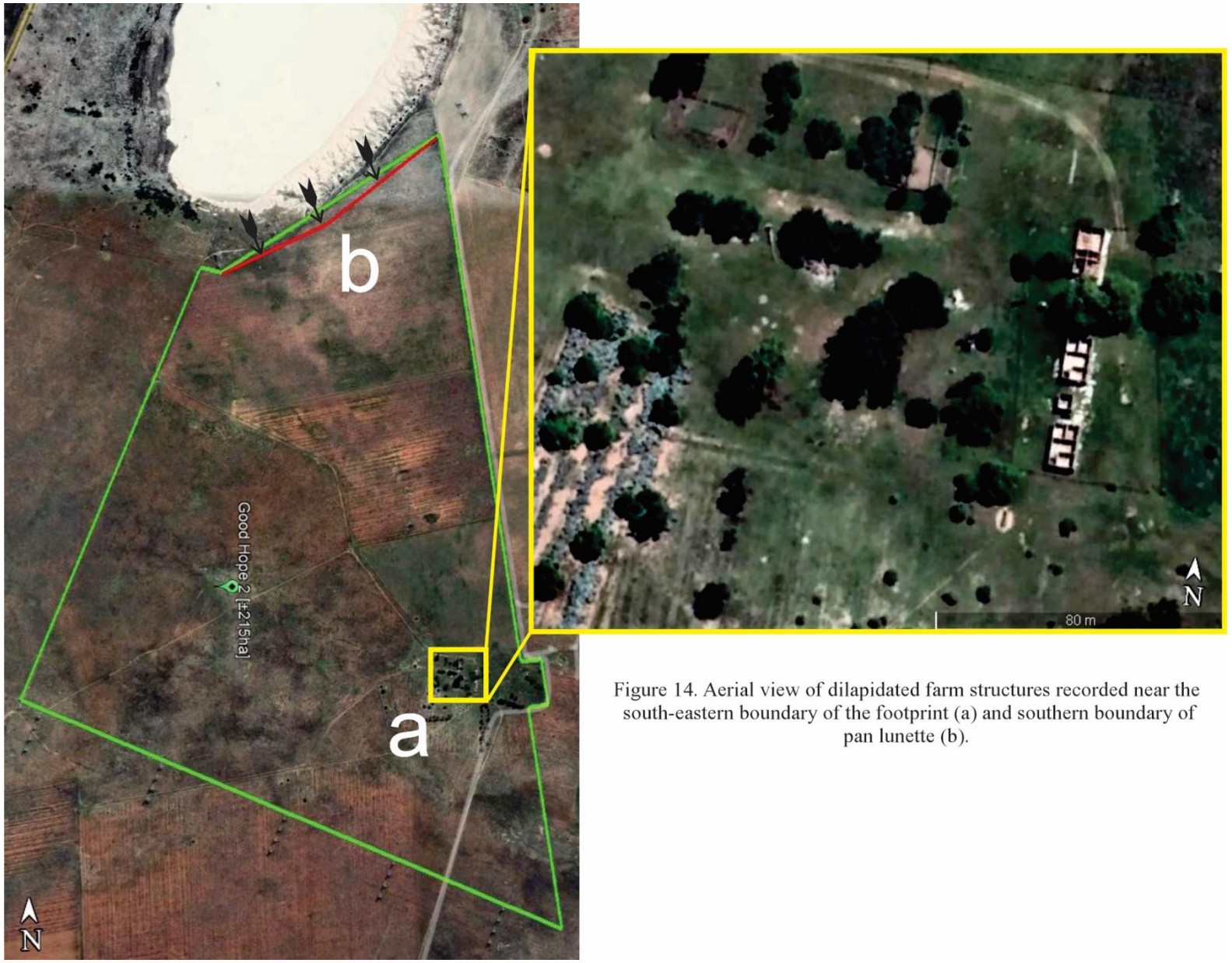

Figure 14. Aerial view of dilapidated farm structures recorded near the south-eastern boundary of the footprint (a) and southern boundary of pan lunette (b).

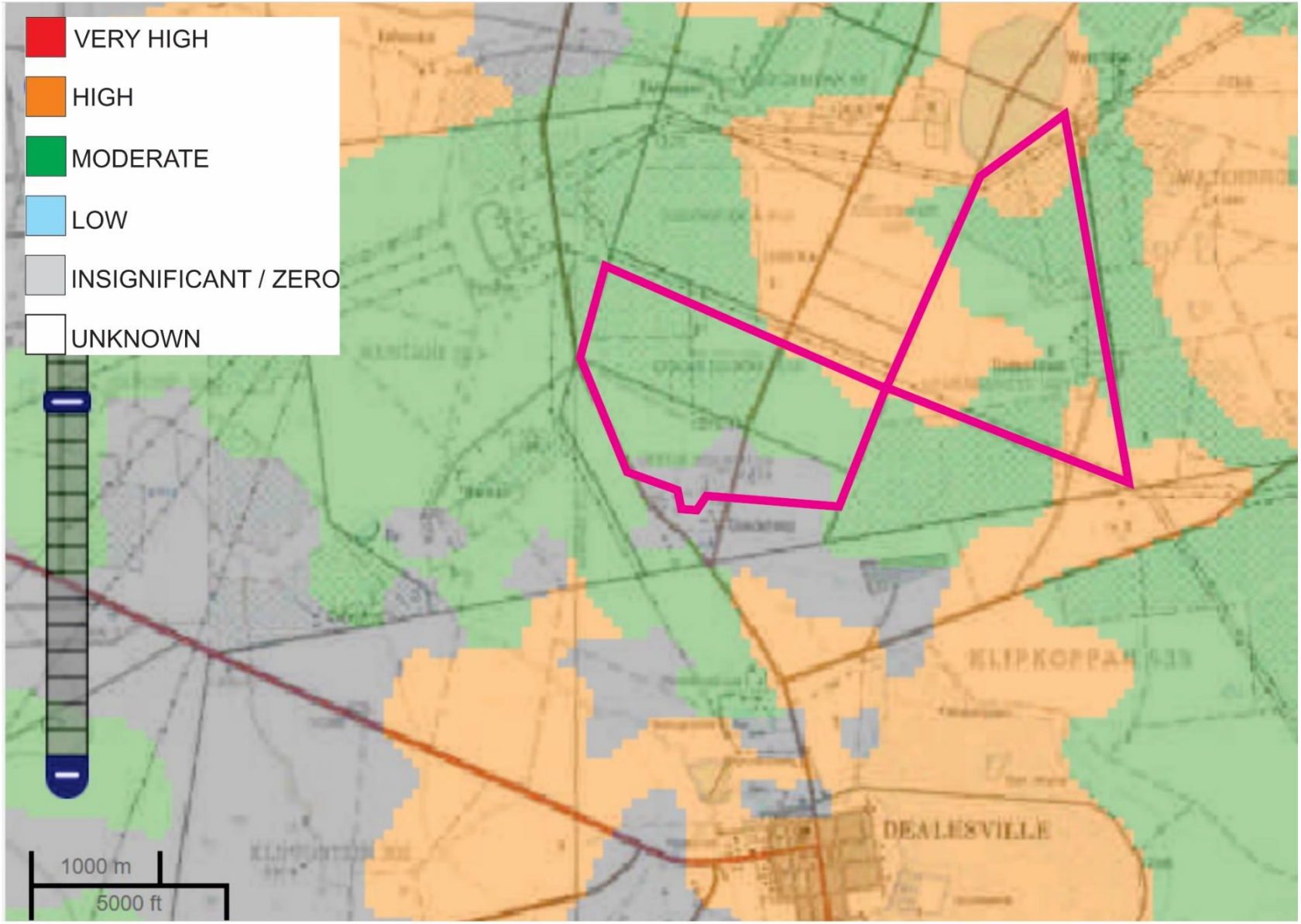

Figure 15. Layout of the proposed footprints marked on SAHRIS palaeosensitivity map (2021)

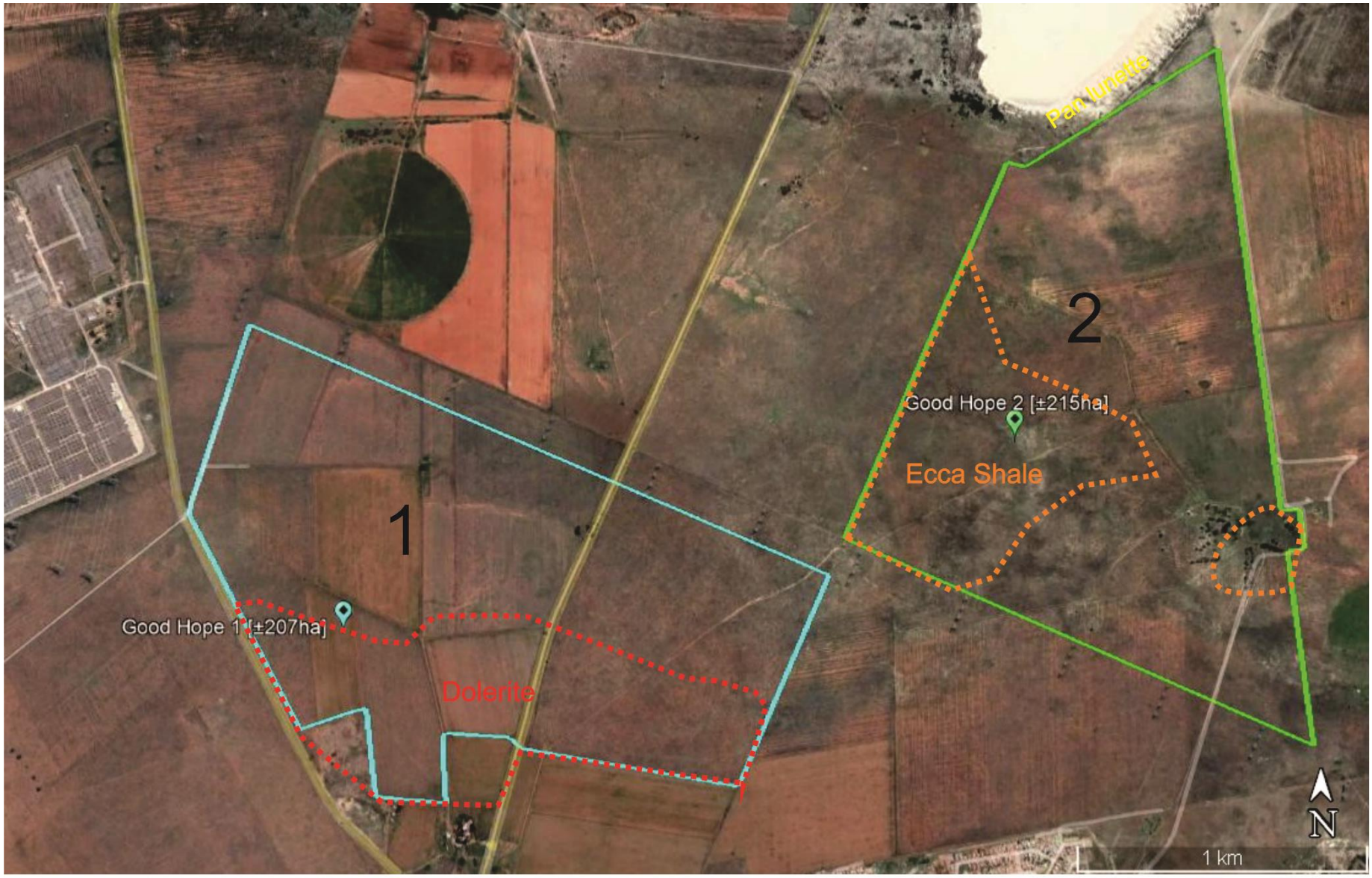

Figure 16. Aerial view of geological and geomorphological features discussed in Impact Statement & Recommendations.

Figure 17. General view of pan situated at the northern boundary of Good Hope 2.

Figure 18 Unconsolidated material (aeolian sands), created by prevailing winds of the past, formed potentially fossil-bearing and archaeologically sensitive lunettes on the lee side of the pan.

Figure 19. The pan dune deposits bordering the northern boundary of the site should be strictly avoided by a ≥ 50 m no-go zone .