Ecological Constraints Analysis, Proposed Walker Bay Wind Farm, Baardskeerdersbos District, Overstrand Municipality Western Cape

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Prepared for Renewable Energy Systems Southern Africa

October 2011

DECLARATION

The botanical assessment reported here was conducted by Dr David J. McDonald BSc. Hons. (Botany), MSc (Botany) and PhD (Botany), who is a botanical ecologist with over 30 years' experience in the field of vegetation science. Dr McDonald is registered as an Ecological Scientist with the South African Council for Natural Scientific Professions (SACNASP), Registration No. 400094/06.

The views expressed in the accompanying report are the objective, independent views of Dr McDonald and the survey was carried out under the aegis of his registered Close Corporation, Bergwind Botanical Surveys and Tours CC. Neither Dr McDonald nor Bergwind Botanical Surveys and Tours CC have any business, personal, financial, or other interest in the proposed development apart from fair remuneration for the work performed.

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CONTENTS

1. Introduction

The ecological constraints analysis reported here was commissioned by Renewable Energy Systems Southern Africa (through Savannah Environmental) to inform the process of selecting suitable terrain for a possible wind farm in the Baardskeerdersbos District, Overstrand Municipality, Western Cape. It must be noted that this report is an extract from a report compiled in November 2010 which considered two farm portions in the Baardskeerdersbos District, i.e. portions Baardskeerdersbos 213/1 and Baardskeerdersbos 214/RE; and the farm Grootvlei 687/3. The main objective of this report was to examine a predetermined area to assess its botanical (ecological) attributes and how these would influence development of a wind farm in the area.

This report provides a description of the vegetation on the farm Grootvlei 687/3 as well as identified ecological constraints that would provide Renewable Energy Systems (RES – the client) with clarity on *inter alia* biodiversity and ecological issues that may limit or restrict the construction of a wind-power generation facility.

This assessment takes careful note of the general requirements and recommendations of CapeNature and the Botanical Society of South Africa for proactive assessment of biodiversity of proposed development sites and follows published guidelines for evaluating potential impacts on the natural vegetation in an area earmarked for some form of development (Brownlie 2005, De Villiers *et al.* 2005).

2. Terms of Reference

To conduct an ecological constraints analysis based principally on a botanical assessment of the Study Area, Baardskeerdersbos District, and Overstrand Municipality, Western Cape. The analysis would describe the following:

Biodiversity patterns:

Community and ecosystem level

- The main vegetation type, its aerial extent and interaction with neighbouring types, soils or topography;
- The types of plant communities that occur

- Threatened or vulnerable ecosystems

Species level

- Documentation of any Red List plant species
- The viability of and estimated population size of the RDB species that are present (include the degree of confidence in prediction based on availability of information and specialist knowledge, i.e. High=70-100% confident, Medium 40-70% confident, low 0-40% confident)
- The likelihood of other RDB species, or species of conservation concern, occurring in the study area (include degree of confidence).

Other pattern issues:

- Any significant landscape features or rare or important vegetation associations such as seasonal wetlands, alluvium, seeps, quartz patches or salt marshes in the study area.
- The extent of alien plant cover of the site, and whether the infestation is the result of prior soil disturbance such as ploughing or quarrying.
- The condition of the site in terms of current or previous land uses.

Biodiversity process:

- The key ecological “drivers” of ecosystems on the site and in the vicinity, such as fire.
- Any mapped spatial component of an ecological process that may occur at the site or in its vicinity (i.e. corridors such as watercourses, upland-lowland gradients, migration routes, coastal linkages or inland-trending dunes, and vegetation boundaries such as edaphic interfaces, upland-lowland interfaces or biome boundaries).
- Any possible changes in key processes e.g. increased fire frequency or drainage/artificial recharge of aquatic systems.
- Would the conservation of the site lead to greater viability of the adjacent ecosystem by securing any of the functional factors listed in the first bullet?
- Would the site or neighbouring properties potentially contribute to meeting regional conservation targets for both biodiversity pattern and ecological processes?

3. Study Area

3.1 Locality

The study area lies in a region of the Western Cape Province known as the Southern Overberg. It lies in an area transitional between the winter-rainfall region of the extreme Western Cape and the non-seasonal rainfall area to the east. It can receive heavy rains in the winter from cold fronts passing from west to east along the coast but it can also receive summer showers due to the ridging of the South Atlantic high pressure system, cut-off lows, and southerly air streams. (Mustart *et al.* 1997). Mean annual rainfall is 546 mm but varies with aspect, elevation, and topography with higher elevations receiving higher rainfall due to orographic effects.

The farm Grootvlei 687/3 in the Baardskeerdersbos District of the Southern Overberg, within the Overstrand Municipality (Figure 1) is the focus of this investigation. This farm is located north of Driekop and straddling the Uilkraals River valley and extending over the sandstone mountain ridge to the north-west (Figure 3).

3.2 Climate

The summers are warm with daytime temperatures of 20 – 30°C whereas winter days are cool with temperatures of 12 – 18°C. The summers are windy with strong south-easterly gales but some of the hottest periods are in winter when hot, northerly berg winds blow from the interior raising temperatures to in excess of 30°C.

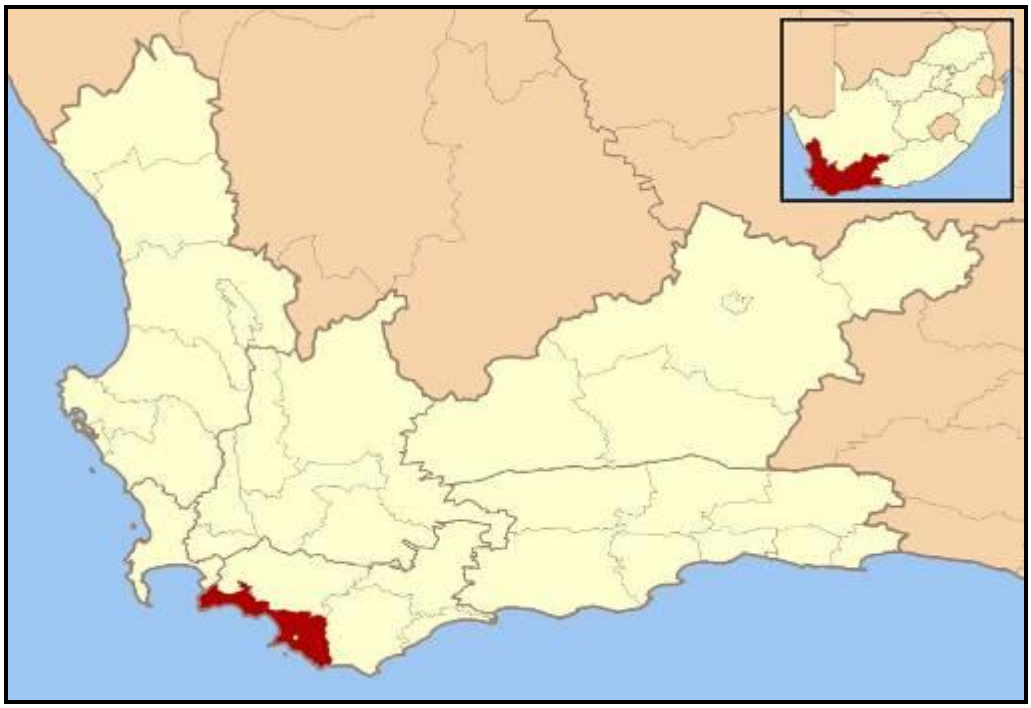


Figure 1. The location of the Overstrand Municipality (within the Overberg District Municipality) in the Western Cape

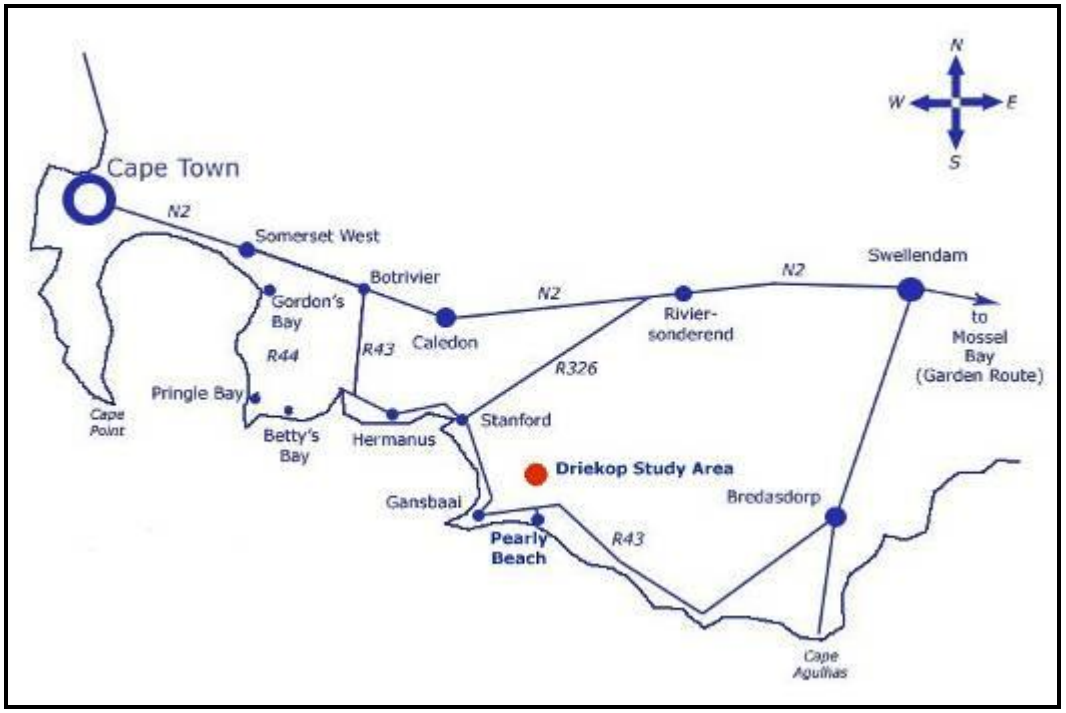


Figure 2. Location of the Driekop Study Area in relation to main towns in the Western Cape.

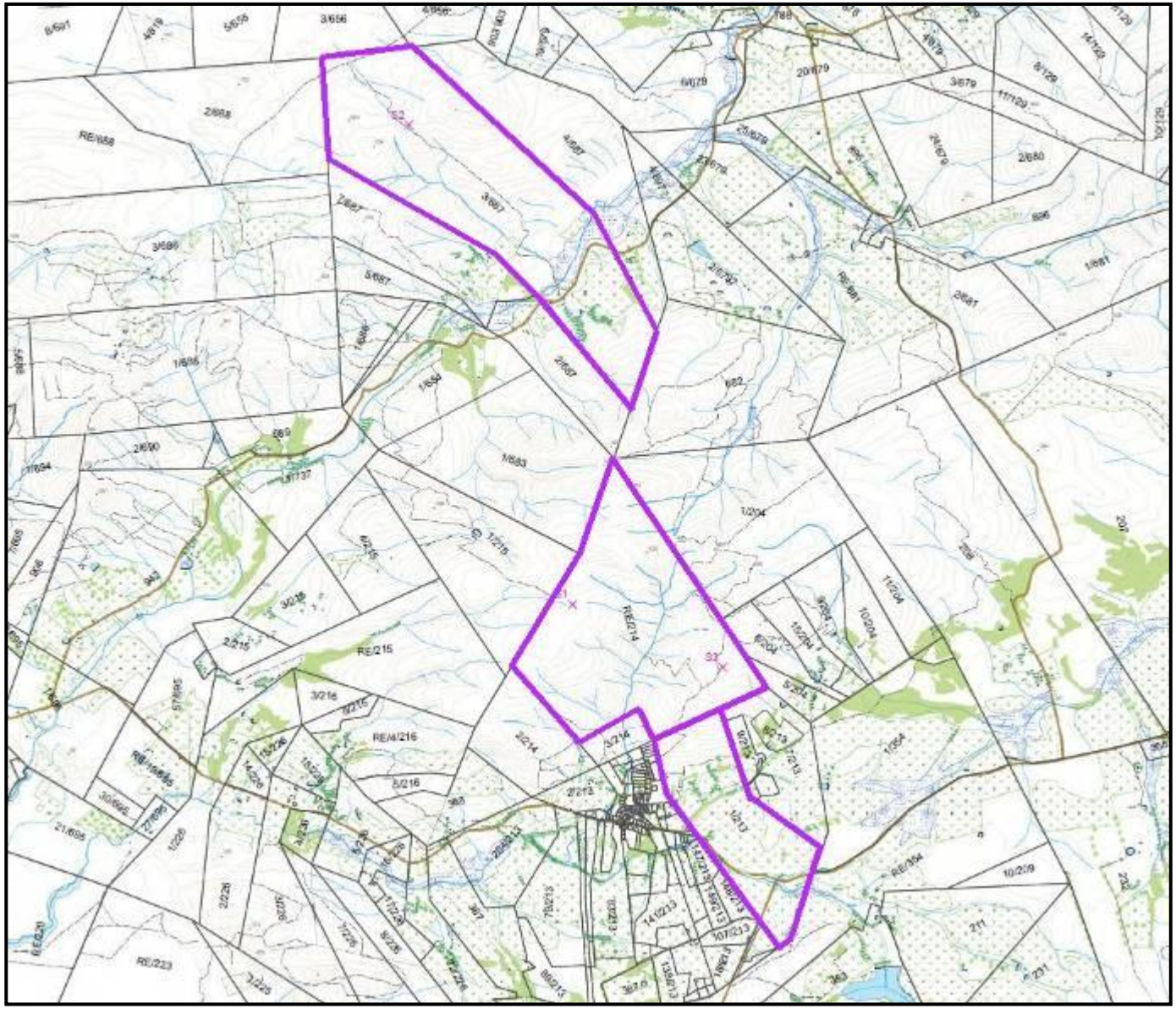


Figure 3. The location of the Driekop study area superimposed on portions of the 1: 50 000 topographical maps 3419 BC Jongensklip and 3419 DA & DC Baardskeerdersbos (Chief Directorate: National Geo-Spatial Information). (Base map supplied by RES).

Figure 4. Aerial photo from Google Earth © with the three portions of the Driekop study area outlined in yellow, red and blue, relative to nearby towns and landmarks.

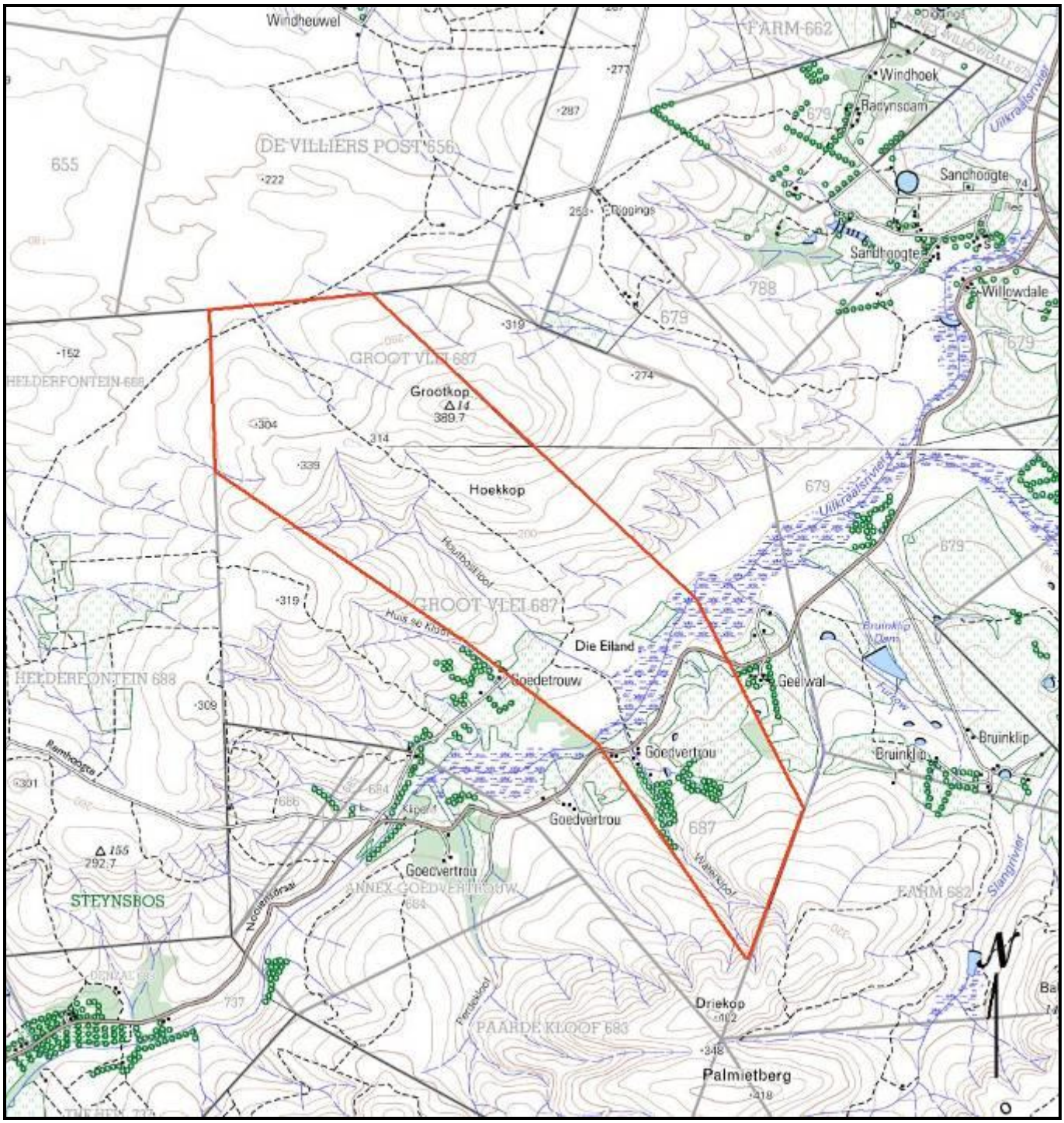


Figure 5. Topographic map of Grootvlei 687/3 (outlined in red), part of the Driekop Study Area, (part of 1: 50 000 map 3419 BC, DA & DC from Chief Directorate: National Geo-Spatial Information)

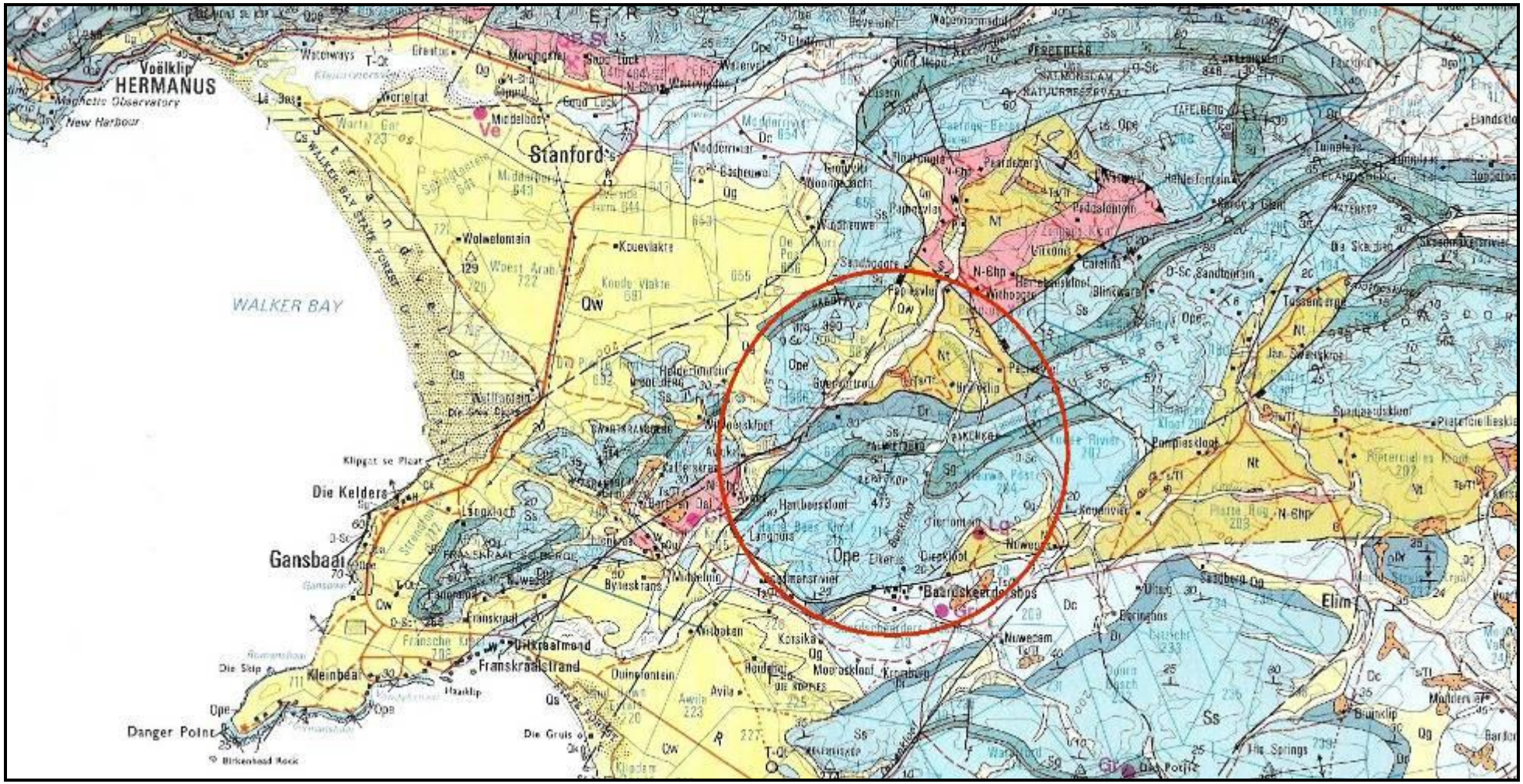


Figure 6. Geological map of the Gansbaai Area with the Driekop Study Area contained in the red circle – the blue areas OPE are Peninsula Formation Sandstone, the yellow areas QW are Bredasdorp Formation limestone and the light grey areas Dr are ferricrete. (Portion of 1:250 000 Geological Map 3319 Worcester, Geological Survey of South Africa).

3.2 Geology, soils and topography

Geology, soils, and topography coupled with climate are the principal determinants of the vegetation found in an area. These 'principal components' occur in gradients across the landscape and result in the variation found in the natural vegetation cover. The farm Grootvlei 687/3 falls within the Syntaxis Domain of the Cape Fold Belt as described by Hälbich (1983) where the folds are north and north-west vergent, compressed and faulted and are characterised by a 'complex interplay of box folds and buckles formed by compressive stress' (Söhnge & Hälbich, 1983) (see also Gresse & Theron, 1992).

The farm Grootvlei 687/3 has a complex geology. At the highest point, near Grootkop in the west, the rocks consist of grey-white quartzitic sandstone of the Peninsula Formation as at Baardskeerdersbos 214/RE. As one proceeds eastwards and descends into the Uilkraals River valley sediments of the Waenhuiskrans Formation (Bredasdorp Group) are encountered. According to Gresse & Theron (1992) citing Malan (1989) this a semi-consolidated aeolianite consisting of cream-coloured, porous, cross-bedded dune sands with shell grains and calcrete lenses. It therefore cannot be described as limestone but it is more alkaline than the leached sandstone-derived soils of the Peninsula Formation. In the bottomlands of the Uilkraals River valley are sandy soils purportedly of the Strandveld Formation (Bredasdorp Group) (Roberts *et al.* 2006). On the north-west facing slopes east of the Uilkraals River shales of the Brandwacht Formation (Malmesbury Group) are found and above this sequentially sandstone of the Rietvlei Formation (Nardouw Sub-group, Table Mountain Group) and on the high ridges, Peninsula Formation sandstone (Table Mountain Group). Cederberg Formation shale occurs in a narrow band across the west-facing slopes below Grootkop near the west boundary of Grootvlei 687/3. A portion of the 1:250 000 Geological Series Map Sheet 3319 Worcester is given in Figure 6, however, for more detail and the legend, the full map with accompanying explanation booklet (Gresse & Theron, 1992) should be consulted.

4. Evaluation Method

The field-evaluation of the study area took place over a 3-day period in October 2010. This was in early summer and contrary to the view that it may have been the 'wrong season' for assessing the fynbos vegetation it was indeed ideal. Many of the winter-flowering plant species were in the last stages of flowering whereas many of the later flowering species were only beginning to show signs of flowering.

At Grootvlei 687/3 a mountain road exists from the Uilkraals River valley north-westwards through the property (Figure 5). This road provided access to the study area. On the high ridge west of Grootkop (in the vicinity of the wind-monitoring mast location) the vegetation survey was conducted on foot. Tracks followed either by vehicle or on foot were recorded by using a hand-held Garmin ® GPS and at selected waypoints notes and photographs of the terrain, vegetation and flora were compiled following standard procedures for biological surveys of this nature.

5. Disturbance regime

An extensive wild-fire occurred in the Southern Overberg in February 2006. Grootvlei 687/3 was affected. The vegetation is thus almost 5 years old and is at a stage where the effects of the fire are less obvious than in the early period following a fire. The vegetation has good cover and the early post-fire ephemeral plant species (particularly Asteraceae) have become less prominent. The vegetation is therefore in a suitable state for floristic evaluation.

Flower-harvesting also takes place at Grootvlei 687/3. This appears to be mainly in taking place on the lower west-facing slopes (west of Grootkop) in proteoid vegetation. No details of plant species harvested and amounts (kg) were available to the author. In general, however, this impact appears to be controlled and the flower-harvesting sustainable.

One main mountain track runs from the Goedvertrou Farm in the Uilenkraals River valley up the south-east-facing slopes north-east of Houtboskloof and south to south-west of Grootkop, a prominent peak in the area (Figure 5). (This track gives access to the RES test mast site west of Grootkop). The track is generally in fair condition but is badly eroded in the mid to lower south-east section. The original ‘old’ road has been abandoned and a ‘new’ track created. The ‘old’ road has been allowed to ‘restore’ but has not been actively rehabilitated. The vegetation on the ‘old’ road escaped the last fire and is therefore older than the vegetation on the surrounding slopes (Figure 7).

The sandy soil (as seen in Figure 7) is susceptible to erosion and mountain tracks and roads would be required for the construction of wind-turbines. The existing road and any new roads at Grootvlei 687/3 would require careful planning, construction, and maintenance to prevent negative effects such as gully erosion (dongas).

Figure 7. Mountain track through the 'centre' of Grootvlei 687/3. The disused eroded 'old' track, now re-vegetating is located immediately on the left side. The vegetation in the old track was not burnt in the last fire.

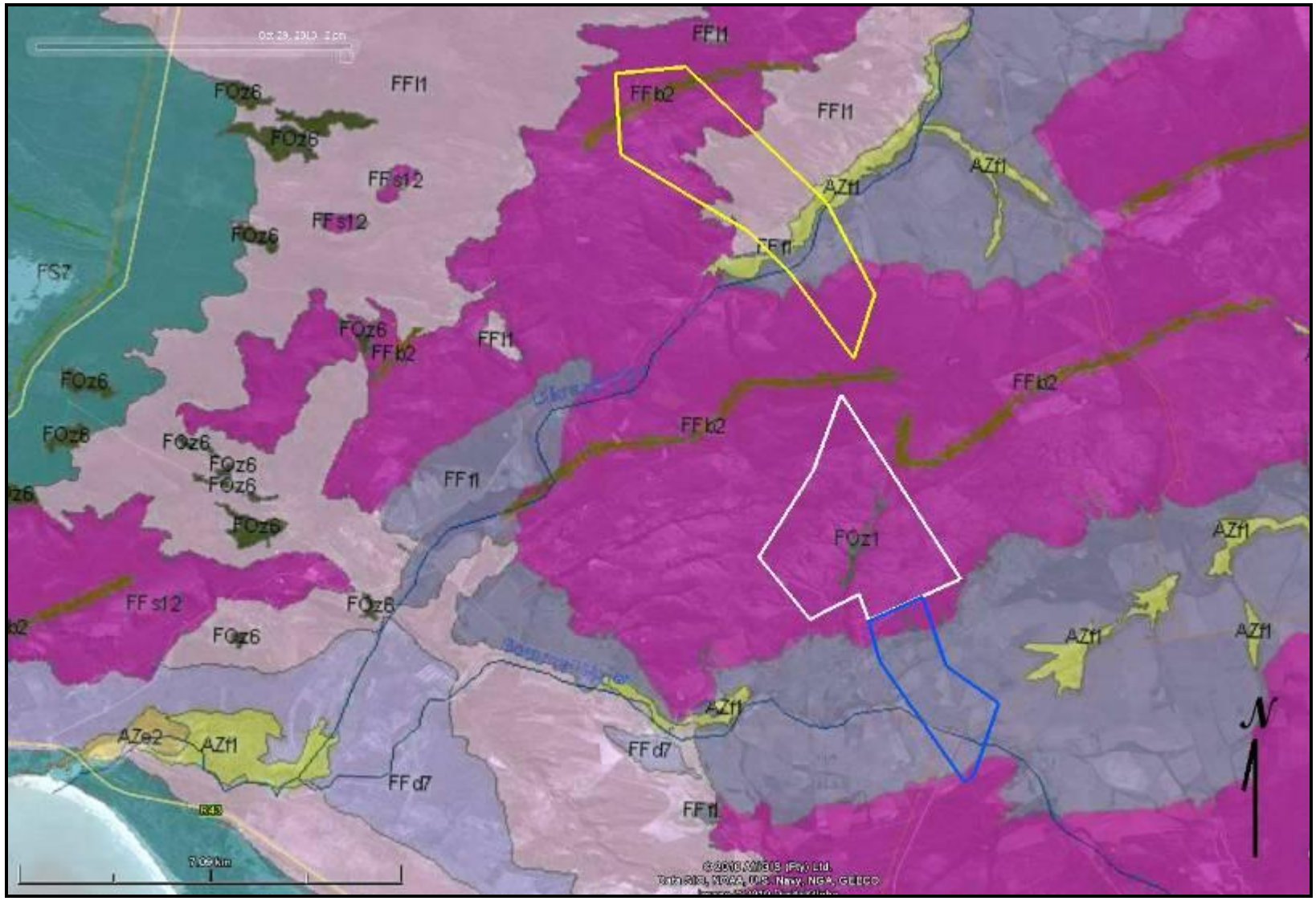


Figure 8. Portion of the National Vegetation Map (Mucina *et al.* 2005) with the study area superimposed. The yellow outline is Grootvlei 687/3 (the white outline is Baardskeerdersbos 214/RE and the blue outline Baardskeerdersbos 213).

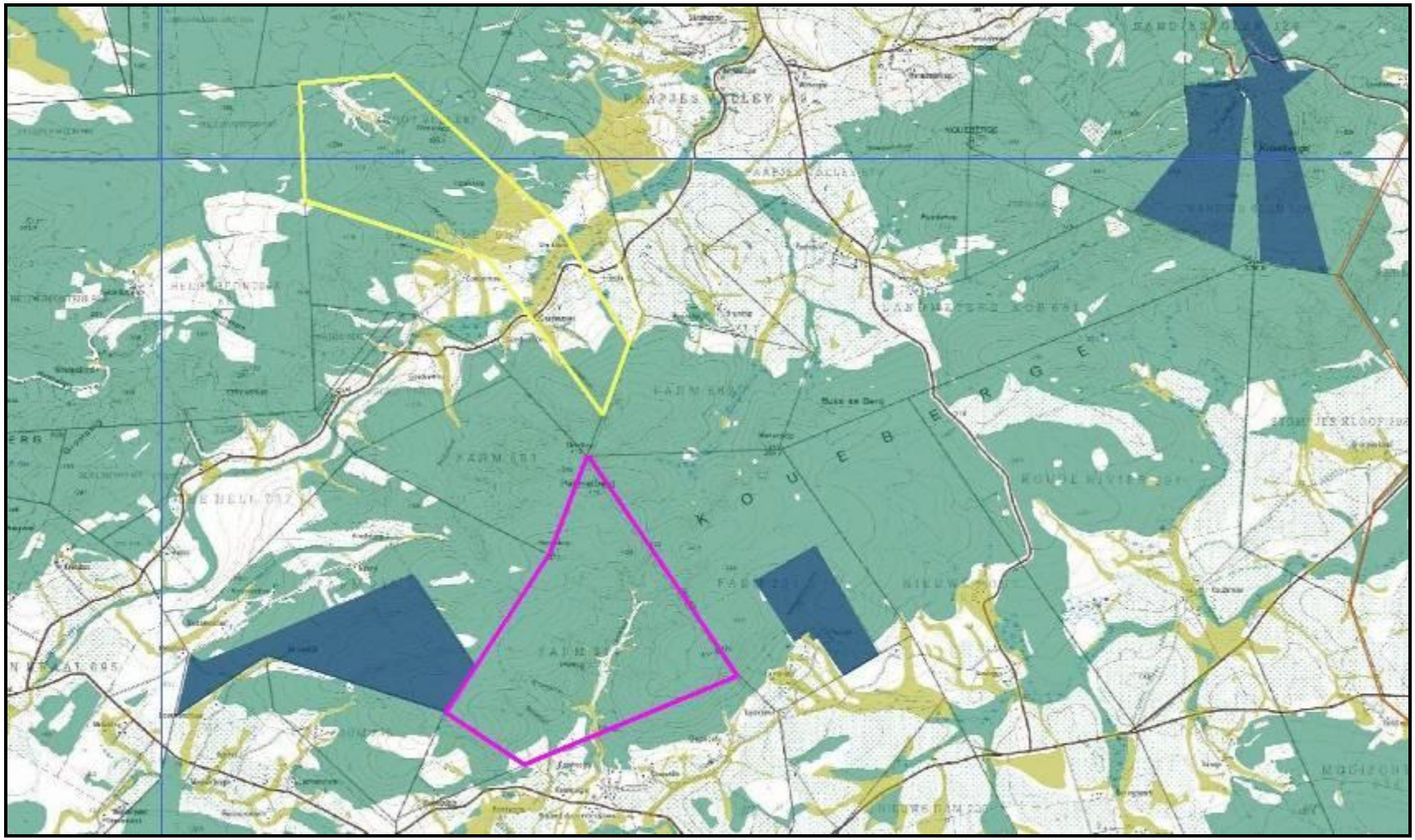


Figure 9. Part of the Critical Biodiversity Areas map compiled by Holness & Bradshaw (2010) with Grootvlei 687/3 shown by the yellow outline (and Baardskeerdersbos 214/RE shown by the pink outline). The green areas are Critical Biodiversity Areas, the yellow areas, Ecological support areas, the white areas are transformed areas and the dark blue areas are proclaimed conservation areas.

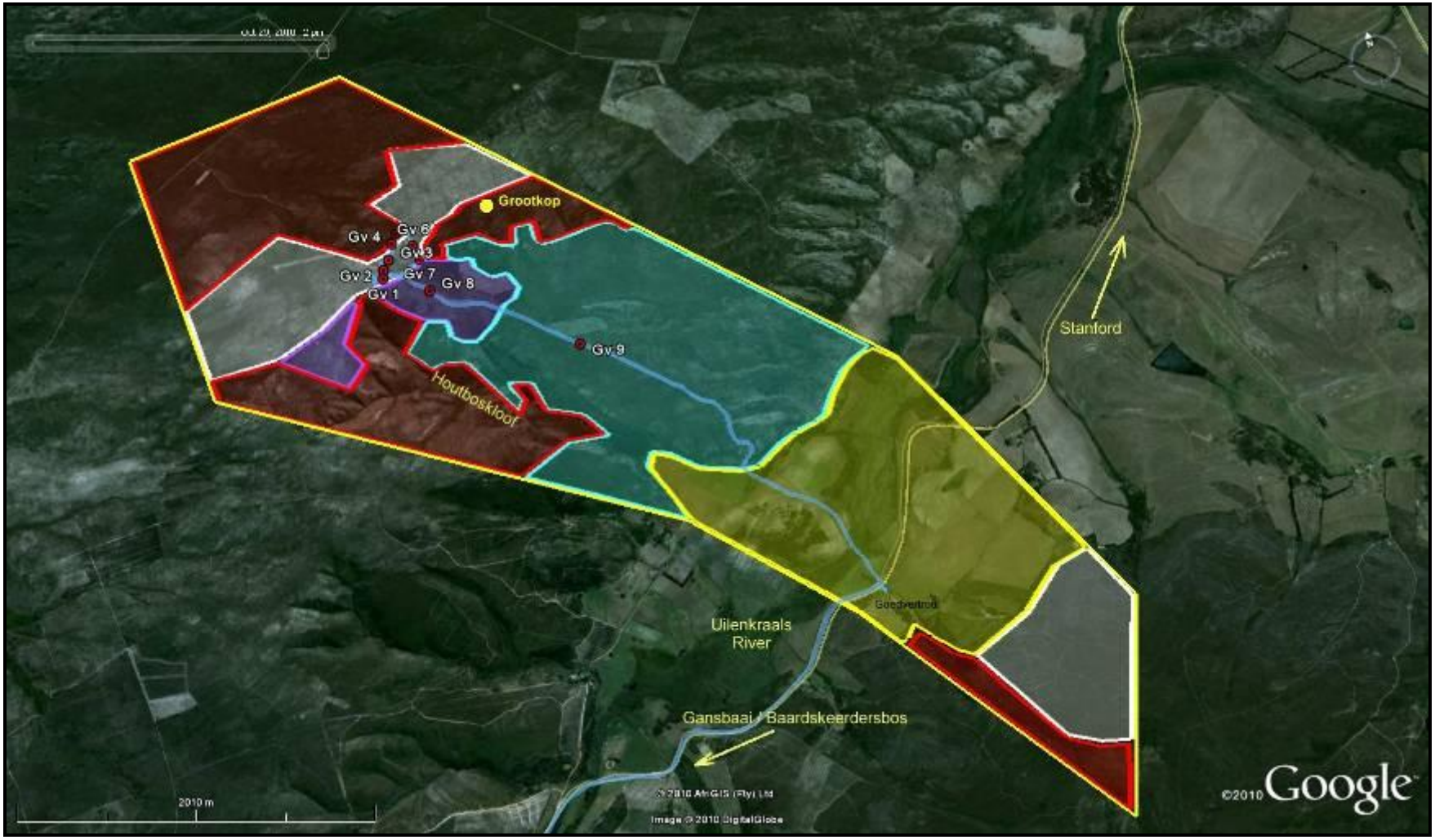
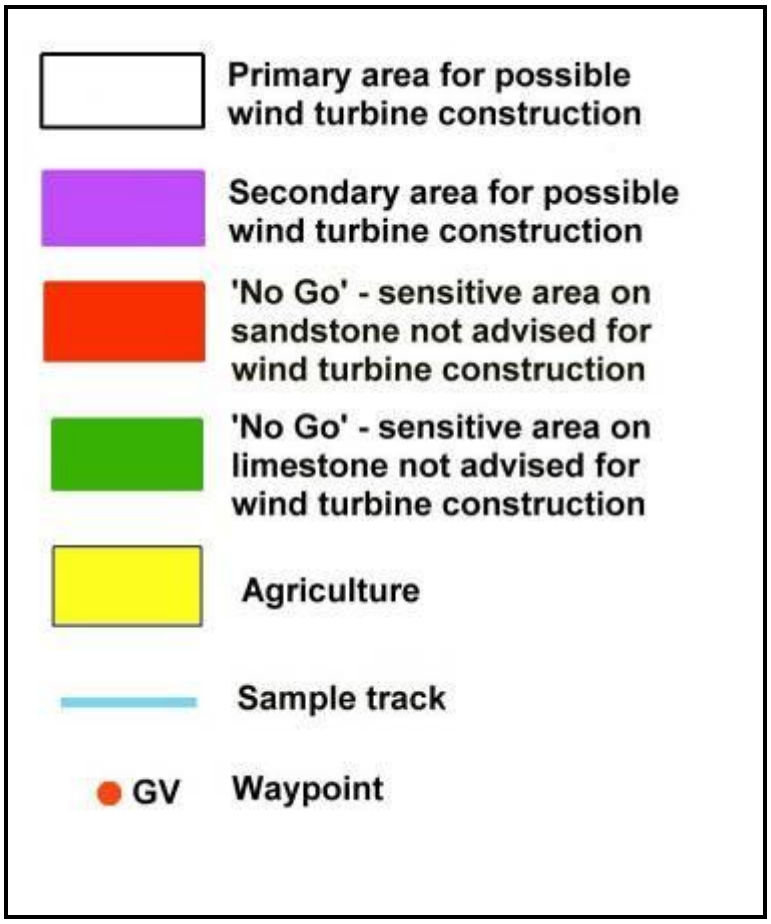


Figure 10. Constraints map of Grootvlei 687/3 based on the ecological assessment (for legend see overleaf)

Legend for Figure 10.



6. The Vegetation

The vegetation at Grootvlei 687/3 varies due to the greater number of different substrates. Mucina *et al* (2005) mapped five different vegetation types at Grootvlei 687/3. Of these the Elim Ferricrete Fynbos east of the Uilenkraals River has been completely converted to agricultural lands. The azonal riparian vegetation is also largely disturbed by agricultural practices. That leaves areas of Agulhas Limestone Fynbos on the lower east-facing slopes and areas of Overberg Sandstone Fynbos at the north-west and south-east ends of the elongate property. The north part of Grootvlei 687/3 was sampled and has typical Overberg Sandstone Fynbos. In addition to the sandstone fynbos in the north there is a 'shaleband' consisting of Cederberg Formation shale. This supports Western Coastal Shaleband Vegetation (Rebelo *et al.* 2006).

6.1 Overberg Sandstone Fynbos

The field-survey was concentrated in the area near and to the north-east of the site of the RES wind test mast (waypoint GV1: S 34° 29' 57.5" E 19° 32' 07.7") (Figure 10). The vegetation is low to mid-high closed restioid shrubland (< 1m) with *Phaenocoma prolifera* emergent to 1.5 m. It occurs on grey-white, leached (acid) sandy soil as seen at the soil-test site (Figure 11). Near the soil-test site is a rocky sandstone ridge typical of the area and the plant community grades from slightly deeper soils of the low-lying non-rocky areas with more restios to shallow soils amongst the rocks where shrubs are more prevalent. No further distinction is made between these microhabitats. The vegetation appears mature but it is uncertain whether this area burnt in the last fire (February 2006). It is also possible that the rocky habitat did not burn due to its fire-protected character (Figure 25). Plant species recorded include *Adenandra viscida, Agathosma bifida, Arctotis acaulis, Aspalathus retroflexa, Aulax umbellata, Bobartia longicyma subsp. magna, Carpobrotus acinaciformis, Cassytha ciliolata, Centella cf. difformis, Cliffortia sp., Corymbium glabrum, Crassula fascicularis, Cymbopogon marginatus, Edmondia sesamoides, Ehrharta sp., Elegia juncea, Erica cerinthoides, Erica corifolia, Erica plukenetii subsp. lineata, Erica sessiliflora, Erica viscaria, Liparia splendens, Gnidia cf. tenella, Hypodiscus albo-aristatus, Hypodiscus aristatus, Leucadendron salignum, Leucadendron xanthoconus, Leucospermum prostratum, Lobelia pinifolia, Metalasia sp., Mimetes cucullatus, Morella quercifolia, Oedera capensis, Osyris speciosa, Oxalis sp., Passerina ericoides, Pelargonium elegans, Pelargonium myrrhifolium, Penaea mucronata, Pentameris macrocalycina, Phaenocoma prolifera, Phylica cf. imberbis, Polygala garcinii, Protea cynaroides, Protea speciosa, Serruria adscendens, Staavia radiata, Staberoha distachyos, Struthiola sp., Syncarpha gnaphaloides, Tetraria cuspidata, Tetraria thermalis, Thamnochortus fruticosus, Ursinia cf. nudicaulis* and *Watsonia schlechteri.*

Figure 11. Soil test pit (covered) fro the wind test-mast west of Grootkop at Grootvlei 687/3 (waypoint GV1). Note the surrounding low fynbos with emergent *Phaenocoma prolifera* shrubs.

Figure 12. The rocky sandstone ridge sampled at waypoint GV1.

The area around waypoint GV2 (S 34° 29' 56.0" E 19° 32' 08.3") is not on a rocky ridge but there are many boulders and stones on the soil surface. The plant community is essentially the same as that described above around waypoint GV1 (Figure 10), with mostly the same species, except that there is much more *Leucadendron xanthoconus* – it is the dominant proteoid shrub (Figure 13). Additional species recorded here include *Bulbine sp., Chironia linoides, Dimorphotheca nudicaulis, Erepsia anceps, Erica ampullaceal, Erica muscosa, Euphorbia tuberosa, Myrsine africana, Passerina corymbosa, Protea longifolia, Roella ciliata,* and *Wachendorfia paniculata.*

Figure 13. The area west and below Grootkop at waypoint GV2. Note the *Leucadendron xanthoconus* forming an upper shrub stratum above the low restioid-ericoid stratum.

Some areas between waypoints GV2 and GV3 (S 34° 29' 54.4" E 19° 32' 10.0") (Figure 10) are open and much more grassy (*Pentaschistis curvifolia* and *Pentameris* sp.). This may have resulted from the fire-pattern but it also appears to be associated with soil conditions i.e. deeper sandy soil (Figure 14). Geophytic species such as *Lachenalia rosea* (Figure 15)*, Pelargonium triste* and *Disa graminifolia* (Figure 16) were found here.

At waypoint GV4 (S 34° 29' 51.7" E 19° 32' 11.7") an old stand of fynbos that obviously escaped the last fire was found (Figure 17). Characteristic of this location were the large (2 m tall) plants of *Leucadendron xanthoconus* as well as old plants of *Erica plukenetii* subsp. *lineata* and *Brunia laevis*.

Figure 14. Open, grassier area in the fynbos shrubland between waypoints GV2 and GV3.

Figure 15. *Lachenalia rosea*

Figure 16. *Disa graminifolia*

Figure 17. Remnant of old, mature fynbos below Grootkop that escaped the last fire (waypoint GV4).

6.2 Western Coastal Shaleband Vegetation

The shaleband on Grootvlei 687/3 runs across the west-facing slopes below Grootkop. It was not specifically sampled in this survey but the vegetation does not differ markedly from the sandstone-associated vegetation. It is mostly mid-high proteoid vegetation with *Leucadendron xanthoconus* once again a prominent species.

6.3 Agulhas Limestone Fynbos

Agulhas Limestone Fynbos is mostly along the coastal foreland from Hermanus to Struisbaai but in some cases Bredasdorp Formation limestone is found well away from the coast as is the case at Soetanysberg near Bredasdorp and in Uilenkraals River valley where it occurs on Grootvlei 687/3 and adjacent farms sandwiched between ferricrete sediments and sandstone. Only one sample in the area mapped as Agulhas Limestone Fynbos (Mucina *et al.* 2005, Figure 8) on Grootvlei 687/3 was taken in the present survey at waypoint GV9 (S 34° 30' 19.9" E 19° 32' 45.9"). This waypoint is on the track and the surrounding vegetation is a mid-high to tall (1 – 1.2m) closed ericoid shrubland dominated by *Erica muscosa* and numerous Restionaceae (Figures 18 & 19). Other notable shrubs were *Staavia radiata* and *Aspalathus callosa*. This vegetation covers a wide area on the mid to lower east- to south-east-facing slopes but was not sampled in extensively enough in this survey to characterise the plant communities. However, it is well-documented that limestone fynbos has a high plant species diversity harbours numerous endemic species. Therefore despite the lack of detail available here this vegetation type on Grootvlei 687/3 has high conservation value and the area where it occurs should be precluded from any plans determining where wind-turbines may be located (see Figure 10). If there is a pressing need to consider this area for possible location of wind-turbines, further vegetation sampling would be necessary to obtain detailed information on the plant communities.

Figure 18. View south-westwards over uniform restioid-ericoid shrubland on alkaline soils in the area mapped as Agulhas Limestone Fynbos on Grootvlei 687/3.

Figure 19. Exposed profile of the sandy, alkaline soils of the Agulhas Limestone Fynbos on Grootvlei 687/3.

6.4 Agricultural lands and azonal vegetation

Agricultural activity at Grootvlei 687/3 has been mostly confined to the lower slopes in the Uilenkraals River valley. All the ferricrete soils have been ploughed and the Elim Ferricrete Fynbos has been lost. The azonal riparian communities in the valley have also been impacted to a certain extent and these communities were not specifically investigated.

6.4.5 Species of importance

No species with threatened or rare status were located in the samples of Overberg Sandstone Fynbos recorded at Grootvlei 687/3. This is not to say that such species do not occur and the precautionary principle should be applied here as well.

In the cases of the Western Coastal Shaleband vegetation and Agulhas Limestone Fynbos both were not optimally sampled and endemic, rare and possibly threatened species are likely to occur there. However, both these areas have been screened out as possible areas for consideration for construction of wind-turbines which significantly reduces the risk of impacting endemic or rare species.

6.6 Alien invasive vegetation

The vegetation in the study area at Grootvlei 687/3 is in reasonably good condition on the mountain slopes where there is low infestation by alien invasive species. On the west-facing slopes below Grootkop there is, however some dense infestation by Acacia *saligna* (Port Jackson Willow). At waypoint GV5 (S 34° 29' 50.2" E 19° 32' 13.2") a strong invasion of *A. saligna* was found which apparently resulted from disturbance caused by ploughing when the local farmers attempted to make a fire-break when fighting the last wild-fire in the area (Figure 20). Subsequent attempts were made to eradicate the *A. saligna* but these have been abandoned. *Pinus radiata* occurs scattered on the sandstone slopes but not in large numbers.

The greatest infestation of alien invasive trees and shrubs is on the lower east- and south-east slopes near the Uilenkraals River as well as in the side valleys. In these areas *Acacia* spp., *Hakea drupacea,* and *Leptospermum laevigatum* (Australian myrtle) are all present.

Any disturbance caused by possible new roads and opening of sites for wind-turbines would be potential sites for invasion by woody alien invasive species. Extreme care must be taken to not import the seed of invasive alien species into the area in building sand and other materials. Post-construction monitoring would also be necessary to ensure that any alien plants that may grow are eradicated.

Figure 20. Aggressive invasion by Acacia saligna (Port Jackson Willow) of disturbed areas in the fynbos on the west-facing slopes below Grootkop on Grootvlei 687/3.

7. Biodiversity processes

7.1 Key ecological drivers

7.1.1 Fire

Within the past five to six years there have been large wild-fires in the Southern Overberg, some of which have affected Grootvlei 687/3. Although necessary for the regeneration of the fynbos it appears, high frequency and fires in the 'wrong' season are detrimental to the vegetation. From the fair to good condition of the vegetation at Grootvlei 687/3 it appears the fire of February 2006 has had a positive outcome on the vegetation.

7.1.2 Pollination

Pollination of the fynbos species by wind, birds, insects, and small mammals is active at Grootvlei 687/3. Wind-pollinated Restionaceae are common, bird-pollinated *Erica* and *Protea* species are well-represented and numerous insect-pollinated species e.g. in the Asteraceae and Rutaceae are found. *Erica ampullacea* (Figure 34), a species pollinated by long-proboscid flies (Cowling & Richardson, 1995) was found at both Baardskeerdersbos 214/RE and Grootvlei 687/3. *Protea aspera* (Figure 35) and *Protea*

cordata, both low-growing 'ground-proteas', pollinated by rodents were found at Baardskeerdersbos 214/RE. The healthy populations of the constituent plant species indicate a healthy interaction with pollinators. Any negative influence on these interactions such as fragmentation of the plant populations by roads and other infrastructure should be avoided.

Figure 21. *Erica ampullacea*

Figure 22. *Protea aspera*

7.2 Human activities and impacts

Two principal impacts resulting from human activity in the study area have been identified: (1) Agricultural activities – ploughing, flower-cultivation and grazing and (2) flower-harvesting.

At Grootvlei 687/3 most of the agricultural activities are confined to pastures and dairy-farming in the Uilenkraals River valley. A limited amount of ploughing has occurred in the mountain catchments where there have been some attempts to establish orchards of fynbos plants for the cut-flower trade. Most of the impact in this area is from harvesting of wild flowers and "greens" from the natural fynbos populations, mostly on the western slopes below Grootkop. There is no evidence of grazing in the fynbos vegetation and as stated above the vegetation is in fair to good condition.

In the long-term wild-flower harvesting could have a negative effect on the vegetation in these mountain catchments but at present it appears that this practice is being pursued on a sustainable basis.

8. Constraints Assessment and Conservation Value

The recently compiled Critical Biodiversity Areas Assessment for the Overberg District Municipality together with the Critical Biodiversity Areas map (Figure 11) shows that large areas of Grootvlei 687/3 (specifically the areas not transformed by agriculture) are classified as critical biodiversity areas (CBA's) or ecological support areas (ESA's) (Holness & Bradshaw, 2010). These areas have now been assigned a high conservation status and the general 'rule of thumb' is that development should be discouraged in these areas. In the published list of threatened ecosystems in South Africa (Government Gazette No 32689, 6 November 2009), Overberg Sandstone Fynbos is listed as Critically Endangered D1, with Agulhas Limestone Fynbos is listed as Vulnerable D1. The D1 criterion indicates that the vegetation contains threatened species associations. This further 'red flags' the areas under consideration in this study and consequently the whole of the study area is treated as being sensitive and conservation-worthy.

Notwithstanding the above classifications, the present assessment has obtained detailed data from the study area as described and attempts to provide information upon which decisions can be made as to whether it would be acceptable from an ecological and general environmental perspective to pursue the possibility of locating wind turbines in the designated area. The assessment is based mainly on the foregoing botanical description and the ecological constraints for Grootvlei 687/3 follow.

8.1 Constraints analysis – Grootvlei 687/3

Based on a qualitative 'sensitivity rating' Grootvlei 687/3 has been classified into the following areas (constraints mapped in Figure 10).

- The principal area where turbines could be constructed with the lowest impact in Overberg Sandstone Fynbos on Grootvlei 687/3 would be on the west-facing slopes below Grootkop, but above the shaleband (white area in Figure 10). Construction should be targeted on open slopes and preferably not on rocky outcrops. Any seeps and

drainage lines (watercourses) would also have to be avoided and buffered. (This accounts for the irregular boundary on the north-west limit of the white area in Figure 10). The other principal area that could be considered is east of the Uilenkraals River and east of the agricultural lands adjacent to the south boundary of the Grootvlei 687/3 property.

- The secondary area for turbine construction would be a limited area on sandstone substrates on the south-east side of the watershed west of Grootkop (purple areas in Figure 10).

- The red areas ('No Go') in Figure 10 are areas on sandstone substrates considered sensitive and ecologically unsuitable for construction of wind-turbines. This is based on an assessment of the topography (steep slopes) and / or the sensitivity of the vegetation. The area north and west of waypoint GV4 contains the Western Coastal Shaleband vegetation which should not be impacted. A narrow 'red area' is also found at the south end of the property – this area contains a kloof and drainage into the Uilenkraals River.

- The extensive green area (Figure 10) in the central part of the Grootvlei 687/3 study area consists of Agulhas Limestone Fynbos. Although not extensively surveyed in this study enough botanical and ecological information exists in published literature to 'red flag' this area as sensitive and from the outset to consider it a 'No Go' area.

- The yellow area (Figure 10) is mostly transformed by agriculture or is heavily invaded by alien invasive woody plants. This area also contains the azonal riparian vegetation along the Uilenkraals River.

9. Conclusions

The farm Grootvlei 687/3 is located in botanically and ecologically sensitive ecosystems. The property has been mapped as containing large tracts of CBA's in recently produced maps of Critical Biodiversity Areas in the Overberg District Municipality and have been included within threatened ecosystems in the most recently published draft national list. These are immediate constraints on any proposed developments in these areas. Further fine-scale botanical and ecological information on the specific areas has been collected in the present study and the data support the view that these areas are highly botanically and ecologically sensitive. However, even though the areas are generally sensitive, an attempt has been

made to analyse the study area in such as way as to provide some guide as to the possibility of constructing wind-turbines on the two properties in question. A qualitative sensitivity rating was applied based on the author's experience and the data accumulated. The outcome of the 'constraints analysis' is presented in the form of a map that would focus any future consideration of the property for wind-farm development. Approximately 15% of Grootvlei

687/3 could be considered for the construction of wind-turbines. The other parts are either unsuitable sensitive 'No Go' areas or are transformed by agriculture.

It must be stressed that if applications are pursued to construct wind-turbines in the possible areas described above the precautionary principle must be invoked even though this study has concluded that some parts of the study area may be ecologically acceptable for wind-farm development. Fine-scale pattern in the vegetation will have a strong influence on the location of wind-turbines and 'micro-siting' (i.e. exact location of wind-turbine sites in an exhaustive field exercise) would be necessary in the planning phase to ensure that wind-turbines and access roads (for construction and maintenance) are placed in ecologically acceptable places even though they may be within a generally acceptable botanical / ecological zone.

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