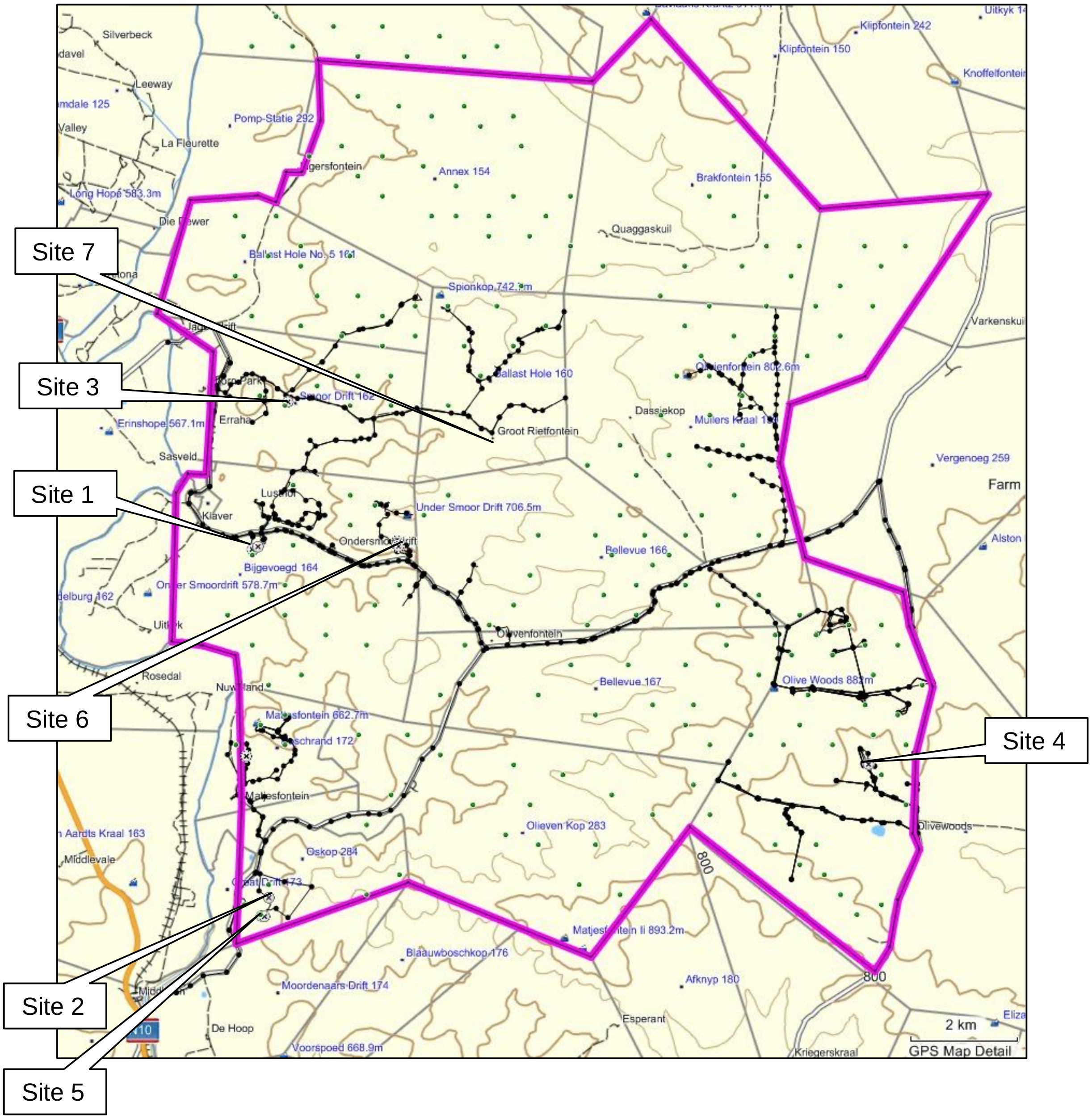

Figure 8-1. Locations of archaeological sites identified in the study area. Track logs are indicated by dark dotted lines.

8.2.2 Recommendations

Given that this study has taken place prior to the development of a draft layout for the wind farm infrastructure, the impacts that we have identified are of a general nature, which means that it will be necessary to review further information as it becomes available so that where necessary, archaeological sites can be mitigated. The following recommendations are offered.

- Turbines must be positioned in such a way that they are at least 500m away from farm complexes, most of which have a moderate degree of heritage significance.
- Turbines must be positioned in such a way that shadow flicker does not affect any farm complexes.
- Guarantees for demolition of turbines after their useful life must be in place as a condition of approval.

- Road alignments must be planned in such a way that the minimum of cut and fill operations are required.
- Existing farm tracks must be re-used or upgraded to minimise the amount of change to un-transformed landscape.
- In general terms, construction of turbines and roads in valley bottoms should be kept to a minimum.
- During the detailed planning phase, drawings of proposed road alignments, infrastructure and near-final turbine positions should be submitted to an archaeologist for review and field-proofing. Micro-adjustment of alignments and turbine positions is likely to be sufficient to achieve adequate mitigation.

8.3 Visual Impact Assessment

The following key findings were made from the Visual Impact Assessment which had the following limitations and assumptions:

- *Spatial Data Accuracy*: Spatial data used for visibility analysis originated from various sources and scales. Inaccuracy and errors are therefore inevitable. Where relevant, these are highlighted in the specialist report (refer to Chapter 6 in **Volume 2: Proposed Terra Wind Energy-Golden Valley Project: Specialist Reports (CES, July 2010**). Every effort was made to minimize their effect.
- *Viewshed Calculations*: Calculation of the viewsheds did not take into account the potential screening effect of vegetation and buildings. Due to the size and height of the wind turbines, and the relatively low thicket cover in the region, the screening potential of vegetation is likely to be minimal over most distances.
- *Simulated views and Photomontages*: In the specialist study, a *simulated view* was defined as a view generated by using 3D computer software using an elevation model and aerial photography. A *photomontage*, for the purposes of the specialist study, is a landscape photograph onto which images of the wind turbines are placed using software which maintains the accurate spatial positions of the turbines and their scale in relation to their distance from the point at which the photograph was taken. The photomontage images used in this report were done using landscape photographs taken specifically for this purpose. Simulated views were produced using 3D modelling software (Visual Nature Studio 3 from 3D Nature - http://3dnature.com/), and a digital elevation model (DEM) interpolated from 1:50 000 contours
- *Shadow flicker modelling*: The following standard assumptions are made when modelling shadow flicker:
    - The sky is 100% clear with no allowance for mist, fog or cloud.
    - Turbines are always rotating;
    - The rotor of the turbine is always orientated such that it is facing the receptor;
    - There is a 2 km limit to the human perception of shadow flicker;
    - The sun can be represented as a point light source;
    - With exception to the consideration of terrain there exists a clear line of site between sun, turbine and receptor. No allowance is made for any obstructions such as vegetation or buildings;
    - The sun must be 3 degrees above the horizon.

  This model is conservative and the impact from shadow flicker is normally lower than predicted by current models (Nielsen 2003).

8.3.1 Identification of Landscape Character Areas

The landscape character of the region is one of commercial agriculture dominated by stock farming in areas outside the Great Fish River floodplain and irrigated cultivation in the floodplain. The natural thicket and grassland have been transformed by grazing and most of the floodplain vegetation has been replaced with cultivated lands. The settlements in the region developed as service centres for the agricultural concerns. Several large roads dissect the region with the N10 a particularly busy route connecting Port Elizabeth with Gauteng. A network of high voltage power lines with large pylons radiate from the Poseidon Substation just north of the site and across the region.

A wind farm of this magnitude will alter the landscape character, but the fact that large structures related to electricity (power lines and pylons) already exist in the landscape (and has had a considerable influence on the aesthetic value of the landscape) makes it less sensitive to this change. It is also expected that current agricultural practices (i.e. stock farming) will be able to continue as before. The area has a low sensitivity to change in its character for this development type.

The following sensitive viewers or viewpoints were identified:

(a) Residents of Cookhouse
Residents are seen as highly sensitive to changes in their views since they have an interest in the landscape that surrounds them. The wind farm is more than 5km away from the town, though, and although there are residents who will potentially have views of many turbines it is unlikely that their views will be significantly altered.

(b) Residents on surrounding farms
Residents on farms surrounding the site (including those farms on which the wind turbines will be built) will be highly sensitive to changes in their views. Many existing views will be altered by introduction of the wind farm into the landscape, especially those of residents in close proximity to the wind farms.

(c) Scenic viewpoints
There are few viewpoints in the region with views on the wind farm which will not also include power lines and major roads. The Glen Avon Falls Natural Heritage Site is approximately 20km north-west of the nearest wind turbine and it's unlikely that any viewpoints will have views of the wind farm.

(d) Protected areas
There are no protected areas of Type 1 or 2 as defined by STEP, and only two game farms (Type 3) within 20km of the wind farm area. The two game farms, Dorn Boom and East Cape, are further than 5km away and show only low visibility.

(e) Motorists
Views from the N10 towards the wind farm will be affected and some views (especially close to Cookhouse) will include many turbines. The other major roads in the area will be much less affected.

8.3.2 Conclusions

The potential visual impacts of the proposed Terra Wind Energy-Golden Valleye Project which were assessed using a number of criteria which provide the means to measure the magnitude and determine the significance of the potential impact (Oberholzer 2005) including:- the **visibility** of the project - an indication of where in the region the development will potentially be visible from. The rating is based on viewshed size only and is an indication of how much of a region will potentially be affected visually by the development. A high visibility rating does not necessarily signify a high visual impact, although it can if the region is densely populated with sensitive visual receptors; **Viewer (or visual receptor) sensitivity** - a measure of how sensitive potential viewers of the development are to changes in their views. Visual receptors are identified by looking at the development viewshed, and include scenic viewpoints, residents, motorists and recreational users of facilities within the viewshed. A large number of highly sensitive visual receptors can be a predictor of a high **intensity/magnitude** visual impact although their distance from the development (measured as **visual exposure**) and the current composition of their views (measured as **visual intrusion**) will have an influence on the significance of the impact yielded the results encompassed in Table 8-7 below.

Table 8-7: Summary of the Visual Assessment Criteria for the Proposed Terra Wind Energy-Golden Valley Project

Criteria	***Impact***
Viewer Sensitivity	Residents of Cookhouse – Highly sensitive to changes in their views. Residents on surrounding farms – Highly sensitive Scenic viewpoints and protected areas – Highly sensitive Motorists – Low sensitivity due to short exposure time and the fact that their focus on landscape is reduced.
Visibility of Development	High
Visual Exposure	Residents of Cookhouse – Medium to low (more than 5km away). Residents of surrounding farms – High for residents in the wind farm area and a couple of residents just outside since they live within 2km of the nearest wind turbine. Scenic viewpoints – high on ridges near turbines (e.g. ridges on northern and southern boundary of wind farm area). Protected areas – low due to their distance from the wind farm. Motorists – medium for N10 and parts of R63, low for other major roads.
Visual Intrusion	Residents of Cookhouse – Low due to their distance from the wind farm. Residents on surrounding farms – High for some due to their proximity to the wind farm. Scenic viewpoints – low due to their distances from the wind farm. Protected areas – Low due to their distances from the wind farm. Motorists – Moderate for motorists on the N10 and low for motorists on other major roads.

The landscape impact which will potentially occur as a result of establishing a wind farm in a rural landscape is expected to be of low significance due to the moderate landscape character sensitivity of the region. It is expected that stock farming will not be altered by introduction of wind turbines in the area. However, this is a large wind farm and the landscape will be affected, especially initially when the wind farm is still a new feature in the landscape.

The visual impact on sensitive viewers and viewpoints due to the construction phase of the proposed project is expected to be high due to the high intensity of the impact on sensitive viewers. However, this impact is not necessarily negative as the assembly of turbines will most likely be a fascinating spectacle due to the size of the components being assembled.

The visual impact on sensitive viewers and viewpoints due to the operational phase of the proposed project is expected to be high due to the dimensions of the turbines and their potential visibility in the region. It is not clear whether the change in the views of sensitive viewers will be perceived as positive or negative since opinions on the aesthetics of wind farms differ radically.

The wind farm will alter a number of views due to its size (spatial extent and the height of the turbines) and visibility (located on ridges). There are a few visual receptors (viewers and viewpoints) for which the visual intrusion will be very high (residents living on or close to the wind farm area), although many of these have agreed to have turbines on their properties. Please refer to Table 8-8 for a list of buildings with potential high visual exposure to the proposed Terra Wind Energy-Golden Valley Project.

The impact of shadow flicker caused by wind turbines appears to be a minor issue in most countries where wind farms are common. There is no official set of regulations governing the levels of exposure to shadow flicker, and it is unclear what the health risks are. Most reports on shadow flicker suggest that the threshold for a significant impact is 30 hours per year or more and many countries have adopted this as an informal regulation.

Table 8-8: Buildings with potentially high visual exposure to the wind farm. The first four (highlighted) are closer than 500m to a wind turbine

FARM NAME	MINIMUM DISTANCE	LONGITUDE	LATITUDE
KLEIN RIET FONTEIN (167/1)	322.85	25.884770	-32.895023
FARM (283/R)	346.35	25.873459	-32.919221
WELTEVREDE (292/R)	354.57	25.845132	-32.816215
MULLERS KRAAL (159/1)	425.91	25.914541	-32.858723
OUDE SMOOR DRIFT (164/40)	515.21	25.852741	-32.878613
OLIVE WOODS ESTATE (169/R)	543.31	25.973016	-32.926642
QUAGAS KUYL (155/R)	562.88	25.908846	-32.826314
KLEIN RIET FONTEIN (167/R)	571.51	25.888494	-32.895983
WAGENAARSE DRIFT (172/R)	645.45	25.835601	-32.920256
VAN AARDTS KRAAL (163/2)	720.10	25.825309	-32.912126
OUDE SMOOR DRIFT (164/37)	762.18	25.837111	-32.871241
OUDE SMOOR DRIFT (164/43)	863.04	25.828901	-32.875798
VAN AARDTS KRAAL (163/3)	878.16	25.823827	-32.936239
GREAT RIET FONTEYN (160/R)	916.06	25.886269	-32.859162
VAN AARDTS KRAAL (163/9)	922.67	25.824817	-32.938188
SMOOR DRIFT (162/12)	986.46	25.827325	-32.851746
OUDE SMOOR DRIFT (164/33)	995.82	25.827571	-32.875335
MIDDELBURG (162/4)	1072.20	25.827873	-32.903164
OUDE SMOOR DRIFT (164/17)	1075.62	25.825826	-32.875984
SMOOR DRIFT (162/16)	1088.59	25.825110	-32.841104
OUDE SMOOR DRIFT (164/18)	1103.30	25.826480	-32.874986
GEZHIRET (161/6)	1178.90	25.823022	-32.839438
LEUWE DRIFT (153/R)	1199.68	25.835190	-32.780664
MOORDENAARS DRIFT (174/1)	1210.68	25.827656	-32.951000
LEUWE DRIFT (153/4)	1252.91	25.834246	-32.780501
MIDDELBURG (162/2)	1270.83	25.821918	-32.903750
JAGERS DRIFT (121/46)	1273.46	25.820583	-32.819332
SMOOR DRIFT (162/1)	1323.94	25.829013	-32.863251
OUDE SMOOR DRIFT (164/11)	1376.85	25.821950	-32.880085
VAN AARDTS KRAAL (163/16)	1380.71	25.820074	-32.938955
SMOOR DRIFT (162/7)	1422.18	25.822592	-32.845681
OUDE SMOOR DRIFT (164/5)	1440.19	25.821050	-32.879434
SMOOR DRIFT (162/9)	1457.43	25.822462	-32.845386
GEZHIRET (161/4)	1472.31	25.817631	-32.831022
MIDDELBURG (162/5)	1539.20	25.820009	-32.903518
OUDE SMOOR DRIFT (164/2)	1556.98	25.819052	-32.880657
OUDE SMOOR DRIFT (164/24)	1566.49	25.815260	-32.892830
SMOOR DRIFT (UNDER) (163/1)	1582.82	25.825538	-32.865405
VERKEERDE WATER (122/19)	1598.56	25.816449	-32.825486
MIDDELBURG (162/3)	1683.66	25.818221	-32.903343
OUDE SMOOR DRIFT (164/7)	1774.45	25.812889	-32.892266
FARM (260/R)	1777.28	25.982219	-32.842188
OUDE SMOOR DRIFT (164/29)	1797.19	25.820147	-32.870969
JAGERS DRIFT (121/30)	1890.73	25.817418	-32.812835
OUDE SMOOR DRIFT (164/16)	1897.57	25.811774	-32.885649
ALTONA (340/R)	1914.74	25.813292	-32.829876
FARM (259/R)	1957.18	25.981006	-32.847770

8.4 Noise Impact Assessment

Seven ambient monitoring points were chosen based on their proximity to noise sensitive receptors as well as the location of the proposed wind turbines. The access to some of the proposed locations was hampered as there are no access roads at present. This also influenced where the ambient monitoring occurred. A number of measurements were taken by placing the noise meter on a tripod and ensuring that it was at least 1.2 m from floor level and 3.5 m from any large flat reflecting surface. The noise emissions were modelled for various wind speeds. The direction of the wind was not taken into consideration as the wind could blow from any direction at the speeds that were modelled. It must be noted that the GE turbines proposed for use in this project are quitter than the turbine specifications used for the modelling exercise. As such the findings of the study are reflective of a worst case scenario with the proposed turbines falling below the modelled nose output levels.

8.4.1 Sensitive Receptors

8.4.1.1. Human Sensitive Receptors

The proposed Terra Wind Energy-Golden Valley Project site is situated in a farming community. Several homesteads are located on the properties where the turbines will be erected as well as on neighbouring farms. It should be noted the certain of the sensitive receptors identified in this report are also owners of the properties on which the turbines are to be located and, as such, are fully supportive of the development. Table 8-9 below indicates the recorded sensitive noise receptors and Figure 8-2 that follows provides a map indicating the locations of the various human sensitive receptors in relation to the wind turbine locations for the proposed project.

Table 8-9: Sensitive noise receptors at the Terra Wind Energy-Golden Valley Project site

Label	Location Description	Position
NSA 1	Leuwedrift Farm House	32°46.8733'S 25°50.0829'E
NSA 2	Ou Smoor Drift Farm House	32°52.7229'S 25°51.0873'E
NSA 3	Matjesfontein Farm House	32°55.0333'S 25°52.0978'E
NSA 4	Jagersfontein Farm House	32°48.9713'S 25°50.7686'E
NSA 5	Olive Woods Farm House	32°55.600'S 25°58.4941'E
NSA 6	Rietfontein Farm House	32°53.6918'S 25°53.0703'E
NSA 7	School	32°56.995'S 25°49.580'E
NSA 8	Thorn Park Farm House	32°51.1086'S 25°49.6574'E
NSA 9	Barn and Farm Workers Houses	32°50.5531'S 25°49.3851'E
NSA 10	Farm House	32°51.923'S 25°49.6973'E
NSA 11	Farm Houses on Longhope Road	32°52.4840'S 25°49.5793'E
NSA 12	Varkenskuil Farm House	32°50.8699'S 25°58.8663'E
NSA 13	Abandoned Building	32°51.6258'S 25°53.1636'E

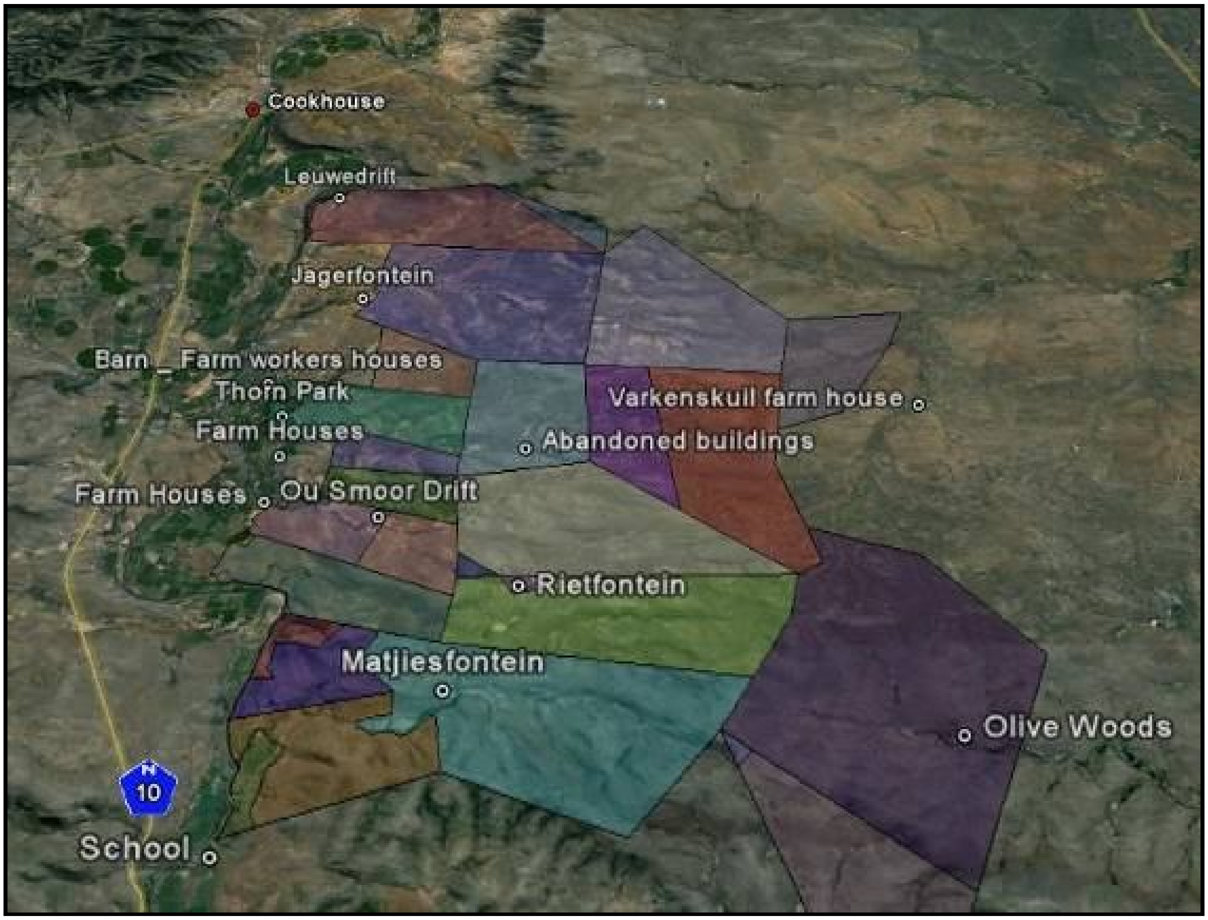

Figure 8-2: Nearby sensitive human receptors in relations to the wind turbines for the proposed Terra Wind Energy-Golden Valley Project

8.4.1.2 Natural Environment Receptors

The vegetation around the site is characterised by thicket and grasslands. The fauna includes bats, birds, commercial livestock and a variety of buck. The impacts on the fauna and avifauna are dealt with in separate studies (refer to sections 8.1 and 8.5 respectively).

8.4.2 Predicted Noise Levels

8.4.2.1. Construction Phase

<u>*Construction Equipment*</u>

If the ambient noise level is at 45dB(A), the construction noise will be similar to the ambient level at approximately 1 300m from the noise source, if the noise characteristics are similar. Beyond this distance, the noise level will be below the ambient noise and will therefore have little impact. The above only applies to the construction noise and light wind conditions.

In all likelihood, the construction noise will have little impact on the surrounding community as it will most likely occur during the day when the ambient noise is louder and there are unstable atmospheric conditions. The construction noise will be transient in nature and in all likelihood not constant for extended periods as the construction team will move from site to site.

8.4.2.2. Operational Phase

During the Scoping Phase, concerns were raised over infrasound and possible impacts to health. Infrasound was a characteristic of some wind turbine models that has been attributed to early designs in which turbine blades were downwind of the main tower. The effect was generated as the blades cut through the turbulence generated around the downwind side of the tower. Modern designs generally have the blades upwind of the tower. Wind conditions around the blades and improved blade design minimise the generation of the effect.

Low frequency pressure vibrations are typically categorized as low frequency sound when they can be heard near the bottom of human perception (10-200 Hz), and infrasound when they are below the common limit of human perception. Sound below 20 Hz is generally considered infrasound, even though there may be some human perception in that range. Because these ranges overlap in these ranges, it is important to understand how the terms are intended in a given context.

The typical range of sound power level for wind turbine generators is in the range of 100 to 105dBA – a much lower sound power level (10dB or more) than the majority of construction machinery such as dozers. In order for infrasound to be audible even to a person with the most sensitive hearing at a distance of, say, 300m would require a sound power level of at least 140dB at 10Hz and even higher emission levels than this at lower frequencies and at greater distances. There is no information available to indicate that wind turbine generators emit infrasound anywhere near this intensity.

Several studies have confirmed that there are no physiological effects below 90dB from low frequency or infrasound from wind turbines. The results of the field study in France by the specialist showed that at no time did the sound level below 20 hertz exceed 25 decibels. This correlates well with the literature review as there are no health effects from infrasound below 90dB.

The effects of low frequency noise could include sleep disturbance, nausea, vertigo etc. These effects are unlikely to impact upon residents due to the distance between the turbines and the nearest communities. Sources of low frequency noise also include wind, train movements and vehicular traffic, which are all sources that are closer to the residential areas.

Table 8-10 provides a summary of the noise impacts during the operational phase on the various sensitive receptors identified in Table 8-9 above.

The results of the modelling in Table 8-10 indicate that noise is be unacceptable at four noise sensitive areas as the impacts would result in a noise level exceeding 45 dB(A), which is regarded as the ambient noise limit. The affected areas are:

- Ou Smoor Drift Farm House (NSA 2) – The wind turbine generator is too close to the dwelling (WTG 117 – 462m). This is resulting in the noise exceeding the recommended limit from 9m/s.
- Matjesfontein Farm House (NSA 3) – The wind turbine generator is too close to the dwelling (WTG 190 – 385m). This is resulting in the noise exceeding the recommended limit from 9m/s.
- Jagersfontein Farm House (NSA 4) – The wind turbine generator is too close to the dwelling (WTG 19 – 269m). This is resulting in the noise exceeding the recommended limit from 6m/s.
- Rietfontein Farm House (NSA 6) – The wind turbine generator is too close to the dwelling (WTG 147 – 245m). This is resulting in the noise exceeding the recommended limit from 5m/s.

Table 8-10: Summary of noise impacts on various receptors as a result of the proposed Terra Wind Energy-Golden Valley Project

Wind Speed	NSA 1	NSA 2*	NSA 3*	NSA 4*	NSA 5	NSA 6*	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11	NSA 12	NSA 13
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5m/s	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓
7m/s	✓	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓
9m/s	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓

8.4.3 Conclusions

The results of the study indicate that the following conclusions can be drawn:

- There will be a short term increase in noise in the vicinity of the proposed Terra Wind Energy-Golden Valley Project site during the construction phase as the ambient level will be exceeded. The impact during the construction phase will be difficult to mitigate.
- The impact of low frequency noise and infra sound will be negligible and there is no evidence to suggest that adverse health effects will occur as the sound power levels generated in the low frequency range are not high enough (i.e. are well below 90 dB) to cause physiological effects.

8.4.4 Recommendations

The following is recommended:

8.4.4.1 Construction Activities

- All construction operations should only occur during daylight hours if possible.
- The area surrounding the construction site will be affected for a short periods of time in all directions, should several pieces of construction equipment be used simultaneously.
- There will be an impact on the immediate surrounding environment from the construction activities, especially if pile driving is to be done. This however will only occur if the underlying geological structure requires this.
- No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions.
- Ensuring that construction staff is given “noise sensitivity” training.

8.4.4.2 Operational Activities

The following recommendations are made for the operational phase:

- WTG 117 should be moved to distance exceeding 500m from Ou Smoor Drift Farm House.
- WTG 190 should be moved to distance exceeding 500m from Matjesfontein Farm House.
- WTG 19 should be moved to distance exceeding 500m from Jagersfontein Farm House.

- WTG 147 should be moved to distance exceeding 500m from Rietfontein Farm House
- All wind turbines should be located at a setback distance of 500m from any homestead and a noise criteria level at the nearest residents of 45 dB(A) should be used to locate the turbines.

8.5 Ecological Assessment

The following key findings were made from the Ecological Impact Assessment which had the following limitations and assumptions:

- Limitations of the study included the timing of the field study, which occurred in February 2010, which, though included much of the summer-flowering plants, could have missed some that could be flowering at other times of the year.

8.5.1 Vegetation and Floristics

8.5.1.1. General Floristics of the proposed project site

During the on-site investigation conducted in February 2010, one hundred and nineteen (119) species were identified on the proposed Terra Wind Energy-Golden Valley Project site. There were high numbers of species from:

- Daisy family (Asteraceae – 11 species) was well represented throughout the site form of shrubs and herbs. This family is typically prevalent within all the communities found on site.
- Grass family (Poaceae – 15 species), had a strong presence within the grassland communities.
- The high number of grass (Poaceae) species is typical of the Bedford Dry Grassland. In addition, the large numbers of shrubs form an essential part of the thicket.

A breakdown of the life forms is given in Table 8-11 and Table 8-12. Of the 119 species that were recorded in the area, many of these were woody plants (33% trees and shrubs). Small shrubs tend to occur within the Bedford Dry Grassland as well as degraded thicket sites whilst most of the tree species were also found in thicket. Graminoids and geophytes are well-represented within the site 16 and 4 % respectively and herbs form the second largest group, forming 30% of the vegetation.

Table 8-11: Summary of the flora of the study area and the number of species in each taxon.

Taxon (Higher Group or Family)	Species Recorded
Dicotyledons	81
Monocotyledons	38
Total	**119**
Major Families	**Species**
Asteraceae	11
Asphodelaceae	6
Poaceae	15
Major Genera	**Species**
Euphorbia	5
Lycium	5

Table 8-12: Life Forms of the species found in the study area

Life Form	No of Species	Percentage of Total
Trees	3	2.5
Shrubs	36	30
Graminoids	19	16
Succulents	21	18
Geophytes	4	3.5
Herbs	36	30
TOTAL	**119**	100

8.5.1.2 Plant species of special concern (SSC)

From the site visit, several plant species of special concern were recorded. These include *Aloe striatus* and *Aloe teniour*, among others listed in Table 8-13. All species of the genus *Aloe* excluding *Aloe ferox* are protected by the Provincial Nature Conservation Ordinance 4. It is recommended that no *Aloe striatus* plants be removed during the construction of the turbines. If this is impossible, they should be relocated to ensure their survival.

Table 8-13: Plant species of special concern for the proposed Terra Wind Energy-Golden Valley Project

Species	Protection	Status
Pachypodium bispinosum	PNCO	Protected
Pelargonium sidoides	IUCN	Declining
Crassula perfoliata	PNCO	Protected
Euphorbia globosa	IUCN/PNCO	Endangered/ Protected
Euphorbia meloformis	IUCN/PNCO	Vulnerable/ Protected
Aloe tenuior	PNCO	Protected
Anacampseros sp.	PNCO	Protected
Euphorbia meloformis	IUCN/ PNCO 4	Near Threatened/ Protected
Tritonia sp.	PNCO	Protected
Watsonia sp.	PNCO	Protected
Drosanthemum sp.	PNCO	Protected
Psilocaulon sp.	PNCO	Protected
Trichodiadema sp.	PNCO	Protected

Field Assessment

The field assessment of the study site showed the existence of four different vegetation types. Most of the site was heavily degraded due to its primary use as a grazing area. As a result, no Southern Karoo Alluvia (STEP) or Southern Karoo Riviere (Mucina & Rutherford) remains within the study site, but has been taken over by irrigated cultivation. Most of the study site is covered with low sensitivity scrub grassland with scattered rocky outcrops.

This vegetation type is comprised mostly of the same grass species as the Bedford Dry Grassland but with scattered thicket elements and is thus determined to be degraded thicket. Some patches of karroid thicket remain but these are also degraded. Bedford Dry Grassland (Mucina & Rutherford) or Aliwal North Dry Grassland (STEP) exists towards the east of the site and is more extensive than the vegetation maps suggest.

This vegetation type has also been degraded by grazing. There are a few small patches of remnant thicket, also somewhat degraded. The proposed placement of turbines is throughout the site in the degraded vegetation.

Reptiles

The list of reptiles of special concern is very significant since it includes five endemic species (two of which are endangered), eight CITES (Committee for International Trade in Endangered Species) listed species, one rare species and four species at the periphery of their range. More than a third of the species are described as relatively tolerant of disturbed environments, provided migration corridors of suitable habitat are maintained to link pristine habitats.

Table 8-14: Threatened and endemic reptiles likely to occur in the Cookhouse region (Source: CSIR, 2004)

Latin name	Notes
Acontias meleagris orientalis	Eastern Cape endemic
Nucras taeniolata	
Tropidosaura Montana subp. *rangeri*	Eastern Cape Endemic
Bradypodion ventrali	Eastern Cape Endemic
Afroedura karroica	Eastern Cape Endemic
Afroedura tembulica	Eastern Cape Endemic
Goggia essexi	Eastern Cape Endemic

Amphibians

Amphibians are well represented in sub-Saharan Africa, from which approximately 600 species have been recorded. A relatively rich amphibian fauna occurs in the Eastern Cape, where a total of 32 species and sub-species occur. This represents almost a third of the species known from South Africa.

Knowledge of amphibian species diversity in the Cookhouse region is limited and based on collections housed in national and provincial museums. It is estimated that as many as 17 species may occur. Table 8-15 lists species of frogs that are endemic or of conservation concern, and occur in the Cookhouse region.

Table 8-15: Threatened and endemic frogs likely to occur in the Cookhouse area (Source: CSIR, 2004)

Latin name	Notes
Anhydrophryne rattrayi	Endangered (Eastern Cape endemic)
Bufo amatolicus	Endangered (Eastern Cape endemic)
Bufo pardalis	Eastern Cape endemic

Mammals

Large game makes up less than 15% of the mammal species in South Africa and a much smaller percentage in numbers and biomass. In developed and farming areas, such as Cookhouse, this percentage is greatly reduced, with the vast majority of mammals present being small or medium-sized. Except where reintroduced into protected areas, lions, black wildebeest, red hartebeest, buffalo, black rhinoceros, elephant, hippopotamus and reedbuck are extinct. Cheetah and hunting dog are no longer found in the area and hyenas, leopard, ratel and vaal ribbok are almost extinct (Skead, 1974b). The antelope that are abundant in the thick bush (thicket or bushclump savanna) are bushbuck, duiker, steenbok and kudu (the most abundant antelope of the valley thicket). Blesbok, bontebok and gemsbok have been reintroduced on some farms.Of the cat species, the lynx (caracal) and black-footed cat are found. Jackal and bat-eared foxes are also found as is the aardwolf, but it is not abundant.

Vervet monkeys are common and baboons are found in appropriate sites in kloofs and valleys. Rock dassies are common, but tree dassies are only found inland in forests along larger rivers. Genet and mongoose species are also common. Aardvarks also occur in the region. Twenty-three rodent species are found in the area and include rats and mice, the cane rat, springhare and porcupine. A number of species of bat also occur. Table 8-16 lists large and medium sized mammals on the IUCN Red Data List that occur in the Eastern Cape Province

Table 8-16: Threatened large to medium-sized mammals in the Eastern Cape Province (Source: Smithers, 1986)

Common name	Latin name	Conservation Status
Wild dog	*Lycaon pictus*	Endangered
Brown Hyaena	*Hyaena brunnea*	Rare
Aardwolf	*Proteles cristatus*	Rare
Black-footed cat	*Felis nigripes*	Rare
Serval	*Felis serval*	Rare
Leopard	*Panthera pardus*	Rare
Blue Duiker	*Philantomba monticola*	Rare
Honey Badger	*Mellivora capensis*	Vulnerable
African Wild Cat	*Felis lybica*	Vulnerable
Aardvark	*Orcteropus afer*	Vulnerable
Cape Mountain Zebra	*Equus zebra*	Vulnerable
Black Rhinoceros	*Diceros bicornis*	Vulnerable
Oribi	*Ourebia ourebi*	Vulnerable
Pangolin	*Manis temminckii*	Vulnerable
Small-spotted cat	*Felis nigripes nigripes*	Rare

Of specific importance for wind farm developments are the presence of bats in the area; a confounding number of bat fatalities have been found at the bases of wind turbines throughout the world. Echolocating bats should be able to detect moving objects better than stationary ones, which begs the question, why are bats killed by wind turbines (Baerwald *et al*.)? Table 8-17 lists the species of bats likely to occur in Cookhouse and surrounds, and thus will be affected by the proposed development.

Table 8-17: Bat species that occur in the Cookhouse area which are likely to be affected by the wind turbines.

Order: Chiroptera		
Common Name	Species Name	SSC
Straw-coloured fruit bat	*Eidolon helvum*	Near Threatened
Egyptian fruit bat	*Rousettus aegypticus*	
Geoffrey's horseshoe bat	*Rhinolophus clivosus*	Least Concern
Cape horseshoe bat	*Rhinolophus capensis*	Least Concern
Temminck's hairy bat	*Myotis tricolor*	Least Concern
Cape serotine bat	*Eptesicus capensis*	Least Concern
Common slit-faced bat	*Nycteris thebaica*	Least Concern
Giant yellow house bat	*Scotophilus nigrita*	Least Concern
Schreiber's long-fingered bat	*Miniopterus schreibersi*	Near Threatened
Tomb bat	*Taphozous mauritianus*	Least Concern
Angola free-tailed bat	*Tadarida condylura*	Least Concern
Wahlberg's epaulated bat	*Epomophorus wahlbergi*	Least concern
Banana bat	*Pipistrellus nanus*	Least Concern
Egyptian free-tailed bat	*Tadarida aegyptiaca*	Least Concern
Lesser woolly bat	*Kerivoula lanosa*	Least Concern

Bat fatalities at wind power facilities are highly variable throughout the year, but there are many more bat fatalities than bird fatalities at wind farms (Brinkman *et al*. 2006). Importantly, bat studies have been done in Europe and the United Sates of America, but none in South Africa. These studies have found that even a few deaths can be seriously detrimental to bat populations, and is thus cause for concern (Hotker *et al*. 2006). Most bats are struck during periods of migration or dispersal (Hotker *et al*. 2006, Johnson *et al* 2003).

Possible mitigation measures for bat fatalities

In a study conducted to determine the effects of turbine size on bat fatalities, Barclay *et al*. (2007) discovered that the diameter of the rotor had no effect on bat fatalities. Height of the turbines, however, though having no effect on bird fatalities, bat fatalities increased exponentially with an increase in turbine height (Barclay *et al*. 2007). There are, as a result, a few mitigation measures that have been suggested to reduce bat fatalities, these are:

- Ultrasound broadcast can deter bats from flying into wind turbines. (Szewczak and Arnett 2007)
- Minimizing turbine height will help to reduce bat fatalities (Barclay *et al*. 2007).
- Turbine sites on ridges should be avoided (Brinkman *et al*. 2006).
- Wind turbine operating times should be restricted during times when bat activity is high (Brinkman *et al*. 2006). Bats are at higher risk of fatality on nights with low wind speeds (Horn *et al*. 2008).

8.5.2 Ecological Sensitivity Assessment

Sensitivity of the site is primarily low, with most of the vegetation quite degraded due to alien invasion as well as sheep and cattle grazing. Sensitivity of the entire site is thus low, with only a couple of isolated instances where the vegetation is of a medium sensitivity. These are shown in Figure 8-3.

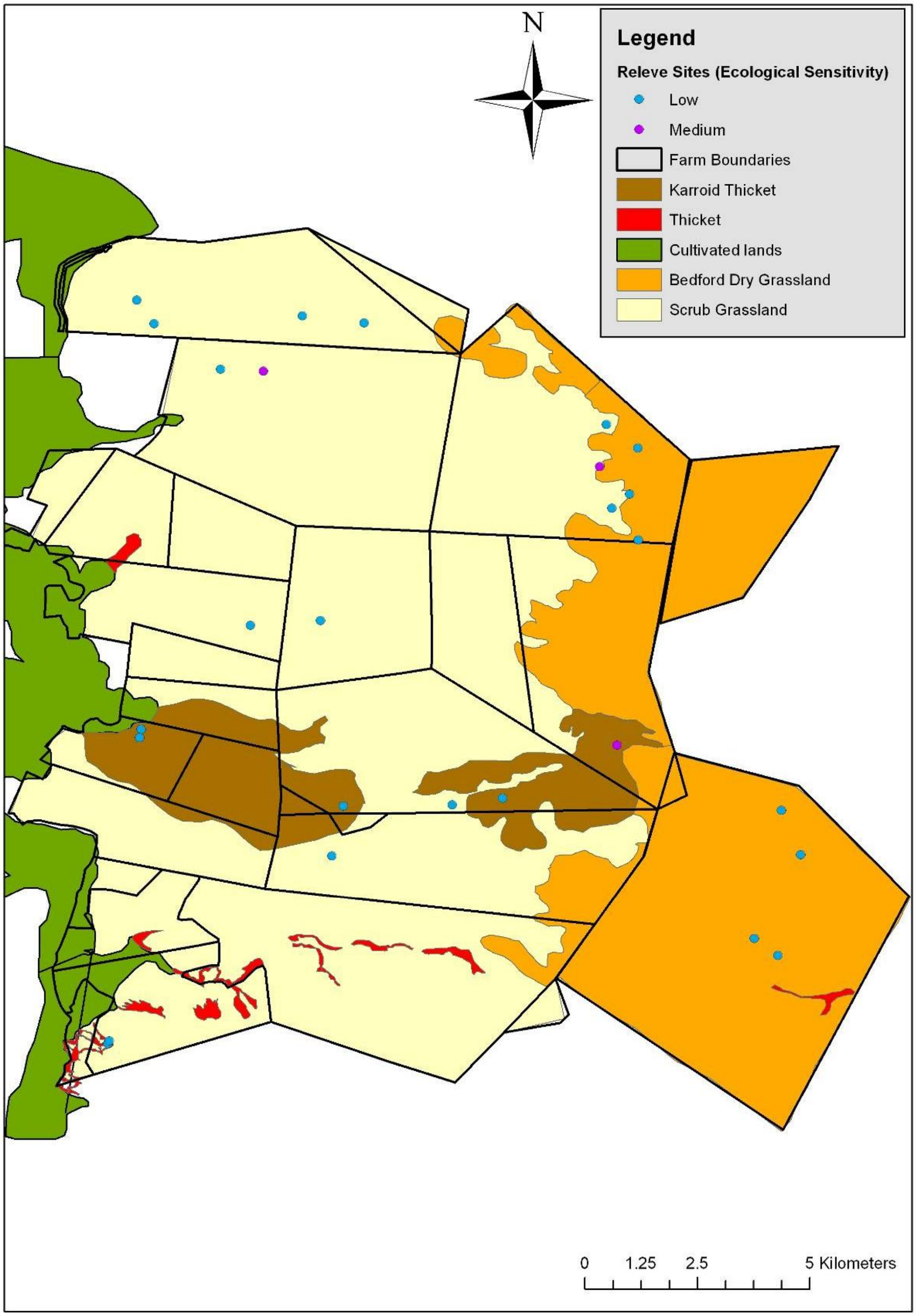

Figure 8-3: Vegetation map of the study area showing the location of each of the study releves and the sensitivity of these sites. There are two isolated areas with a medium sensitivity (purple), while the rest of the study sites had a low sensitivity (blue).

Eastern Cape Biodiversity Conservation Plan (ECBCP)

The Eastern Cape Biodiversity Conservation Plan (ECBCP) is responsible for mapping areas that are priorities for conservation in the province, as well as assigning land use categories to the existing land depending on the state that it is in (Berliner et al. 2007).

As can be seen from Figure 8-4, the majority of the study site occurs in a corridor area. Importantly, wind farms, if managed properly, have a low impact on the vegetation and these corridor areas are unlikely to be negatively affected by the construction and operation of the wind farm, thus leaving them intact.

Figure 8-5 shows the Critical Biodiversity Areas (CBAs) in and around the study area. The majority of the study area is CBA T2. CBA T2 areas were mapped based on the following:

- Endangered vegetation types identified through the ECBCP systematic conservation assessment
- Endangered vegetation types from STEP
- Endangered forest patches in terms of the National Forest Assessment
- All expert-mapped areas less than 25 000ha in size (includes expert data from this project, STEP birds, SKEP, Wild Coast, Pondoland and marine studies)
- All other forest clusters (includes 500m buffers)
- 1km coastal buffer strip

This rest of the study site comprises CBA T3, which are areas already transformed. Ground assessments of the area show most of the study site to be transformed as it is used as grazing land and is thus somewhat degraded. As CBA T2 ideally should comprise corridors as it is semi-natural landscape, the proposed development poses no threat to this functionality as the wind turbines will not result in any habitat fragmentation and minimal impacts on the existing flora and fauna of the study site. The ten principles of land use planning for biodiversity are reproduced here:

- Avoid land use that results in vegetation loss in critical biodiversity areas.
- Maintain large intact natural patches – try to minimise habitat fragmentation in critical biodiversity areas.
- Maintain landscape connections (ecological corridors) that connect critical biodiversity areas.
- Maintain ecological processes at all scales, and avoid or compensate for any effects of land uses on ecological processes.
- Plan for long-term change and unexpected events, in particular those predicted for global climate change.
- Plan for cumulative impacts and knock-on effects.
- Minimise the introduction and spread of non-native species.
- Minimize land use types that reduce ecological resilience (ability to adapt to change), particularly at the level of water catchments.
- Implement land use and land management practices that are compatible with the natural potential of the area.
- Balance opportunity for human and economic development with the requirements for biodiversity persistence.

The proposed development, if managed properly, subscribes to these guidelines. As can be seen by the more detailed figure 8-5, much of the site is transformed; the rest of the site is formed by natural landscapes. However, as previously mentioned these natural areas are heavily impacted by current land uses and thus are not valuable as conservation areas unless a great deal of rehabilitation is undertaken. The land use will remain the same, fragmentation kept to a minimum and impacts to the existing near-natural landscape including both flora and fauna will be limited.

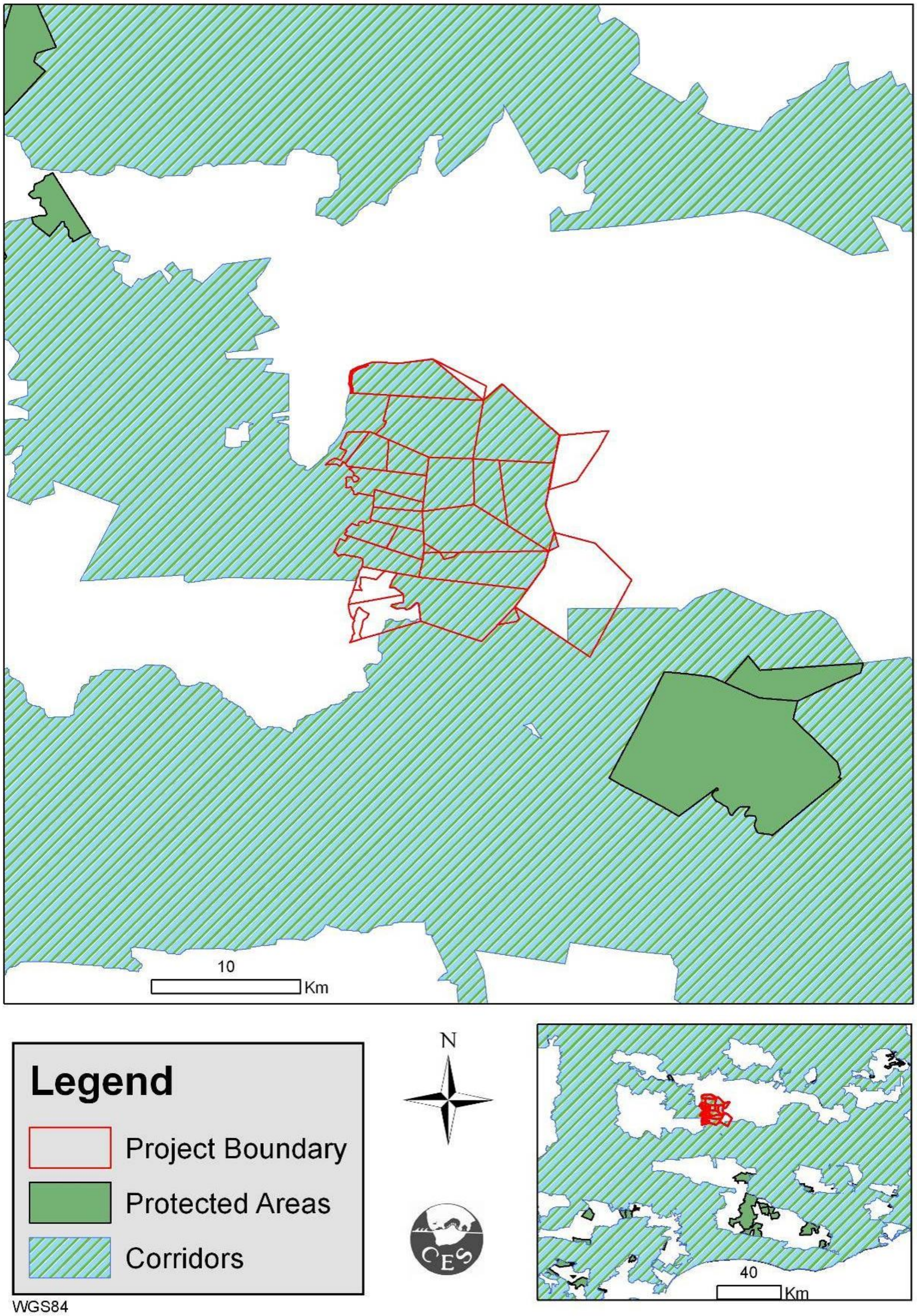

Figure 8-4: Map of the study area in relation to corridors and protected areas as described by the ECBCP.

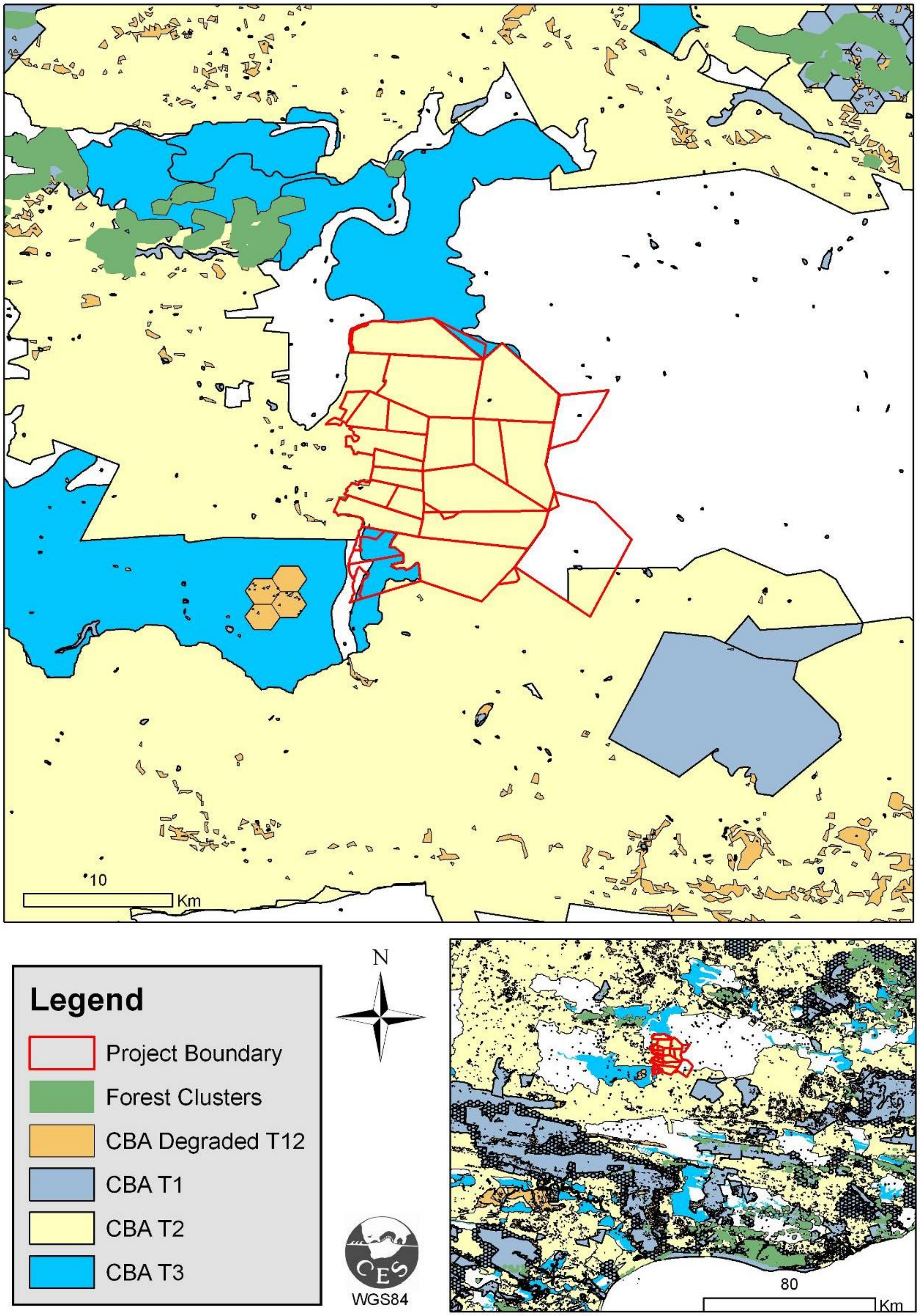

Figure 8-5: Map showing the study area and surrounds and the Critical Biodiversity Areas (CBAs) of the area.

8.5.3 Conclusions and Recommendations

8.5.3.1 Current status

The vegetation on the study site is mostly in a poor condition due to heavy grazing as well as alien plant infestation. There are many invader species along with some degraded grassland and thicket sites, both of which could potentially result in further degradation of the site in the future. Where possible it is recommended that areas within the study site be set aside for conservation allowing the vegetation to reach its natural state free from grazing pressure and alien infestation. The most important and long term impact is likely to be the introduction and infestation of alien plant species. This should be managed effectively to prevent huge impacts on the study area

8.5.3.2 Comparison of impacts

Because of the very nature of a wind farm, it is suspected that many of the impacts will be reduced with effective management of the site as well as the utilization of rehabilitation after construction. For the plant species of special concern, it is recommended that any of these species are identified and rescued before building commences. In addition to this, any extra land needed for the construction phase of the development that will not be used during the operation phase of the development should be rehabilitated after construction is completed.

It is recommended that a botanist/ecologist is on site to determine if any of the species of special concern or protected species occur where the turbines and associated infrastructure are positioned. Before the clearing of the site is authorised, the appropriate permission must be obtained from the Department of Agriculture, Forestry and Fisheries (DAFF) for plants listed in the National Forests Act, and from the Department of Economic Development and Environmental Affairs (DEDEA) for the destruction of species protected in terms of Provincial Nature Conservation Ordinance (PNCO) Schedule 4.

In order to acquire a permit to destroy or remove plant species that fall under the National Forest Act an application form will need to be submitted to DAFF. A letter needs to be drafted and sent to DEDEA prior to the destruction\removal of any PNCO Schedule 4 species: This letter must list the species that will be removed or destroyed and the reason for their removal or destruction.

These permits may be subject to certain conditions, for example allowing various nurseries to collect plants before vegetation clearance commences; the removal of certain species for rehabilitation purposes, etc.

The plants can also be removed and placed in a nursery for use for rehabilitation purposes. If a species is identified for relocation, individuals of the species will need to be located within the proposed site, before vegetation clearing commences, and carefully uprooted and removed by a skilled horticulturist. Prior to removal, however, suitable relocation areas need to be identified, either within the site or in other disturbed areas on the property. Individual plants that cannot be relocated at the time of removal should be moved to the nursery.

It should be noted that many critical SSC are plants that will not be able to be successfully uprooted and replanted at all (Phillipson, 2002), or at best may have a low survival rate. In all cases the species will require very careful treatment to give them the best chances of survival, and specialist horticultural knowledge will be needed.

8.5.3.3 Invasion of alien species

Any form of disturbance to the natural vegetation provides a gateway for alien species to invade the site of disturbance. In this regard, it is recommended that a strict monitoring plan be implemented to prevent the additional spread and the continued removal of alien species such as those of *Opuntia* and *Agave* species, which are already present on site. Sterilization of vehicles entering the construction site should be considered as this would reduce alien infestation in the long term as well as dramatically decreasing future control costs.

8.5.3.4 Impacts on bats

As there is little bat research applicable to South Africa, and, more specifically, the Eastern Cape the impacts on bats should be very carefully monitored and any available mitigation measures employed, and their success or failure also monitored.

8.5.3.5 Operational phase recommendations

- Continued monitoring of the site for potential alien invasion, especially of plant species already present on the site.
- Careful monitoring of the effects of the wind turbines on bat populations, especially mortality as a direct result of the turbines and associated infrastructure. Recent research, especially that applicable to wind farms in South Africa and the Eastern Cape should be regularly consulted and every effort should be made to use recommended mitigation measures.
- Maintenance of areas set aside within the site for conservation to make sure these are not being impacted further in any way.

8.6 Palaeontological Assessment

The following key findings were made from the Palaeontological Impact Assessment which had the following limitations and assumptions:

Published geological maps of the study area are used to determine which geological units (e.g. sedimentary formations) are represented both at the surface and below the surface within the study area. The preparation of these maps usually involves extensive extrapolation from limited areas of bedrock exposure (e.g. natural rocky outcrops, artificial road and railway cuttings, quarries and pits) since a high fraction of the outcrop area of any formation is generally obscured by surface deposits (e.g. soil, alluvium) and vegetation cover. For the purposes of palaeontological impact studies the maps are taken to be substantially correct. Later fieldwork, such as the examination of recent excavations during the impact study, may suggest necessary corrections to the geological maps, but these changes are generally small.

Most fossil heritage is buried below the surface of the ground and can only be sampled and assessed from occasional sites where bedrock is well exposed, as listed above. Extrapolation from the palaeontological record at these recorded sites is used to infer the nature and density of fossil remains that may well be exposed in the study area during development, mainly through new excavations in the construction phase. It is often assumed for practical purposes that the palaeontological heritage within a given formation is fairly evenly distributed within the entire outcrop area of the sedimentary unit, although experience shows that this is in fact often not the case. A more accurate picture of the variety and distribution of fossil heritage within the study area can only be obtained through intensive field collection as well as monitoring of excavations during construction.

8.6.1 Description of the Geological and Palaeontological Environment

8.6.1.1 Geological Environment

As shown on the relevant 1: 250 000 geological map, Sheet 3224 Graaff-Reinet published by the Council for Geoscience, the study area is largely underlain by Late Permian continental sediments of the Lower Beaufort Group (Adelaide Subgroup, Karoo Supergroup). In particular the Karoo sediments belong to the Middleton Formation (Pm) (Hill 1993, Cole et al. 2004, Johnson et al., 2006).

In the southern part of the study area the Middleton Formation is intruded by a major, narrow, WNW-ESE trending intrusion of the Karoo Dolerite Suite (Jd) of Early Jurassic age (c. 183 Ma). Dips of the Beaufort Group sediments recorded on the geological map in the study region are generally shallow (5 to 10°), with small-scale E-W fold axes to the south and east of Cookhouse, so low levels of tectonic deformation and cleavage development are expected. However, as outlined below, frequent small-scale faults, including low-angle thrusts and normal faults, are very evident where outcrop is good. These structural features are most clearly seen where they affect sandstone bodies in roadcuts. They can be related to both the Permo-Triassic Cape Orogeny (mountain-building event) as well as later stretching of the continental crust prior to the break-up of Western Gondwana during the Cretaceous Period.

8.6.1.2 Palaeontological heritage within the study area

In the section of the report the known fossil heritage within each of the major rock units represented within the study area is summarized and new palaeontological data from the scoping fieldwork is briefly outlined.

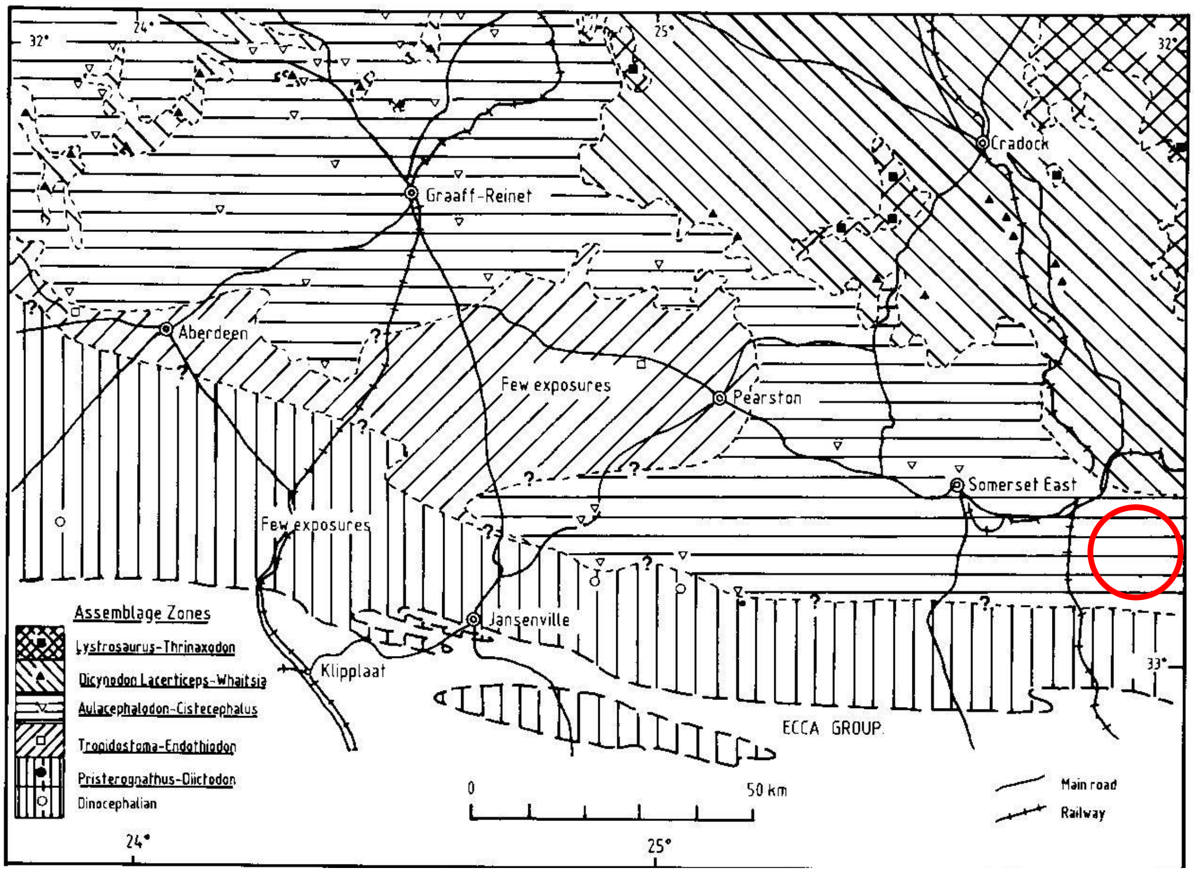

Figure 8-6: Distribution of Beaufort Group fossil assemblage zones in the Graaff-Reinet sheet area (After Keyser & Smith 1977-78). The location of study area near Cookhouse within the *Cistecephalus* Assemblage Zone (previously known as the *Aulacephalodon* – *Cistecephalus* Zone) is indicated by the red circle. Note the comparative paucity of fossil records from this particular area of the eastern Great Karoo.

The overall palaeontological sensitivity of the Beaufort Group sediments is high (Rubidge 1995, Almond *et al*. 2008). These continental sediments have yielded one of the richest fossil records of land-dwelling plants and animals of Permo-Triassic age anywhere in the world. A chronological series of mappable fossil biozones or assemblage zones (AZ), defined mainly on their characteristic tetrapod faunas, has been established for the Main Karoo Basin of South Africa

(Rubidge 1995). Maps showing the distribution of the Beaufort assemblage zones within the Main Karoo Basin have been provided by Keyser and Smith (1979) and Rubidge (1995), and for the Graaff-Reinet sheet area they are available in Hill (1993).

The Middleton Formation comprises portions of three successive Beaufort Group fossil assemblage zones (AZ) that are largely based on the occurrence of specific genera and species of fossil therapsids. These are, in order of decreasing age, the *Pristerognathus*, *Tropidostoma* and *Cistecephalus* Assemblage Zones (Rubidge 1995).

The three biozones have been assigned to the Wuchiapingian Stage of the Late Permian Period, with an approximate age range of 260-254 million years (Rubidge 2005). According to published maps showing the distribution of the Beaufort assemblage zones within the Main Karoo Basin (Keyser & Smith 1977-78, Hill 1993, Rubidge 1995), the Middleton Formation succession to the southeast of Cookhouse lies within the ***Cistecephalus* Assemblage Zone** (= upper *Cistecephalus* Biozone or *Aulacephalodon-Cistecephalus* Assemblage Zone of earlier authors; see Figure 8-6 above).

The following major categories of fossils might be expected within *Cistecephalus* AZ sediments in the study area (Kitching 1977, Keyser & Smith 1977-78, Anderson & Anderson 1985, Hill 1993, Smith & Keyser *in* Rubidge 1995, MacRae 1999, Cole *et al*., 2004, Almond *et al*. 2008):

- isolated petrified bones as well as rare articulated skeletons of **terrestrial vertebrates** such as true **reptiles** (notably large herbivorous pareiasaurs, small insectivorous owenettids) and **therapsids** or “mammal-like reptiles” (*e.g.* diverse herbivorous dicynodonts, flesh-eating gorgonopsians, and insectivorous therocephalians)

- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*; these are often represented by scattered scales rather than intact fish)

- freshwater **bivalves** (*Palaeomutela*)

- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings), plant roots

- **vascular plant remains** including leaves, twigs, roots and silicified woods (“*Dadoxylon*”) of the *Glossopteris* Flora, especially glossopterid trees and arthrophytes (horsetails). Plant remains are usually sparse and fragmentary.

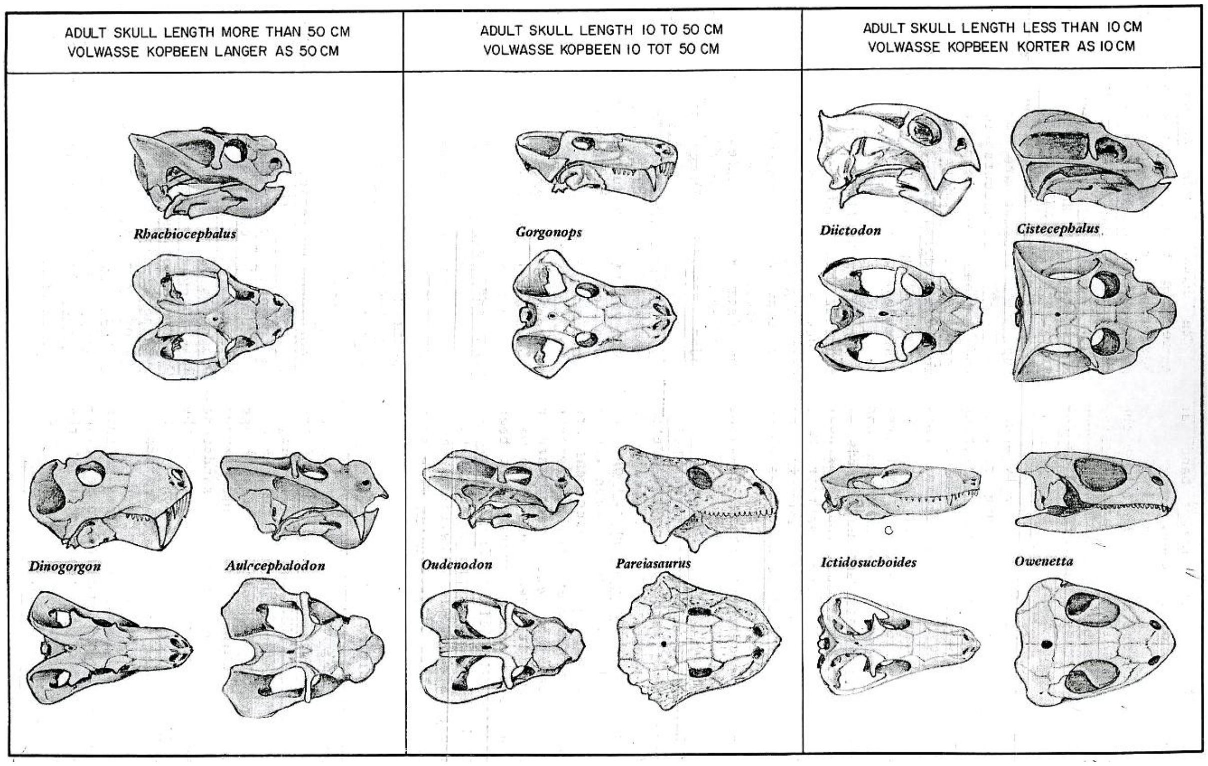

Figure 8-7: Skulls of characteristic fossil vertebrates from the *Cistecephalus* Assemblage Zone (From Keyser & Smith 1977-78). *Pareiasaurus,* a large herbivore, and *Owenetta*, a small insectivore, are true reptiles. The remainder are therapsids or "mammal-like reptiles". Of these, *Gorgonops* and *Dinogorgon* are large flesh-eating gorgonopsians, *Ictidosuchoides* is an insectivorous therocephalian, while the remainder are small to large-bodied herbivorous dicynodonts.

Authoritative lists of vertebrate genera and species recorded so far from the Cistecephalus Assemblage Zone are given by Smith and Keyser (1995). As far as the biostratigraphically important tetrapod remains are concerned, the best fossil material is generally found within overbank mudrocks. In contrast, fossils preserved within channel sandstones (e.g. channel lag breccio-conglomerates of reworked mudflakes and calcrete nodules) tend to be fragmentary and water-worn (Smith & Keyser 1995, Smith 1993).

Many fossils are found in association with ancient soils (palaeosol horizons) that can usually be recognised by bedding-parallel concentrations of calcrete nodules. The fossil bones are isolated and disarticulated for the most part, and are typically permineralised and encrusted in a mantle of calcrete (often brown-weathering). Fossil bone embedded in mudrocks adjacent to major dolerite intrusions may be modified by thermal metamorphism; for example, bones in the Graaff-Reinet District may acquire a smooth, white "porcellanite" pallor, while bones recorded near Bedford, just east of the study area, may be black (Smith & Keyser 1995). Fossil vertebrate remains appear to be surprisingly rare in the Lower Beaufort Group outcrop near Cookhouse compared to similar-aged deposits further west within the Great Karoo (Apparently, a team of experienced palaeontologists working in this area several years ago for about a week failed to find any substantial fossil remains). The important compendium of Karoo fossil faunas by Kitching (1977) lists numerous finds from the Cistecephalus Assemblage Zone near Pearston, some 75km to the WNW of the study area. A few therapsid genera - the dicynodonts Emydops and Cistecephalus plus the therocephalian Ictidosuchoides – are reported from Bruintjieshoogte, between Pearston and Somerset East, although fossils are recorded as rare even here, despite the excellent level of exposure.

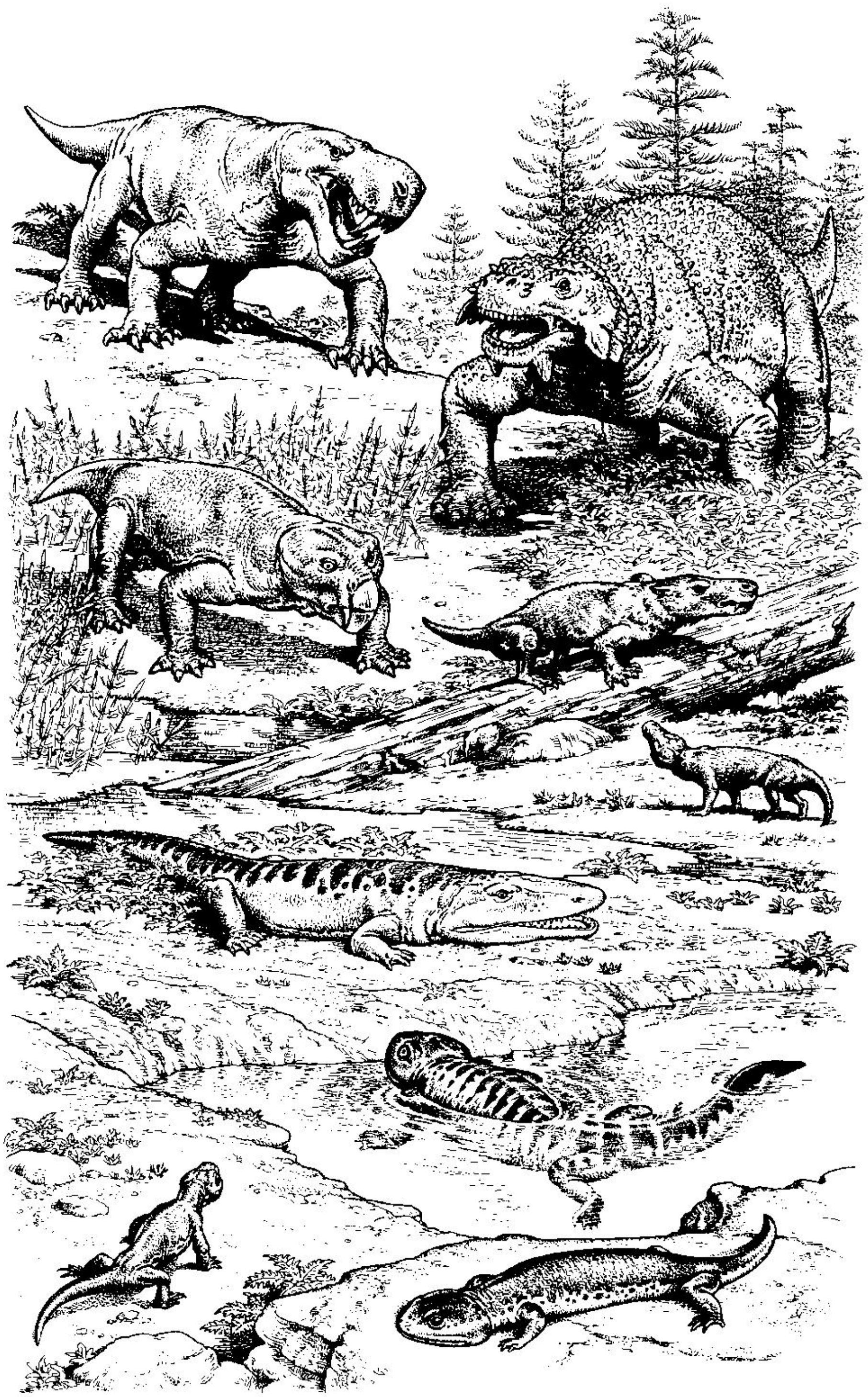

Figure 8-8: Reconstruction of a typical Late Permian continental biota (From Benton 2003). TOP: predatory gorgonopsian (left), rhino-sized herbivorous pareiasaur (right). MIDDLE: herbivorous, two-tusked dicynodont (left), carnivorous therapsids, including a therocephalian and small cynodont (right, below). BOTTOM: predatory amphibians with a procolophonid – a small insectivorous reptile (bottom left). *N.B.* Not all of these animals were present in the *Cistecephalus* Assemblage Zone.

Sparse dicynodonts are also mentioned from Bedford, c. 30km to the east of Cookhouse. The most relevant fossil record for the present study, however, is that of the small, communal burrowing dicynodont Diictodon from Slachtersnek to the south of Somerset East (precise location not provided, Kitching 1977, p. 66). The very few fossil specimens recorded during the present scoping study southeast of Cookhouse were, as expected, found where extensive, gentle hillside exposures of overbank mudrocks with numerous calcretized palaeosol horizons are present.

The reason for the comparative scarcity of fossil material within the Beaufort beds near Cookhouse is unknown. It might be related to the area's southern, high palaeolatitudinal position within the N-S orientated Main Karoo Basin. The comparative scarcity of calcretized pedogenic horizons and maroon mudrocks may suggest colder, wetter climates here. The paucity of coarse clastic material, the rarity of deeply erosive channel bases within the river systems, the soft-sediment deformation seen at some channel sandstone bases, and the high proportion of ferruginous and pyritic calcrete nodules possibly suggest distal, swampy environments that may have been less conducive to terrestrial wildlife. This is all highly speculative, however. The most palaeontologically productive sites in the study area were gentler slopes of well-exposed mudrocks with numerous palaeosols rich in calcrete nodules that were examined on Smoorsdrift 162 (Loc. 338) and Farm 283 (Locs. 321). Small bone fragments embedded within blue-grey mudrock or as surface float were found at Loc. 324 (Oudesmoorsdrif 164), Loc. 332 (Farm 283, Matjesfontein) and Loc. 336-338 (Smoorsdrift 162). In most cases the disarticulated bone fragments were encrusted with a thick mantle of micritic calcrete. The Matjesfontein bones occur in association with pedogenic calcrete and are often tinged pink or lilac (The discoloration may be related to the nearby dolerite intrusion). They belong to the post-cranial skeleton of a medium-sized animal that is still partially embedded in mudrock (Plate 8-1).

Plate 8-1: Fragments of fossil bone float together with an embedded rib of a medium-sized tetrapod (probably therapsid), Loc. 332, Farm 283 (Matjesfontein) (Rib fragment seen here is 8cm long, for scale).

The important Smoorsdrift 162 vertebrate fossils were found on an extensive N-facing exposure of Middleton Formation mudrocks just south and north of the farm track to Groot Rietfontein. The mudrocks here contain thin crevasse splay sandstones, wave-rippled playa lake sediments, and an extensive horizon of large, irregular, isolated to confluent ferruginous calcrete nodules. The disarticulated bones are embedded in calcrete or indurated grey mudrock and include two moderately well-preserved therapsid skulls as well as fragments of a couple of other skulls plus fragmentary postcranial remains. According to palaeontologist Dr Roger Smith (Iziko: South African Museums, Cape Town) the medium-sized (c. 18cm long), tusk-bearing dicynodont skull shown in Plate 8-2 bears a broad resemblance to the genus Robertia which is only recorded, however, from the significantly older Tapinocephalus Assemblage Zone of the Lower Beaufort Group (Rubidge 1995).

The second dicynodont skull shown in Plate 8-3 is tuskless and may be a female specimen of the long-ranging small dicynodont Diictodon. It should be emphasized that these identifications are provisional, based on an examination of photos rather than the original material, and that further preparation of the specimens – especially in the palatal region – is necessary before firm conclusions can be drawn. These skulls are, to the author's knowledge, among the first identifiable fossil vertebrate remains recorded so far from the Cookhouse area and are therefore of considerable scientific importance for biostratigraphic purposes. The Smoorsdrift site may well yield further valuable vertebrate remains when intensively searched, so further mitigation before construction of the proposed wind farm is suggested here.

Plate 8-2: Dorsal view of fossil skull of a medium-sized dicynodont preserved within a ferruginous calcrete nodule (Scale = 16cm) (Smoorsdrift 162, Loc. 338).