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HYDRA-PERSEUS AND BETA-PERSEUS 765KV TRANSMISSION POWER LINES ENVIRONMENTAL IMPACT ASSESSEMENT

Endangered Wildlife Trust
www.ewt.org.za

Avifaunal Impact Assessment Study

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EXECUTIVE SUMMARY

At this preliminary stage the following findings can be highlighted:

- The study area is extremely well covered in terms of bird distribution and abundance data sources including the Southern African Bird Atlas Project, the Co-ordinated Avifaunal Road counts project, the Co-ordinated Waterbird Counts & the Important Bird Areas projects.

- Collision of large terrestrial birds with the earth wires of the proposed power line will be the most significant impact of this development on the birds.

- Sensitive areas, around which the above impact is likely to be most significant, include the salt pans, wetlands, dams, arable lands and river crossings. Where possible the power line should be routed to avoid or minimise the crossing of the above microhabitats, where this cannot be avoided, suitable on site mitigation measures will be recommended.

- At this early stage, the most important factor influencing the selection of the most preferred of the four preliminary alternatives, is the issue of placing the line adjacent to existing lines. A strong argument is made for the positioning of the new line adjacent to the existing 765kV line ie the "Alternative 5 Existing 765kV".

- The additional 12km section of line appears to pass through an area relatively devoid of the above sensitive areas. Its exact placement within the identified buffer is therefore unlikely to affect its impact on avifauna.

- The additional 33km section of line passes through an area with a high concentration of large pans, these can to a certain extent be avoided if the line is placed in the eastern half of the identified buffer area. Furthermore it is suggested that it be placed adjacent to one of the existing lines in this area.

HYDRA-PERSEUS AND BETA-PERSEUS
765KV TRANSMISSION POWER LINES ENVIRONMENTAL IMPACT ASSESSEMENT

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ABBREVIATIONS

DEAT	Department of Environmental Affairs and Tourism
EWT	Endangered Wildlife Trust
SABAP	Southern African Bird Atlas Project
kV	kilovolt
CWAC	Co-ordinated Water Avifaunal Counts
CAR	Co-ordinated Avifaunal Road counts
IBA	Important Bird Area

1 INTRODUCTION

1.1 Background

Eskom Transmission plan to build a new 765kV overhead power line from the existing Perseus Substation at Dealesville to the existing Hydra Substation at De Aar. This will include the extension of the substation yard at Perseus Substation to accommodate the new line.

ARCUS GIBB were appointed as main consultants to conduct the Environmental Impact Assessment for the proposed development, and subsequently appointed the Endangered Wildlife Trust (EWT) to conduct the specialist Avifaunal Impact Assessment Study for the above developments.

A broad study area was identified prior to the site visit, and field investigation of this study area by specialists resulted in four preliminary alternatives and one cross over option being determined for the alignment of this power line (APPENDIX 4) as follows: Alternative1 - Eastern; Alternative2 – Central; Alternative3 – Western; Alternative4 - Cross over options; Alternative5 - Existing 765kV. Alternative5 is situated adjacent to the existing 765kV Beta Hydra line. This Beta Hydra line is the westernmost of the four existing transmission lines in the study area.

Subsequent to the site visit and assessment of the above alternatives, an amendment to the scope of the study was made as follows: an additional 12km 765kV length of line from Perseus to Beta Substations, and a 33km section of 400kV line from Perseus Substation to the existing 400kV Beta Hydra line. Broad buffer areas were assessed for these two additional sections of line, no alternatives were presented at this stage, and it is unlikely that many alternatives will be feasible due to the short length of these two lines and the presence of numerous other existing lines in the vicinity.

Overhead power lines and associated infrastructure such as substations are known to impact significantly on various bird species, both directly through causing mortality of birds, and indirectly through disturbance of birds and destruction of habitats. This study will identify these impacts, their location and significance, and recommend suitable mitigation measures that can be implemented to minimise these impacts. The study will also determine the order of preference of the five alternatives from a bird impact perspective.

1.2 Study Approach

1.2.1 Methodology

In predicting impacts of a proposed power line on birds, a combination of science, field experience and common sense is required. More specifically the methodology used to predict impacts in the current study was as follows:

- The various data sets discussed below under “sources of information” were collected.

- This data was examined to determine the location and abundance of power line sensitive Red Data species as well as non-Red Data power line sensitive species in the study area.
- The area was visited to obtain a first-hand perspective of the proposed routes and birdlife and to determine which bird micro-habitats are present and relevant to the study. This involved one and a half days of driving – from Perseus to Hydra and a short session in the helicopter flying from Hydra to Perseus.
- The impacts of the proposed power line on birds were predicted on the basis of experience in gathering and analysing data on wildlife impacts with power lines throughout southern Africa since 1996 (see van Rooyen & Ledger 1999 for an overview of methodology), supplemented with first hand data.
- The additional two short lines that were late additions to the study scope were assessed purely at a desk top level as they were added subsequent to the site visit. This was perfectly acceptable as the initial site visit covered the broader area, and the general characteristics of the two new buffer areas are well known to the author.

1.2.2 Sources of information

The study made use of the following data sources:

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997) obtained from the Avian Demography Unit of the University of Cape Town, in order to ascertain which species occur in the study area. A separate data set was obtained for each quarter degree square within the study area (marginal overlaps were discounted).
- Data from the Co-ordinated Avifaunal Road count project (CAR – Young, Harrison, Navarro, Anderson & Colahan, 1997) for the "Southern Free State" and "Eastern karoo" precincts (Young, Harrison, Navarro, Anderson & Colahan, 2003).
- Data from the Co-ordinated Waterbird Count (CWAC) project was also used to determine which species occur at dams in the study area (Taylor, Navarro, Wren- Sargent, Harrison & Kieswetter, 1999).
- The Important Bird Areas project data (Barnes 1998)
- The conservation status of all bird species occurring in the aforementioned degree squares was then determined with the use of The Eskom Red Data book of birds of South Africa, Lesotho and Swaziland (Barnes, 2000).
- The power line bird mortality incident database of the Eskom/Endangered Wildlife Trust Strategic Partnership (1996 to present) was consulted to determine which of the species occurring in the study area are typically impacted upon by power lines.
- A classification of the vegetation types in each degree square was obtained from Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown (1997).
- Information on the micro-habitat level was obtained through visiting the area and obtaining a first hand perspective.

1.2.3 Limitations & assumptions

This study made the assumption that the above sources of information are reliable. The following factors may potentially detract from the accuracy of the predicted results:

- The SABAP data covers the period 1986-1997. Bird distribution patterns fluctuate continuously according to availability of food and nesting substrate.
- Sources of error in the SABAP database.
  - Inadequate coverage of some areas. This study area in particular was not very well covered by counters. This means that the report rates of species may not be as accurate as in areas that were covered better.
  - Errors in species identification during data capturing stage
  - Biases in the reporting process due to several factors
    (For a full discussion of potential inaccuracies in ASAB data, see Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997).
- Difficult road access made examination of the study area from the ground exceptionally difficult.

General comment: Predictions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can not be reduced to formulas that will hold true under all circumstances. However, power line impacts can be predicted with a fair amount of certainty, based on experience gained by the authors through the investigation of more than 400 localities in southern Africa where birds have interacted with power lines since 1996.

2 DESCRIPTION OF AFFECTED ENVIRONMENT

2.1 Topography & vegetation

The topography of the study area is generally very flat, relieved by intermittent smallish kopjes. These kopjes become more common further south and there is a minor "mountain range" just north of Hydra. In terms of the general surrounding topography, the study area appears to be situated within a low lying area in the landscape. Within the study area are a number of pans which are considerably lower than the surrounding areas.

TABLE 2 and the vegetation description below make extensive use of the work of Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown (1997). The vegetation composition of the study area can be seen in TABLE 2 – per quarter degree square (Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997).

It is generally accepted within ornithological circles that vegetation structure is more important in determining bird distribution, than the actual species themselves (in Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997). This vegetation description below will therefore probably differ from botanical descriptions in that it concentrates on factors relevant to birds, rather than exhaustively listing plant species. Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown (1997) present a vegetation classification intermediate between Rutherford and Westfall's 7 biomes (1986) and Acocks' 70 veld types (1953). It is important to note that no new boundaries were created, use was made only of previously published data.

It is clear that in the north of this study area, most squares comprise mainly "Grassy karoo" with some "Sweet grassland". Towards the middle of the study area most squares are almost totally dominated by "Grassy karoo" and in the south "Nama karoo" appears more frequently. One square in the north 2825CD has 11% of "Central Kalahari". These vegetation types and their relevance to birds are discussed in more detail below.

2.1.1 Nama karoo

The Nama Karoo vegetation type largely consists of low shrubs and grasses. Trees such as *Acacia karoo* and the exotic mesquite *Prosopis glandulosa* are largely restricted to the watercourses, where they often form dense stands. The Nama Karoo has a much higher proportion of grasses and trees than the Succulent Karoo.

The Karoo (both Succulent and Nama Karoo biomes) supports a high diversity of bird species that are endemic to southern Africa. This is due to the availability of two distinct habitat types in the karoo ie the open areas which support ground dwelling species, and the watercourses with their taller trees which support species that would normally be found in Arid Woodland.

2.1.2 Grassy karoo

Grassy Karoo is basically a transition between the Nama Karoo and Grassland biomes. It is primarily composed of dwarf shrubs, with more grasses and trees than the Nama Karoo. The bird species present in this vegetation type are typical of both Grassland and Karoo biomes, for example the Karoo Korhaan and Blue Korhaan. Several grassland species which have declined due to the loss of grassland habitat, have found refuge in the Grassy Karoo. A prime example of such a species is the Blue Crane, which is present in this study area.

2.1.3 Sweet grassland

The dominant plants in the grassland biome are grass species, with geophytes and herbs also well represented (Low & Robelo 1996). Grasslands are maintained mainly by: relatively high summer rainfall; frequent fires; frost and grazing. These factors preclude the growth of trees and shrubs. This biome has been largely transformed in SA already through various land uses such as afforestation and crop cultivation.

Sweet grassland is generally found in the lower rainfall areas. Vegetation is taller and sparser, and nutrients are retained in the leaves during winter. Relatively few bird species favour sweet grassland over sour or mixed grassland. One such species is the Melodious Lark, which has been recorded in this study area.

2.1.4 Central Kalahari

Classified as one of the “arid” woodland types, this vegetation type is characterised by sparse to dense shrubland dominated by species such as *Acacia*, *Boscia albitrunca, Terminalia sericea* and *Grewia* shrubs. Grass cover is varied and dependant on rainfall, grazing and fires. There are no watercourses but there are fossil river valleys and numerous pans on calcrete which may hold water after rainfall.

Whilst woodland species are the most species rich bird community in southern Africa, there are complex differences in presence and abundance between the different types of woodland. The three Kalahari woodland types have few truly endemic species as most species found there are also found in other woodland types.

In this study area the “Central Kalahari” is particularly important as it is one of the only areas where woodland is found – in the remainder of the study area the only woodland is found along water courses and drainage lines.

2.2 Bird microhabitats

Although much of the distribution and location of bird species within the study area can be explained by vegetation as discussed briefly above, it is necessary to look more closely at the habitats available to birds, ie the microhabitats, in order to determine where the relevant species will most likely occur within the study area. These microhabitats do not always correspond to vegetation types and are determined by a combination of vegetation type, topography, land use, food sources and other factors.

Investigation of this study area revealed the following bird microhabitats, examples of which can be seen in APPENDIX 1:

- Arable lands:

Arable or cultivated land represents a significant feeding area for many bird species in any landscape for the following reasons: through opening up the soil surface, land preparation makes many insects, seeds, bulbs and other food sources suddenly accessible to birds and other predators; the crop or pasture plants cultivated are often eaten themselves by birds, or attract insects which are in turn eaten by birds; during the dry season arable lands often represent the only green or attractive food sources in an otherwise dry landscape.

In this study area arable lands are almost all under irrigation and as such most definitely represent almost the only source of “green” and moisture in this landscape for much of the year. Whilst some crops are more suitable than others for birds, most of these lands are under a rotational system whereby at some point in the year or over several years a crop will be planted that is suitable to birds. Very often the most attractive phase of crop production to birds is when the land is first ploughed – before planting even takes place.

- Salt pans:

Although the pans in the study area were dry at the time of the site visit, they would almost certainly hold water for a while after rainfall and will then be a significant attraction to birds. In particular the flamingos would use the pans, and flocks of Blue Cranes may use them as roost sites. The stork species are also likely to use them extensively.

- Wetland:

Wetlands are characterized by slow flowing water and tall emergent vegetation, and provide habitat for many water birds. The conservation status of many of the bird species that are dependant on wetlands reflects the critical status of wetland nationally, with many having already been destroyed.

In this study area, several areas of wetland were observed. These areas are considered as separate from the pans in terms of bird habitat, primarily because they are not fed only by rainfall and so may represent attractive areas for certain species year round – not only after rainfall. Furthermore the wetlands have more extensive vegetation cover than the pans and so would be used by different bird species.

- Rivers:

Most rivers in southern Africa are in the east and extreme south, in the higher rainfall areas. Thirteen species of water bird are mostly restricted to riverine habitat in southern Africa. The map distribution of these species correlates with the river courses in southern Africa.

In this largely “Karoo type” landscape, although many of these water courses seldom contain water, these systems are important, as they have a different vegetation composition to the remainder of the plains, often including woody species such as *Acacia karoo* as discussed elsewhere. Furthermore any river, stream or drainage line represents an important flight path for many bird species.

- Flats or plains:

These areas are conspicuously flat and may hold water in places after rainfall events. Drainage lines and river courses generally bisect the plains, and in some places these drainage lines have been dammed. Large bare patches of partially exposed soil are often evident. Species commonly found here, are Blue Cranes, bustards, and korhaans.

- Kopjes or ridges:

These kopjes are extremely rocky and are usually derived from dolerite. In this study area, the kopjes are relatively small in size, although towards Hydra Substation there are some significant “mini ranges”.

These kopjes are normally important for bird nesting and breeding, and many raptors prefer to fly in the vicinity of the ridges as air currents are favourable.

- Dams:

Many thousands of earthen and other dams exist in the southern African landscape. Whilst dams have altered flow patterns of streams and rivers, and affected many bird species detrimentally, a number of species have benefited from their construction. The construction of these dams has probably resulted in a range expansion for many water bird species that were formerly restricted to areas of higher rainfall. These include the pelicans, darters and cormorants. Many species from these families occur in this study area.

Most importantly, in this arid landscape, dams will be used as roost sites by flocks of Blue Cranes and other species. This has serious implications for their interaction with power lines, as the cranes leave the roost in the early morning during low light conditions, and arrive at the roost in the late evening, again during low light conditions. During these conditions, the earth wires of a power line are almost invisible and the chance of collision is much greater.

Dams will also be used by storks and flamingos as foraging areas.

- Bushveld or thicket:

A few areas of bushveld or thicket exist in this study area, primarily along drainage lines or rivers. As the only areas containing trees in this study area, these areas are important for birds as perching, roosting and nesting areas and as foraging areas for species such as the Kori Bustard.

TABLE 1 shows the microhabitats that each Red Data bird species typically frequents in the study area. It must be stressed that birds can and will, by virtue of their mobility, utilise almost any areas in a landscape from time to time. However, the analysis below represents each species most preferred or normal habitats. These locations are where most of the birds of that species will spend most of their time – so logically that is where impacts on those species will be most significant. Species typically vulnerable to collision with power lines (the most significant impact of this proposed development) have been shaded.

TABLE 1 makes use of the authors’ extensive experience gained through personal observations, supported by data from the CAR project (Young, Harrison, Navarro, Anderson & Colahan, 2003). It is recognised that the location of the routes in the CAR project does not always allow equal observation of all of the microhabitats, which means that the data on habitat use needs to be used carefully as this may have resulted in certain microhabitats for certain species not being adequately reflected in the final results.

TABLE 1 – Microhabitat use by Red Data species.

Species	Cons. status	Arable lands	Salt pans	Wet land	Rivers & riverine habitat	Flats or plains	Kopjes or ridges	Dams	Bushveld or thicket
White-backed Vulture	V	-	-	-	-	Yes	Yes	-	Yes
Martial Eagle	V	-	-	-	-	Yes	Yes	-	Yes
Tawny Eagle	V	-	-	-	-	Yes	Yes	-	Yes
Blue Crane	V	Yes	Yes	Yes	-	Yes	-	Yes	-
Kori Bustard	V	-	-	-	-	Yes	-	-	Yes
Cape Vulture	V	-	-	-	-	Yes	Yes	-	-
African Marsh Harrier	V	-	-	Yes	-	-	-	-	-
Greater Flamingo	NT	-	Yes	-	-	-	-	Yes	-
Lesser Flamingo	NT	-	Yes	-	-	-	-	Yes	-
Secretarybird	NT	-	-	-	-	Yes	-	-	-
Black Harrier	NT	-	-	Yes	-	Yes	-	-	-
Lesser Kestrel	NT	Yes	-	-	-	Yes	-	-	-
Ludwig's Bustard	NT	-	-	-	-	Yes	-	-	-
Blue Korhaan	NT	Yes	-	-	-	Yes	-	-	-
Melodious Lark	NT	-	-	-	-	Yes	-	-	-
Short-clawed Lark	NT	-	-	-	-	Yes	-	-	-
Yellow-billed Stork	NT	-	Yes	Yes	Yes	-	-	Yes	-
Black Stork	NT	-	Yes	Yes	Yes	-	Yes (br.)	Yes	-
Painted Snipe	NT	-	Yes	Yes	-	-	-	Yes	-
Lanner Falcon	NT	Yes	Yes	-	-	Yes	Yes	-	-
Caspian Tern	NT	-	Yes	-	Yes	-	-	Yes	-
Chestnut-banded Plover	NT	-	Yes	-	-	-	-	Yes	-
White Stork	Bonn	Yes	Yes	Yes	Yes	Yes	-	Yes	-
Abdim's Stork	Bonn	Yes	Yes	Yes	Yes	Yes	-	Yes	-

2.3 Relevant bird populations

Various data sources were used in determining the distribution and abundance of bird species in the study area:

- SABAP Data - TABLE 3 below shows a list of the Red Data bird species recorded in the study area and their report rates in each quarter degree square (Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997). Report rates are essentially an expression (%) of the number of times a species was seen in a square divided by the number of times that square was counted. A total of 22 Red Data species are listed, with the White Stork and Abdim's Stork being included as they are protected internationally under the "Bonn Convention on Migratory Species". With the exception of the Melodious Lark, Short-clawed Lark, Painted Snipe, Caspian Tern & Chestnut-banded Plover all of the above species are known to potentially interact directly with power line infrastructure ie by perching, roosting, nesting on it or colliding with the line. All five species listed above will be impacted on "indirectly" by the power line through disturbance and habitat destruction.

  Many of the species in TABLE 3 are vulnerable to collision with the overhead cables of the power line – an impact anticipated to be the most significant impact on birds of this project. FIGURE 1 below shows that many of the species present in this study area are amongst the species most impacted on through collision between 1996 and March 2003 as per EWT database.

The position of the quarter degree squares in the study area can be seen in APPENDIX 4a.

- CAR Data – TABLE 4 shows the report rate for several of the Red Data large terrestrial species identified in TABLE 4, per quarter degree squares. This is an adaptation of the data per route of the CAR project (Young, Harrison, Navarro, Anderson & Colahan, 2003). In most cases each quarter degree square had more than one CAR route passing through it. For the purposes of this study, the scores from the route that was deemed to cover the square best were used. These report rates are expressed in number of birds per 100km. See APPENDIX 4a for the coverage of the study area by CAR routes, and the position of the routes that were used by this study in each quarter degree square.

- Important Bird Areas (IBA) data – APPENDIX 4a shows the position of the IBA's in the study area (Barnes, 1998). These are areas that have been selected according to a set of criteria determined by Birdlife International and applied globally. For a full explanation of the criteria used see Barnes (1998)

  Of particular importance to this study area is the large IBA – SA037 Platberg Karoo Conservancy situated in the south of the study area (a total area of 1 200 000ha). Reasons for this area being selected as an IBA include having extremely important populations of almost all the Red Data species listed in TABLE 3 below, in particular the Lesser Kestrel and Blue Crane.

  Unfortunately due to the position and size of this IBA – surrounding the Hydra Substation itself – it is not possible to avoid it with the position of this new line.

- Coordinated Waterbird Counts (CWAC) data – APPENDIX 4a shows the position of the CWAC sites in the broader study area. The CWAC project aims to monitor populations of waterbirds by carrying out counts in summer and winter at each site (Taylor, Navarro, Wren-Sargent, Harrison, Kieswetter, 1999).

  None of the CWAC sites are very close to any of the preliminary alternatives proposed for the new line.

It must be noted that many "non Red Data" bird species also occur in the study area and will also be impacted on by the power line. Although this impact assessment focuses on Red Data species, the impact on non Red Data species is also assessed, albeit in less detail (APPENDIX 3).

The above data sources, combined with the author's personal observations of habitat preferences will be used to determine the exact locations of impacts of the proposed line on the various bird species, and to select the preferred alternative from a bird impact perspective.

TABLE 2 – Vegetation composition (%) of the quarter degree squares in the study area (Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997).

Biome	Vegetation type	2825CD	2825DA	2825DC	2925AA	2925AB	2925AC	2925AD	2925BA	2925CA	2925CB	2925CC	3024CA	3024CB	2924BD	2924CD	2924DA	2924DB	2924DC	2924DD	3024AB	3024AC	3024AD	3024BA	3024BB	3024BC
Nama Karoo	Nama Karoo	-	-	-	-	-	-	-	-	-	-	-	41	-	-	100	42	1	54	1	60	100	14	1	-	-
	Grassy karroo	87	9	72	100	100	100	100	100	100	100	100	59	100	100	-	58	99	46	99	40	1	86	100	100	100
Grassland	Sweet Grassland	1	91	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Woodland	Central Kalahari	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 3 - Report rates of Red Data bird species per quarter degree square within the study area (Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997). Report rates are essentially expressions of the number of times a species was recorded as a percentage of the number of times that square was counted ie # cards below.

Species	Cons stat	2825CD	2825DA	2825DC	2925AA	2925AB	2925AC	2925AD	2925BA	2925CA	2925CB	2925CC	3024CA	3024CB	2924BD	2924CD	2924DA	2924DB	2924DC	2924DD	3024AB	3024AC	3024AD	3024BA	3024BB	3024BC
# cards		15	24	13	13	48	18	12	17	11	19	13	27	16	11	11	5	9	13	4	16	30	39	12	14	8
# species		189	144	164	141	153	156	141	156	135	181	165	132	120	104	163	94	113	147	124	122	158	143	139	156	134
White-backed Vulture	V	7	-	-	8	2	11	-	-	-	-	-	-	-	9	-	-	11	-	-	-	-	-	-	-	-
Martial Eagle	V	7	4	-	-	-	6	-	-	9	-	15	4	38	-	-	-	-	-	-	-	10	21	-	14	13
Tawny Eagle	V	-	4	8	8	10	11	8	-	9	5	-	-	6	9	18	-	11	8	-	-	3	15	-	-	-
Blue Crane	V	-	-	-	-	56	-	25	24	-	21	23	30	56	-	18	-	-	8	-	63	30	69	-	36	13
Kori Bustard	V	-	-	-	-	4	-	-	-	-	-	-	22	-	-	-	-	-	-	-	56	20	-	-	-	-
Cape Vulture	V	-	-	-	-	-	11	-	-	-	16	8	-	-	-	-	-	-	8	-	-	-	-	-	-	-
African Marsh Harrier	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-
Greater Flamingo	NT	20	29	8	-	8	6	-	6	9	21	-	7	6	18	-	-	-	-	-	-	-	8	-	-	-
Lesser Flamingo	NT	7	4	8	-	2	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-
Secretarybird	NT	27	4	-	8	75	6	42	35	18	5	-	19	63	9	9	40	44	-	25	63	27	72	8	50	25
Black Harrier	NT	33	4	-	-	-	-	17	6	-	-	15	4	-	-	-	-	22	-	-	-	23	13	-	-	13
Lesser Kestrel	NT	13	21	15	8	15	11	8	18	-	21	15	11	50	9	18	20	33	-	-	6	30	41	17	36	13
Ludwig's Bustard	NT	7	4	8	-	-	6	-	-	-	5	8	7	56	-	9	-	11	-	-	56	7	10	-	7	13
Blue Korhaan	NT	47	17	46	-	2	6	17	12	9	32	31	-	69	-	-	-	11	15	-	-	3	36	-	-	13
Melodious Lark	NT	13	8	15	-	2	-	-	12	-	5	15	-	-	-	-	-	-	-	-	-	-	-	-	-	13
Short clawed Lark	NT	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow-billed Stork	NT	-	4	-	-	-	-	-	-	18	16	8	-	-	-	18	-	-	-	-	-	-	3	-	-	-
Black Stork	NT	-	-	-	-	2	-	8	-	-	11	8	4	38	9	9	-	11	-	-	-	-	21	-	21	13
Painted Snipe	NT	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lanner Falcon	NT	-	-	-	-	-	-	8	6	-	-	8	-	19	-	-	-	-	8	25	-	7	10	-	36	-
Caspian Tern	NT	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chestnut-banded Plover	NT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	20	-	-	-	-	-	-	-	-	-
White Stork	Bonn	7	8	-	-	13	6	-	12	-	5	-	-	19	18	18	-	33	-	-	-	7	23	-	21	-
Abdims Stork	Bonn		8	8	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

# cards = the number of counts that were carried out in that quarter degree square.
# species = the total number of bird species recorded in that quarter degree square
V = Vulnerable
NT = Near-threatened
Bonn = Protected under the Bonn Convention on Migratory Species

TABLE 4 - Report rates for large terrestrial species per quarter degree square as recorded by the CAR project between 1993-2001 (Young, Harrison, Navarro, Anderson & Colahan, 2003).

Species	2825CD	2825DA	2825DC	2925AA	2925AB	2925AC	2925AD	2925BA	2925CA	2925CB	2925CC	3024CA	3024CB	2924BD	2924CD	2924DA	2924DB	2924DC	2924DD	3024AB	3024AC	3024AD	3024BA	3024BB	3024BC
Route #	FS 56	FS 55	FS 54	FS 43	FS 43	FS 22	FS 21	FS 47	FS 16	FS 20	FS 14	NK 131	NK 352	FS 39	NK 233	FS 59	FS 15	NK 233	FS 15	NK 072	NK 083	NK 082	NK 073	NK 103	NK 173
Length (km)	74.8	59.9	66	71	71	59.3	64.2	82.4	83.7	77.7	70.8	20	20	73.5	20	75.5	90.5	20	90.5	20	20	20	20	20	20
Blue Crane	-	-	-	-	-	0.85	-	-	3.28	0.43	9.53	-	15	2.7	-	-	-	-	-	1	-	-	-	24.17	62.5
Kori Bustard	-	-	-	0.47	0.47	-	-	-	-	-	0.7	2.5	-	4.5	5	-	-	5	-	-	-	-	-	-	-
Ludwig's Bustard	9.35	-	15.15	1.4	1.4	-	3.5	-	2.4	8.57	12.3	17.5	-	-	-	10.5	0.83	-	0.83	8.33	7.5	-	4.17	3.33	8.75
Abdim's Stork	557.45	60.1	214.4	275.3	275.3	-	-	-	-	-	-	-	-	102	-	-	-	-	-	-	-	-	-	-	-
Black Stork	-	28.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.83	-
White Stork	26.7	141.9	0.75	3.27	3.27	43.85	35.05	52.6	65.7	-	0.35	-	-	17.7	-	-	-	-	-	38	-	-	-	-	625
Secretarybird	-	-	3	3.27	3.27	0.85	1.95	1.6	2	0.98	0.7	-	3.75	2.8	2.5	1.3	2.48	2.5	2.48	1.67	3	2	2	0.83	-
Blue Korhaan	14.7	12.5	4.5	-	-	2.1	-	3.6	5.4	2.25	2.83	-	3.75	19	-	7.95	0.73	-	0.73	-	-	-	8.33	7.5	6.67

The above report rates for each species are number of birds per 100km – this means that all report rates are comparable even between the FS precinct (varied lengths) and the NK precinct (all routes 20km).

FS = Southern Free State precinct

NK = Eastern karoo precinct

3 IDENTIFICATION OF RISK SOURCES

3.1 General description of impacts of power lines on birds

Because of their size and prominence, electrical infrastructures constitute an important interface between wildlife and man. Negative interactions between wildlife and electricity structures take many forms, but two common problems in southern Africa are electrocution of birds (and other animals) and birds colliding with power lines. (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs & Ledger 1986a; Hobbs & Ledger 1986b; Ledger, Hobbs & Smith, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000). Other problems are electrical faults caused by bird excreta when roosting or breeding on electricity infrastructure, (Van Rooyen & Taylor 1999) and disturbance and habitat destruction during construction and maintenance activities.

3.1.1 Electrocutions

Electrocution of birds on overhead lines is an emotional issue as well as an important cause of unnatural mortality of raptors and storks. It has attracted plenty of attention in Europe, USA and South Africa (APLIC 1994; van Rooyen & Ledger 1999). However, in the context of overhead lines above 132 kV, electrocutions are not a major issue. Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). Due to the large size of the clearances on most overhead lines of above 132kV, electrocutions are generally ruled out as even the largest birds cannot physically bridge the gap between dangerous components. In fact, transmission lines have proven to be beneficial to many birds, including species such as Martial Eagles *Polemaetus bellicosus*, Tawny Eagles *Aquila rapax*, African White-backed Vultures *Gyps africanus*, and even occasionally Verreaux's Eagles *Aquila verreauxii* by providing safe nesting and roosting sites in areas where suitable natural alternatives are scarce (van Rooyen 2004). Cape Vultures have also taken to roosting on power lines in certain areas in large numbers (van Rooyen 2004a), while Lappet-faced Vultures are known to using power lines as roosts, especially in areas where large trees are scarce (pers.obs.).

3.1.2 Collisions

Collisions are the biggest single threat posed by transmission lines to birds in southern Africa (van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (van Rooyen 2004, Anderson 2001).

Unfortunately, many of the collision sensitive species are considered threatened in southern Africa. FIGURE 1 below shows the number of collisions reported per species on transmission lines from August 1996 to present (EWT Database). Most of the heavily affected species are Red Data species. The top five most affected species ie the Ludwig's Bustard, Blue Crane, White Stork, Greater Flamingo and Cape Vulture are all present in this study area. It should be noted that these are only the reported mortalities, it is suspected that a large number of mortalities go unreported. It is also important to note that the mortalities recorded by Anderson (2001) as discussed below are not included in the EWT database, shown in FIGURE 1 below.

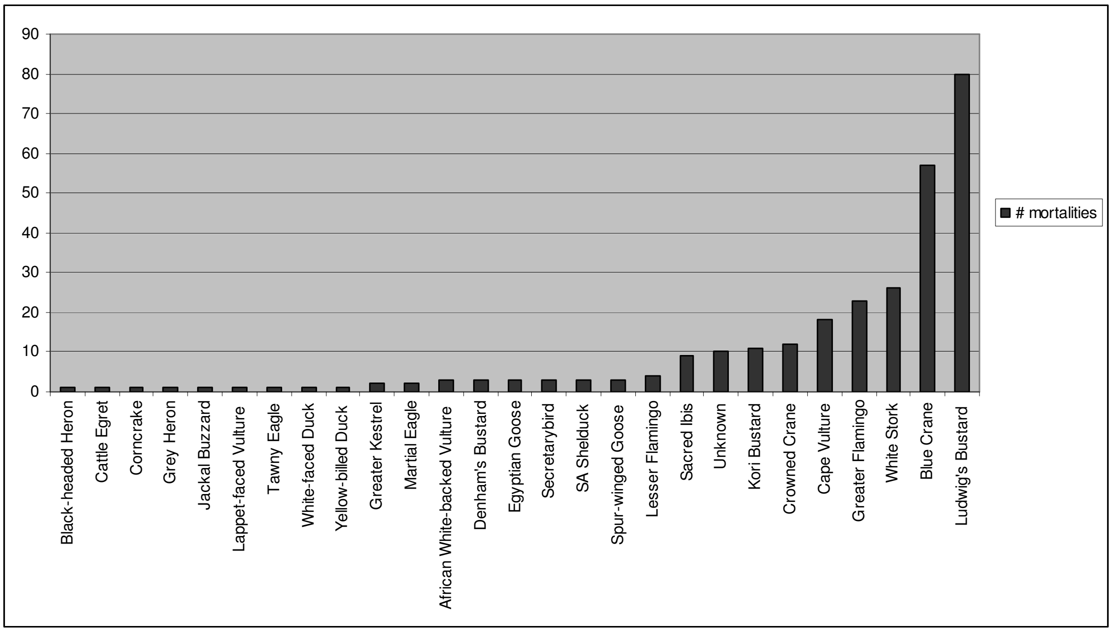

FIGURE 1 – Number of reported collisions per species on transmission lines from August 1996 to the present (EWT Database).

Although significant in itself, the above FIGURE 1 is not a true reflection of the extent of the problem, because few of the collision localities were closely monitored over a substantial period of time. Where long term monitoring did happen, the picture is disturbing. In one instance, where bi-monthly monitoring did take place, a single 10 km section of 132kV distribution line killed 59 Blue Cranes, 29 Ludwig's Bustard, and 13 White Storks in a three year period (van Rooyen unpubl. data). In 2004, fifty-four Blue Crane carcasses were discovered near Graaf-Reinett in the Northern Cape province under 3.7km of distribution line.

Data collected in the Northern Cape province between 1997 and 1999 provides further evidence of the gravity of the problem. During an initial clearing of transects, a total of 194 large bird carcasses were found under 40km of Transmission line (220 and 400kV) near De Aar in the Northern Cape. Subsequent monitoring of 140 km of power lines (transects of 10km each from 22kV up to 400kV) in the same area over a period of 12 months produced another 196 carcasses (mostly cranes and bustards) the majority under transmission lines (Anderson 2001).

The Red Data species vulnerable to power line collisions are generally long living, slow reproducing species under natural conditions. Some require very specific conditions for breeding, resulting in very few successful breeding attempts, or breeding might be restricted to very small areas. A good example of this is the two flamingo species that occur in southern Africa, which have experienced hardly any successful breeding attempts at Etosha Pan in Namibia for several decades. Another example is the Great White Pelican that only breeds successfully at Dassen Island in the Western Cape. These species have not evolved to cope with high adult mortality, with the results that consistent high adult mortality over an extensive period could have a serious effect on a population's ability to sustain itself in the long or even medium term. Many of the anthropogenic threats to these species are non-discriminatory as far as age is concerned (e.g. habitat destruction, disturbance and power lines) and therefore contribute to adult mortality, and it is not known what the cumulative effect of these impacts could be over the long term.

Using computer modelling, the South African Crane Working Group estimated that an annual mortality rate of 150 adult Blue Cranes could reduce the eastern population of Blue Cranes (app. 2000 individuals in Mpumalanga and KwaZulu-Natal) by 90% by the end of the 21st century (McCann *et al* 2001). At that stage the population would be functionally extinct.

From the figures quoted above, it is clear that power lines are a major cause of avian mortality among power line sensitive species, especially Red Data species. Furthermore, the cumulative effects of power lines and other sources of unnatural mortality might only manifest itself decades later, when it might be too late to reverse the trend. It is therefore imperative to reduce any form of unnatural mortality in these species, regardless of how insignificant it might seem at the present moment in time.

3.1.3 Habitat destruction

During the construction phase and maintenance of power lines and substations, some habitat destruction and alteration inevitably takes place. This happens with the construction of access roads, the clearing of servitudes and the levelling of substation yards. Servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, to prevent vegetation from intruding into the legally prescribed clearance gap between the ground and the conductors and to minimize the risk of fire under the line which can result in electrical flashovers. These activities have an impact on birds breeding, foraging and roosting in or in close proximity of the servitude through modification of habitat.

3.1.4 Disturbance

Similarly, the above mentioned construction and maintenance activities impact on bird through disturbance, particularly during breeding activities.

3.2 Description of impacts of this proposed power line

NOTE: Time did not permit presentation of the full detailed assessment of the impacts discussed below and their ratings (APPENDIX 2 & 3). This will be presented in the next phase of this study. Impacts will be assessed according to the criteria below in TABLE 5.

3.2.1 Electrocution during the lifespan of the power line

On this size power line and with this proposed tower structure, electrocution of birds is highly unlikely and is not considered further in this study.

3.2.2 Collision with overhead cables during the lifespan of the power line

Collision of birds with the earth wires, is considered as the major impact that this power line will have on birds. Red Data species in the study area that will be most affected include: Blue Crane, bustards, flamingos, storks, Secretarybird, korhaans.

3.2.3 Disturbance during the construction and maintenance activities associated with the power line

Disturbance of birds, both during their normal daily activities, and during breeding, is not considered likely to have a major impact in this study area. It will however be discussed further in this study.

3.2.4 Habitat destruction during the construction and maintenance activities associated with the power line

Destruction of habitat is not likely to be a significant impact on the birds in the area, provided that sensitive areas are avoided. This impact will be discussed further.

3.2.5 Impact of birds on quality of electrical supply during the lifespan of the power line

Due to the proposed tower structure (compact cross rope suspension) having no suitable perching or nesting space above the conductors, it is highly unlikely that birds will impact on the electrical supply by bird pollution or nests at the "in line" towers, however the strain towers will be the usual "self supporting" and will need to be fitted with Bird Guards to prevent the birds perching in the high risk areas above the live hardware.

TABLE 5 – Criteria used to rate impacts of the proposed power line on the Red Data bird species (Adapted from Guideline Document, EIA Regulations, Implementation of sections 21, 22 and 26 of the Environment Conservation Act, April 1998, DEAT).

CRITERIA	DESCRIPTION OF ELEMENTS THAT ARE CENTRAL TO EACH ISSUE.
Conservation Status	A Red Data species is classified as one of the following according to Barnes *et al* (2000): **Critically endangered** Species faces an extremely high risk of extinction in the wild **Endangered** Species faces a very high risk of extinction in the wild **Vulnerable** Species faces a high risk of extinction in the wild **Near-threatened** Species is close to or likely to become vulnerable in the near future
Nature of impact	**Collision** This is a direct impact that occurs when a bird flies into or collides with the overhead conductors or earth wires of a power line **Electrocution** This is a direct impact that occurs when a bird touches either two live phases, or one live phase and an earthed object simultaneously **Nesting** Certain bird species build their nests on the towers **Habitat destruction** This is an indirect impact, whereby construction and/or maintenance of the power line destroys or degrades a particular birds habitat **Disturbance** This is an indirect impact, whereby construction and/or maintenance activities disturb the bird, particularly during breeding season **Impact of birds on quality of electrical supply** Through perching or nesting on the towers birds may impact on quality of supply through their nest material or excreta
General susceptibility	**High** The species is known to be frequently impacted on **Medium** The species is known to be impacted on **Low** The species is known to be infrequently impacted on **Unknown** It is unknown whether the species is impacted on
Degree of Certainty	**Definite.** More than 90% sure of a particular fact or of the likelihood of an impact occurring.
	Probable. Over 70% sure of a particular fact or the likelihood of an impact occurring.

	Possible. Only over 40% sure of a particular fact or of the likelihood of an impact occurring.
	Unsure. Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Expected Locality	This is a description of the specific locality that the impact is likely to occur at.
Duration	**High (long term).** Permanent. Beyond decommissioning. Long term (more than 15 years).
	Medium (medium term). Reversible over time. Lifespan of project. Medium term (5-15 years).
	Low (short term). Quickly reversible. Less than the project lifespan. Short term (0-5 years).
Intensity or Severity	**High.** Destruction of rare or endangered species.
	Medium. Significant reduction in species occurrence
	Low. Minor change in species occurrence
Magnitude and Significance	**High.** Of the highest order possible within the bounds of impacts that could occur. In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time consuming or a combination of these. Project must be abandoned in part or totality
	Medium. Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur /the impact is substantial in relation to other impacts that might take effect within the bounds of those that could occur, but mitigation is both feasible and fairly easily possible.
	Low. Impact is of a low order and therefore likely to have little real effect/ impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur and mitigation is both feasible and fairly easily possible
	No impact. Zero impact.

4 ENVIRONMENTAL ASSESSMENT

Below is a description of the four alternatives, the cross over option – and the two additional short lengths of line. Since the study area in general is fairly uniform the differences between the alternatives relates mainly to their proximity to sensitive features such as the pans, arable lands, and dams. The description below therefore focuses on these features. The exact position of the alternatives and the two new buffer areas can be seen in APPENDIX 4b to f. The maps in APPENDIX 4b to f have made use of land cover data to display the position of pans, dams, river, and arable lands (the main sensitive features in this study area from a bird perspective). Due to the size of the study area and the features above, it was necessary to split the study area into four sections in order to adequately display the difference between alternatives. APPENDIX 4b shows the entire study area, with the four sections, and APPENDIX c to f shows the four sections individually.

4.1 Aternative1 - Eastern

- For the first part from Perseus Substation, it is adjacent to Alternative5
- Whilst still adjacent to Alternative5 it passes between a group of pans
- It then branches off and remains approximately 2km west of Alternative5 for most of its full length
- It then stays relatively far from any significant features until 2924BD where it passes over a small group of arable lands
- In 2924DB it then passes right next to a large pan
- In 2924DA it passes over a group of arable lands along the Sarel Hayward Canal area
- Further south, in 2924DC, it passes over several more arable lands along the Orange River
- For the remainder of the route it remains clear of any features until it reaches Hydra Substation

4.2 Aternative2 - Central

- The Central alternative is situated approximately 8 kilometres west of the existing 765kV line
- This route passes really close to three significant pans in 2825CD & 2925AA
- It passes between two large pans in 2924DB (problematic as birds will fly between pans)
- It passes over the main concentration of arable lands along the Sarel Hayward Canal area and Orange River
- For the remainder of its length it is relatively featureless

4.3 Alternative3 - Western

- The Western alternative is situated approximately 12 kilometres west of the existing 765kV line
- This route passes close by two significant pans in 2825CC and 2925AA
- It passes close to another large pan in 2924DA
- It crosses the Sarel Hayward Canal area through a dense area of arable lands
- It crosses the Orange River area at a point relatively free of arable lands
- It then remains well clear of any sensitive features for the remainder of the route.

4.4 Alternative4 - Cross over options

- Most of the various cross over options make little difference to the other alternatives in terms of proximity of sensitive features.

4.5 Alternative5 - Existing 765kV

- This alternative is situated as close to the existing 765kV line as is technically possible ie a distance of approximately 80m
- The first part of its route is shared with Alternative1
- It then branches off and passes fairly close to two or three medium sized pans and a sprinkling of small arable lands
- It keeps well clear of the large pans that Alternative1 passes in 2924DB
- It crosses the Sarel Hayward Canal area just to the east of the main congregation of arable lands, thereby avoiding passing over any lands
- At the Orange River it crosses through a gap in the arable lands thereby avoiding crossing many lands
- Of the four alternatives, Alternative5's crossing point over the Sarel Hayward Canal area and Orange River is most optimal in terms of avoiding arable lands

4.6 Additional line 1 – 12 km 765kV from Perseus to Beta Substations

- It appears from the land use data that this line will be situated well clear of any pans, arable lands or dams and rivers (Appendix 4c). However this will need to be confirmed once the exact alignment is decided upon.

4.7 Additional line 2 – 33km 400kV from Perseus Substation to existing Beta-Hydra 400kV line

- The land use data (Appendix 4c) shows a number of large pans (up to approximately 2.5km in diameter) in the buffer area for this section of line. There is a strong possibility that wherever the line is placed within this buffer it will pass close to one or more of the pans. In general there is less concentration of pans to the east of the buffer area.
- There are several existing lines in the east of the buffer area – it would make sense to try to place this new line adjacent to one of these.

5 RECOMMENDED MITIGATION MEASURES

The mitigation measures that will be recommended for the impacts of this line on the birds will depend on the exact ratings of the various impacts for the various species (APPENDIX 2 & 3) and so will be detailed in the next phase of the study.

6 CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations will only be written once the detailed assessment of impacts has been carried out.

6.1 Selection of alternatives

This phase of the study did not enter into any detailed analyses of the different alternatives. At this preliminary stage, bearing in mind that the main bird impact is that of collision, it is felt that the most preferred alternative from a bird impact perspective will be the “Alternative5 - Existing 765kV”. This preliminary observation is based on the premise that building additional lines adjacent to existing lines will minimise the collision impact as opposed to building them on their own in the landscape. The argument for this premise is detailed below:

- The more overhead power lines there are together, the more visible they would be to the birds in the area (Avian Power Line Interaction Committee - 1994).
- Resident birds in an area become accustomed to a power line that crosses their flight paths, and learn to avoid it during their everyday activities. Hence adding a new power line adjacent to an existing line would probably have less impact than putting it in a totally new area, where the resident birds are not yet accustomed to overhead power lines.
- Spatially, it makes more sense to have all the threats to birds (in particular through collision) in one relatively confined area, rather than spread out across the landscape.
- Building the new line adjacent to an existing line should to a certain extent eliminate the need for new access roads and gates etc. This would reduce the level of disturbance and habitat destruction. In addition, birds in the immediate vicinity of the existing line would already be relatively tolerant of disturbance as a result of maintenance activities on this line.

6.2 Assessment of two additional sections of line

- The 12km section of line appears to pass through an area relatively devoid of sensitive avifaunal areas.
- The 33km section of line should preferably be placed as far to the east of the buffer as possible to avoid the concentration of large pans in the west of the buffer area. This would also present the opportunity to place the line adjacent to one of the already existing lines in the area which would be advantageous for reasons already discussed elsewhere in this report.

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APPENDIX 1

BIRD MICROHABITATS

Arable lands

Salt pans

Wetland

River & riverine habitat


River & riverine habitat

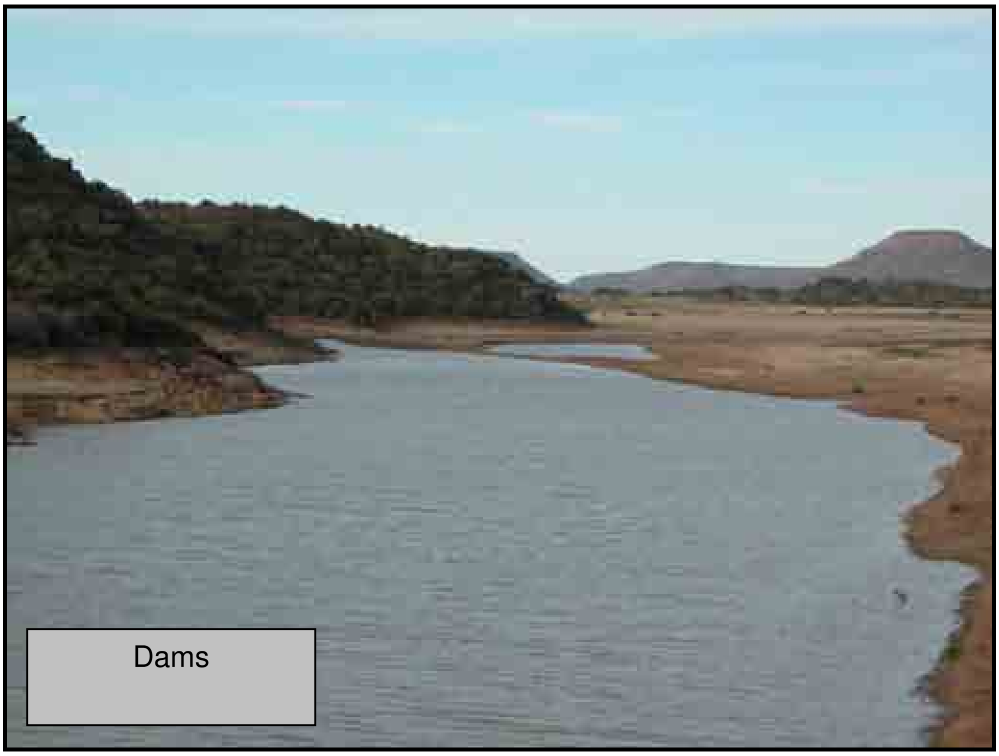

Flats or plains


Flats or plains


Rocky kopjes or ridges


Rocky kopjes or ridges


Dams


Dams


Bushveld or
thicket

APPENDIX 2

IMPACTS RATING RED DATA SPECIES

Note: Electrocution of birds is highly unlikely and is not considered an impact on the proposed tower structure and is not discussed further.

Species	**Conservation status**	**Nature of impact**	**General susceptibility to impact**	**Degree of certainty**	**Expected locality**	**Duration**	**Intensity or severity**	**Magnitude & Significance**
White-backed Vulture	V							
Martial Eagle	V							
Tawny Eagle	V							
Blue Crane	V							
Kori Bustard	V							
Cape Vulture	V							
African Marsh Harrier	V							
Greater Flamingo	NT							
Lesser Flamingo	NT							
Secretarybird	NT							
Black Harrier	NT							
Lesser Kestrel	NT							
Ludwig's Bustard	NT							
Blue Korhaan	NT							
Melodious Lark	NT							
Short-clawed Lark	NT							
Yellow-billed Stork	NT							

Black Stork	NT							
Painted Snipe	NT							
Lanner Falcon	NT							
Caspian Tern	NT							
Chestnut-banded Plover	NT							
White Stork	Bonn							
Abdim's Stork	Bonn							

APPENDIX 3

IMPACTS RATING NON RED DATA SPECIES

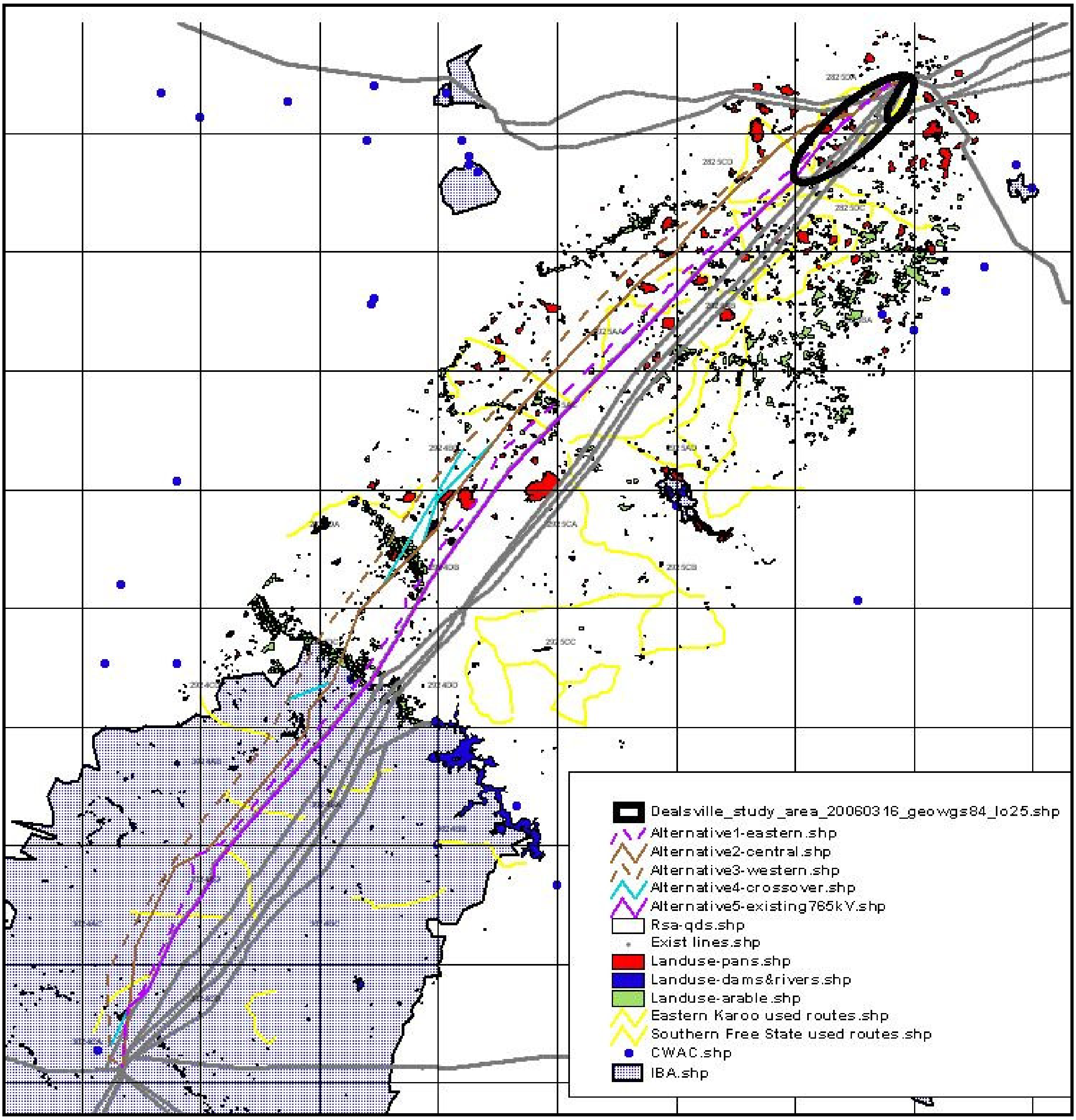
Note: as mentioned elsewhere, electrocution of birds on the proposed compact cross rope suspension towers is highly unlikely and is not included as an impact below.

Species	**Impact & general susceptibility**	**Location**	**Significance**
Waterbirds:			
Large & medium raptors:			
Ibises & spoonbill:			
Corvids:			
Large terrestrial birds:			

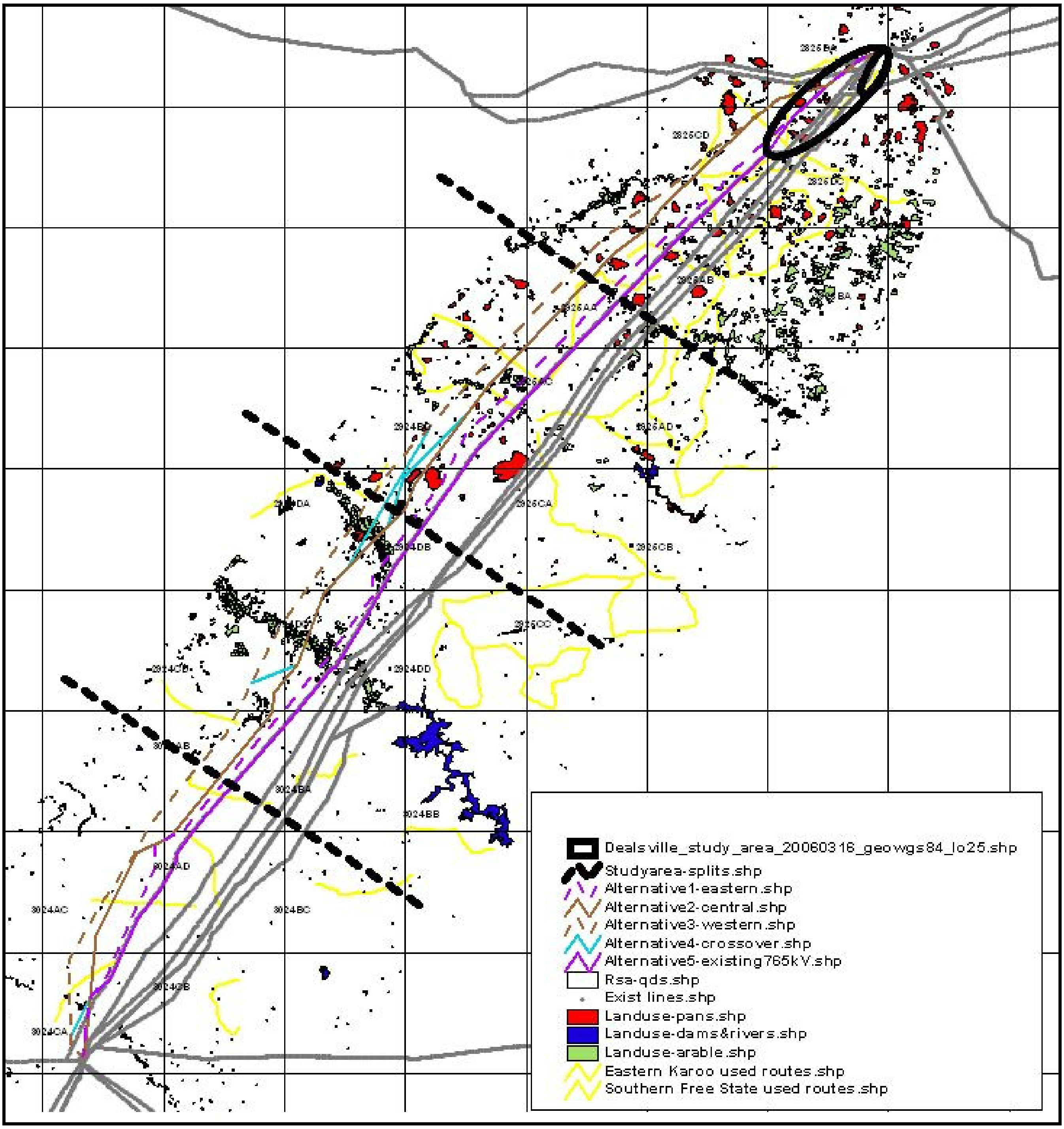
APPENDIX 4

MAPS OF STUDY AREA

Appendix 4a


Dealsville_study_area_20060316_geowgs84_lo25.shp
Alternative1-eastern.shp
Alternative2-central.shp
Alternative3-western.shp
Alternative4-crossover.shp
Alternative5-existing765kV.shp
Rsa-qds.shp
Exist lines.shp
Landuse-pans.shp
Landuse-dams&rivers.shp
Landuse-arable.shp
Eastern Karoo used routes.shp
Southern Free State used routes.shp
CWAC.shp
IBA.shp

Appendix 4b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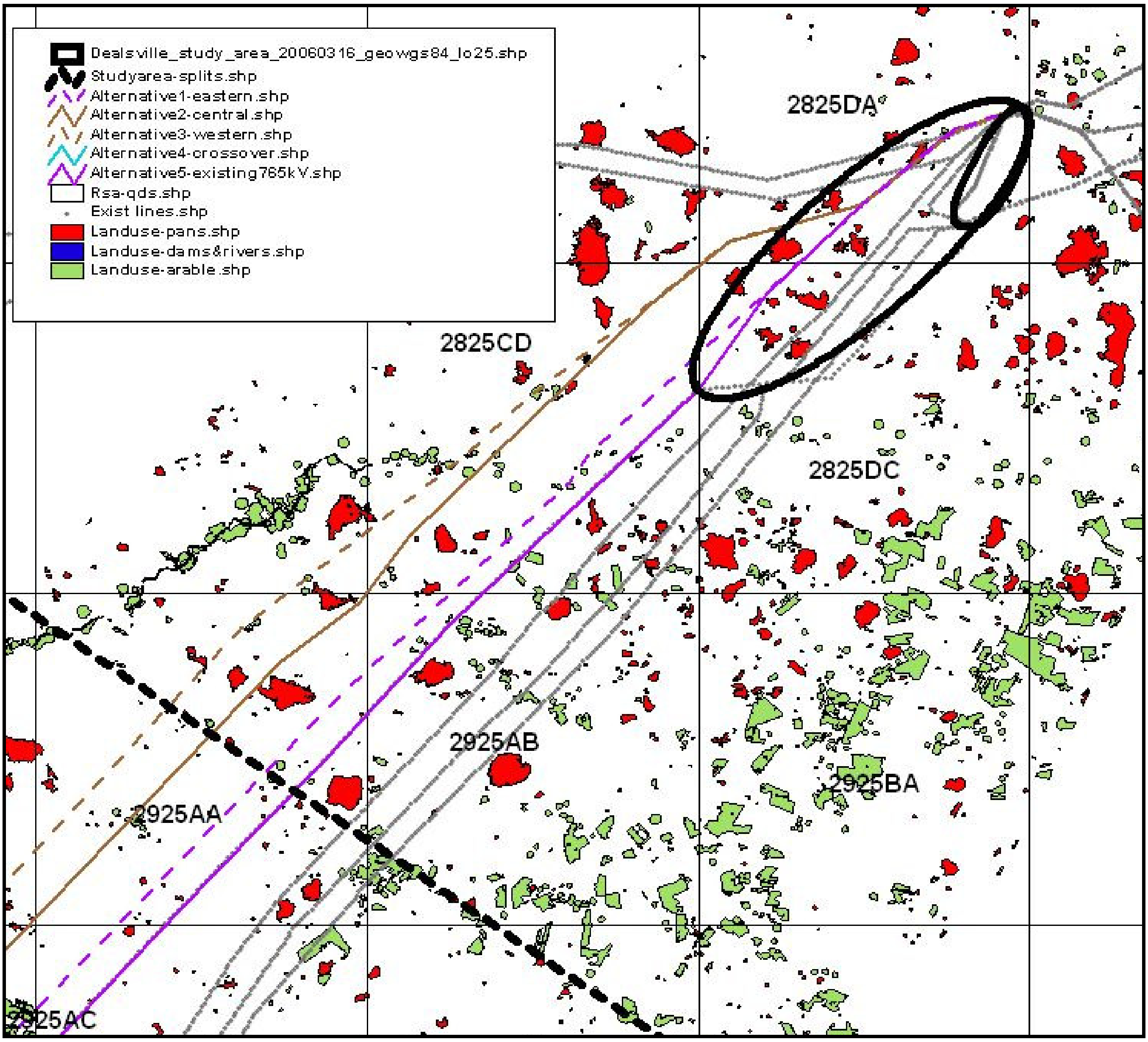
Studyarea-splits.shp
Alternative1-eastern.shp
Alternative2-central.shp
Alternative3-western.shp
Alternative4-crossover.shp
Alternative5-existing765kV.shp
Rsa-qds.shp
Exist lines.shp
Landuse-pans.shp
Landuse-dams&rivers.shp
Landuse-arable.shp
Eastern Karoo used routes.shp
Southern Free State used routes.shp

Appendix 4c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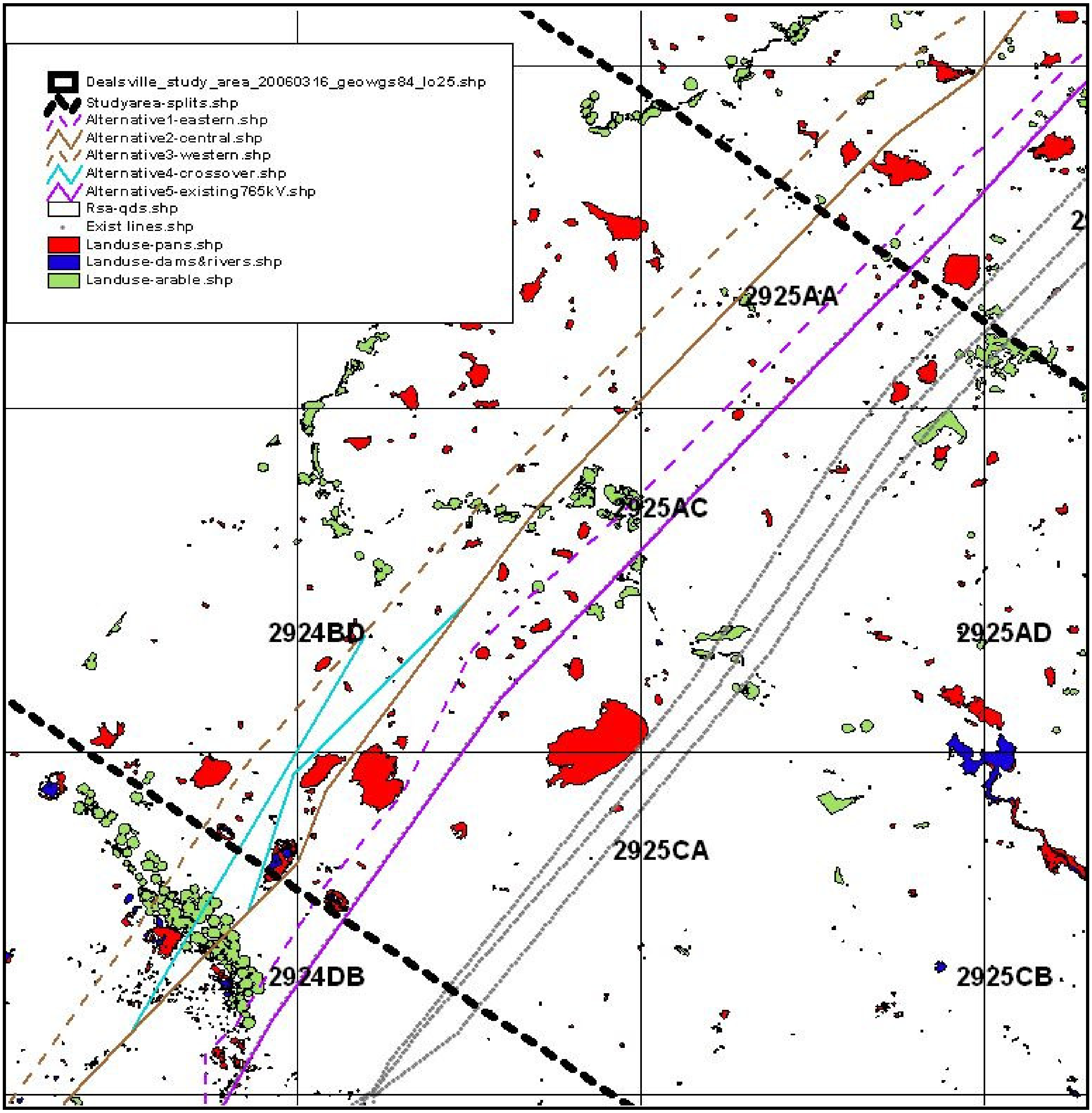
Alternative4-crossover.shp
Alternative5-existing765kV.shp
Rsa-qds.shp
Exist lines.shp
Landuse-pans.shp
Landuse-dams&rivers.shp
Landuse-arable.shp
2825DA
2825CD
2825DC
2925AB
2925BA
2925AA
2925AC

Appendix 4d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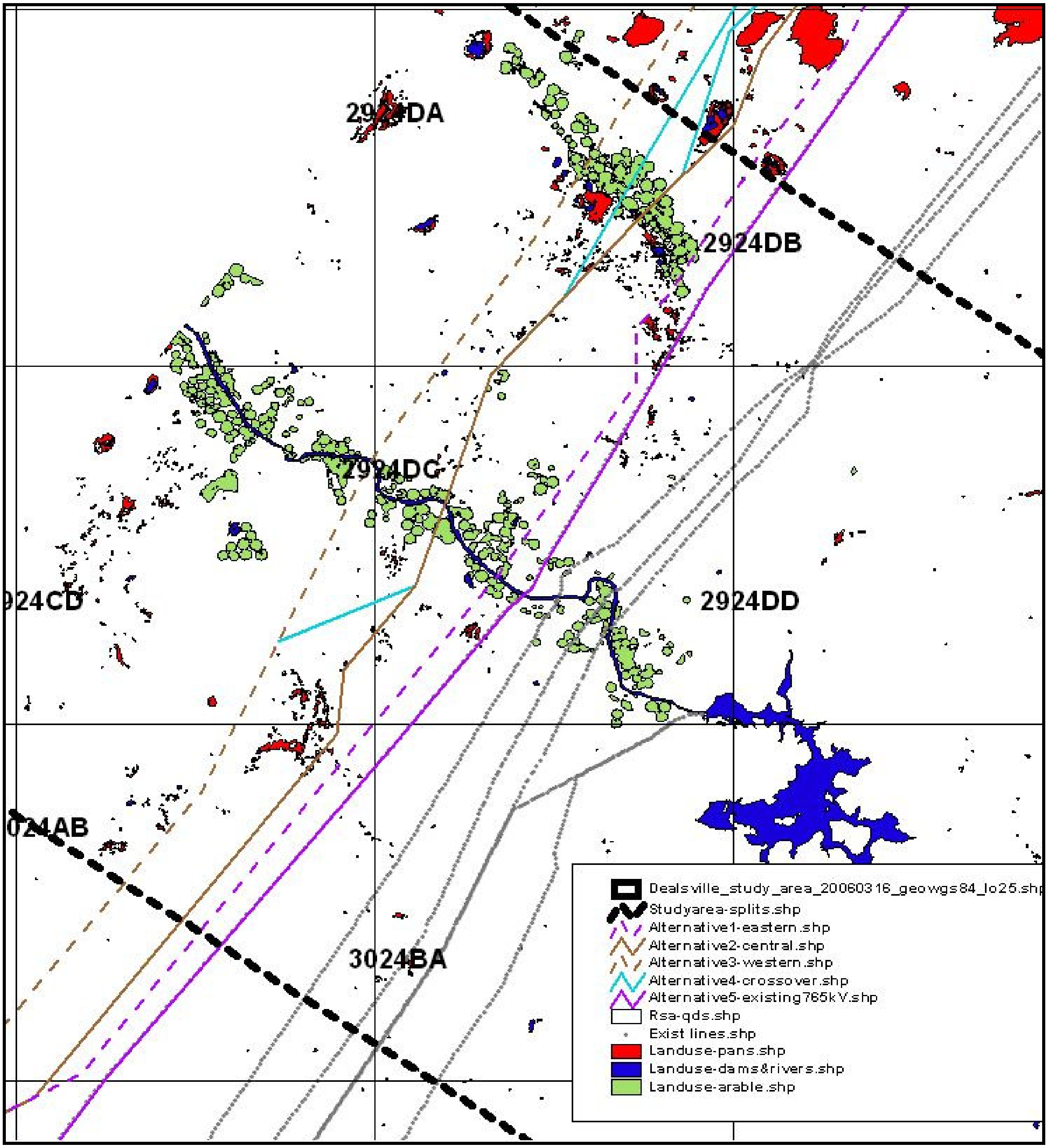
Alternative3-western.shp
Alternative4-crossover.shp
Alternative5-existing765kV.shp
Rsa-qds.shp
Exist lines.shp
Landuse-pans.shp
Landuse-dams&rivers.shp
Landuse-arable.shp
2925AA
2925AC
2924BD
2925AD
2925CA
2924DB
2925CB

Appendix 4e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2924DB
2924DC
924CD
2924DD
024AB
3024BA
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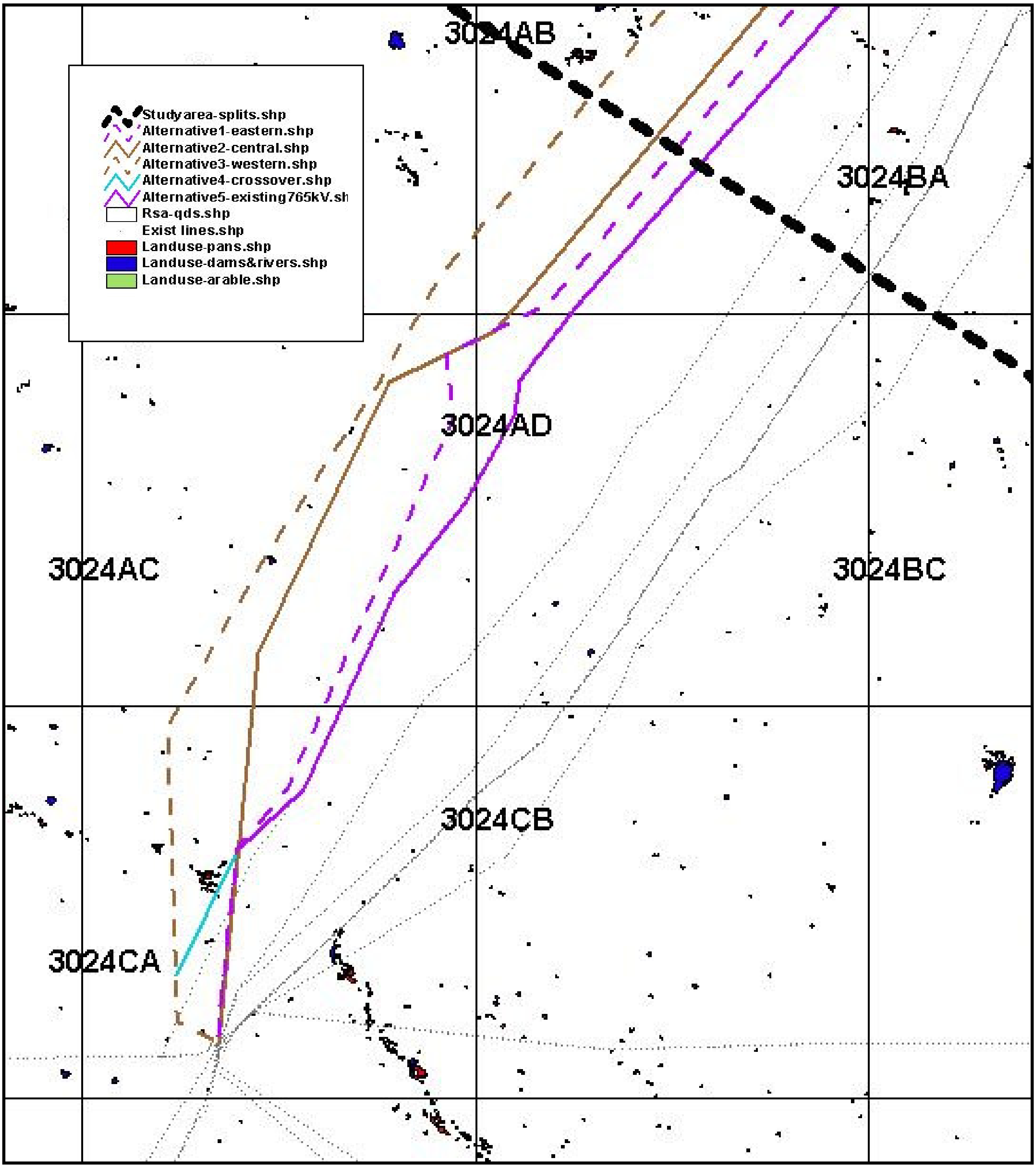
Studyarea-splits.shp
Alternative1-eastern.shp
Alternative2-central.shp
Alternative3-western.shp
Alternative4-crossover.shp
Alternative5-existing765kV.shp
Rsa-qds.shp
Exist lines.shp
Landuse-pans.shp
Landuse-dams&rivers.shp
Landuse-arable.shp

Appendix 4f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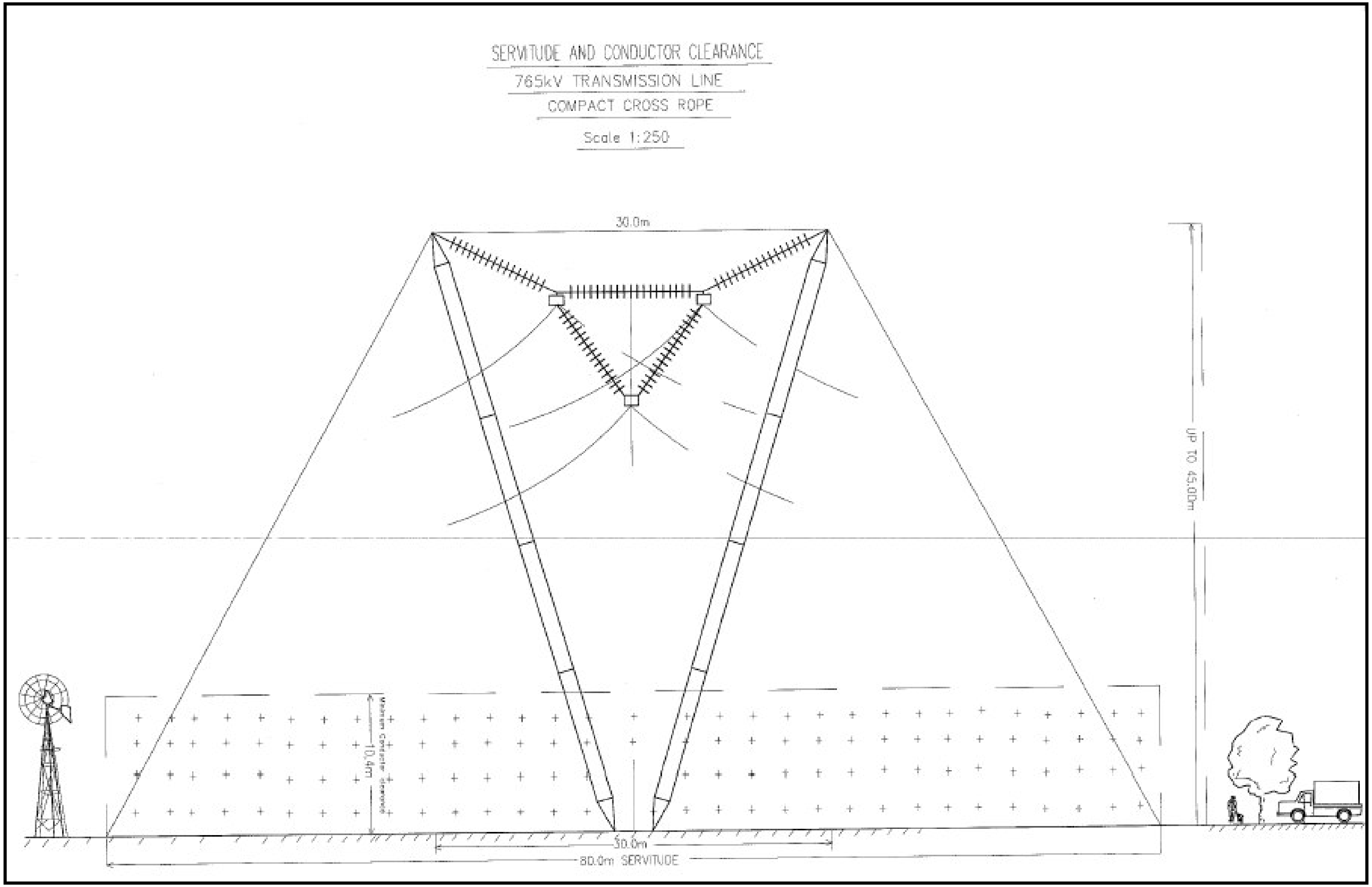
Alternative1-eastern.shp
Alternative2-central.shp
Alternative3-western.shp
Alternative4-crossover.shp
Alternative5-existing765kV.sh
Rsa-qds.shp
Exist lines.shp
Landuse-pans.shp
Landuse-dams&rivers.shp
Landuse-arable.shp
3024AB
3024BA
3024AD
3024AC
3024BC
3024CB
3024CA

APPENDIX 5

TECHNICAL DIAGRAM OF PROPOSED TOWER STRUCTURE


SERVITUDE AND CONDUCTOR CLEARANCE
765kV TRANSMISSION LINE
COMPACT CROSS ROPE
Scale 1:250
30.0m
UP TO 45.0m
10.4m
30.0m
80.0m SERVITUDE