SKA PHASE I INFRASTRUCTURE

FAUNA AND FLORA PRECONSTRUCTION WALK-THROUGH REPORT

PRODUCED GAEA ENVIRONMENTAL

3Foxes Biodiversity Solutions

Simon.Todd@3foxes.co.za

FEBRUARY 2020

Introduction & Background

GAEA Enviro has appointed 3Foxes Biodiversity Solutions to undertake the Ecology (Fauna and Flora) Assessment and fieldwork for the proposed gap analysis for the SKA site and the three spiral arms to comply with the requirements of the SKA1_MID IEMP and EMPr. The scope of work includes:

- review SAEON assessment and fieldwork report and updated maps/spatial data;
- conduct specialist fieldwork within the SKA site and spiral arms based on latest SKA1_MID layout and identify any areas unsuitable for development or very sensitivity area or features which require further mitigation or avoidance;
- refine the fine-scale map and four tier sensitivity maps for the SKA site and three spiral arms;
- review and add inputs where required to the Alien Invasive Control and Monitoring Plan, the revegetation and rehabilitation plan and to the plant rescue and translocation programme;
- address any gaps in terms of the ecological assessment and mapping specified in Appendix A in order to comply with the requirements of the IEMP and EMPr.

The purpose of the ecological walk-through of the approved SKA Phase 1 infrastructure located in the Carnarvon-Brandvlei-Williston area in the Northern Cape is to locate and identify any protected or threatened plant species or fauna of conservation concern within the development footprint of the SKA and which may be impacted by the development. This report details the findings of the walk-through study that was conducted within certain identified parts of the development footprint. The identity and location of all listed and protected species is provided, which can be used as input for the vegetation clearing permit application that is required from the provincial authority before construction can commence. Recommendations for avoidance or search and rescue are provided as appropriate.

It is important to note that the complete SKA Phase 1 layout has also been walked by SAEON and a report on the findings of this study has been produced and provided to SKA. This included the identification of habitats or 'biotypes' that are considered sensitive based on the rarity or ecological role of the habitats present and the presence of species or features of conservation concern within these areas. This information has been used to inform the final layout of the SKA Phase 1 infrastructure as follows "*In a meeting held the 25th of July 2018, the SAEON ecologist and SARAO managers and engineers reconfigured SKA Phase 1 infrastructure and routing to be more ecologically sensitive. All infrastructure and routing that were classified as areas Unsuitable for Development were moved. No areas Unsuitable for Development are left, and each infrastructure or routing moved given a new ecological assessment.*" As such, the final layout as considered in this report represents a mitigated layout where ecological impacts have already been minimised as far as possible.

Relevant Aspects of the Development

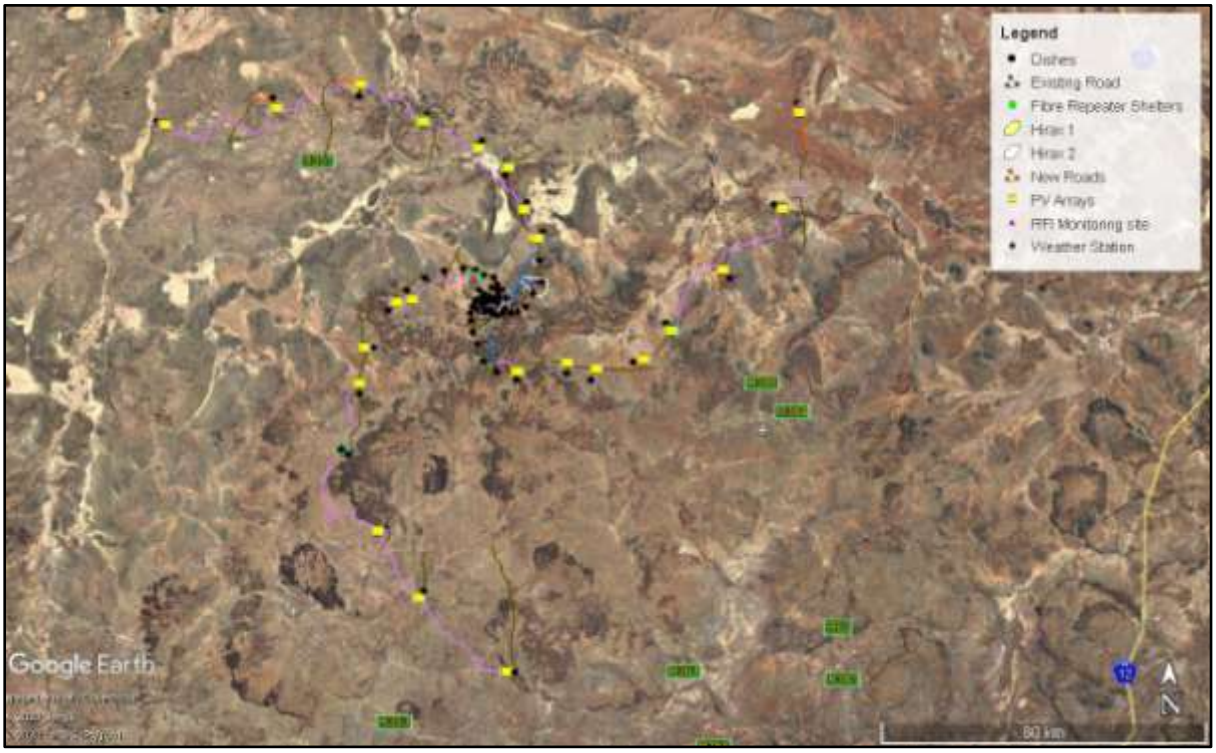

Figure 1. Satellite image illustrating the layout of the SKA Phase 1 Mid.

The layout of the facility is illustrated above in Figure 1 and comprises 133 telescope dishes with supporting infrastructure. The list of infrastructure to be assessed for SKA1_MID includes the following:

- Underground fibre and power cable
- Overhead fibre and power cable
- Dish antennas
- Roads (new roads + existing roads to be rehabilitated)
- Proclaimed roads in the area (extra if necessary for your consideration)
- Borrow pits
- Quarries
- Visserkloof construction camp
- PV plants – spiral arms
- Site monitoring stations locations (including: repeater, weather RFI and visual stations)
- HIRAX (16 ha) and Visserkloof construction camp

Environmental Baseline Study of the SKA Site and three spiral arms

During the SKA1_MID SEA, an environmental baseline study was conducted by SAEON (Dr Simon Todd) for the SKA core and by the SEA specialist (Dr Sue Milton) for the larger SKA site and three spiral arms. Based on further analysis and fieldwork, SAEON conducted an extensive fieldwork and produced an environmental baseline based on biotope classification including the key terrestrial biotopes in the SKA radio astronomy observatory to guide sensitivity mapping, and the key transient aquatic biotopes in the SKA radio astronomy observatory. These studies are summarized and reviewed here with the major findings and gaps highlighted and addressed where possible.

Fauna

Milton (2017) provides a broad-baseline for the whole KCAAA1 area and includes a description of the fauna likely to be present within the KCAAA1 area. However, the KCAAA1 is much larger than the actual development footprint of the SKA and includes numerous vegetation and habitat types that are not present within the SKA development footprint, with the result that significantly fewer fauna of concern are likely to be present within the SKA footprint than within the broader KCAAA1. Tables of mammals, reptiles and amphibians and the likelihood that they are present within the SKA Core Area and Spiral Arms are presented in Annex 5, 6 and 7 of this report. The fauna of concern that are likely or potentially present within the site are discussed in Table 1 below. Several of the species of concern mentioned by Milton (2017) are not likely to be present within the SKA Core Area or the Spiral Arms.

In terms of red-listed species total of 9 terrestrial mammals, 1 reptile and 1 amphibian can be considered potentially or likely present within the SKA Core Area or the Spiral Arms. Some of these such as the Vaal Rhebok would certainly benefit from the protection of the SKA Core Area while others such as the Black-footed Cat have likely been locally extirpated and are likely to return once the habitat in the SKA Core Area becomes more favourable. In terms of the species mentioned by Milton (2017), the Ground Pangolin *Smutsia temminckii* is not likely to be present within the site as this species prefers Savannah and Kalahari veld which is not present within the SKA Core or Spiral Arms. The Honey Badger is no longer red-listed and while this species has a high probability of being present, it is no longer considered to represent a species of conservation concern.

In general there are two main habitats within the SKA that can be considered to be of high general importance for terrestrial vertebrates. The drainage lines are an important habitat for many species due to the forage and cover these dense vegetation provides, while for amphibians, the presence of freshwater is required for breeding. The rocky hills of the area are also generally important for fauna as the rocky habitats present provide cover for many species of mammals and reptiles, while the high-lying ground also provides some refuge from the heat and aridity of the surrounding plains.

Table 1. Summary of terrestrial vertebrates of conservation concern that are likely to be present within the SKA.

Scientific name	Common name	Red list category	Probability of Occurrence	
			SKA Core	Spiral Arms
Mammals				
Pelea capreolus	Vaal Rhebok	NT	Not observed to be present currently, but would likely return to the SKA Core area where it would be associated with the larger mountains of the site, especially in the south. Likely to benefit from protection of the site.	This species is likely to be present within the southern and eastern spiral arm on higher ground.
Atelerix frontalis	Southern African Hedgehog	NT	This species is not likely to be present within the SKA Core Area as it usually prefers areas with dense vegetation.	Unlikely to be present, but possibly in the far east if at all.
Felis nigripes	Black-footed Cat	VU	Has not been recorded from the SKA Core area, but is widespread in the Upper Karoo and is likely to present and is likely to benefit from the decrease in grazing pressure and an increase in cover and prey availability.	Likely to be present, especially in the east at typical low density.
Panthera pardus	Leopard	VU	Unlikely, most suitable habitat is the rugged terrain in the south of the SKA Core Area.	Unlikely due to limited extent of favourable terrain and persecution from farmers.
Hyaena brunnea	Brown Hyena	NT	Free-ranging Brown Hyena on farmland are rare and it is not likely to be present. Would potentially benefit from protection of the site and an increase in prey availability.	Possible but free ranging populations in this part of the Northern Cape are not known to occur in recent times.
Bunolagus monticularis	Riverine Rabbit	CR	Highly unlikely that Riverine Rabbits are present in the SKA Core area as the amount of suitable habitat is limited and there are no records from this far north.	Possible, especially in the south towards Fraserburg.
Parotomys littledalei	Littledale's Whistling Rat	NT	This little known species has been recorded from across the Upper Karoo and is likely present within the SKA Core.	This little known species has been recorded from across the Upper Karoo and is likely present within the SKA Spiral Arms.
Aonyx capensis	African Clawless Otter	NT	Highly unlikely as there is little permanent water in the SKA Core Area	Unlikely as there is little perennial water in the area but may occur along some of the major drainage lines with permanent pools.
Poecilogale albinucha	African Striped Weasel	NT	Highly unlikely as this species prefers wetter habitats than occur in the SKA Core Area.	Possible in far east, but prefers wetter habitats.
Reptiles				
Chersobius boulengeri	Karoo Padloper	NT	Possible as there is suitable habitat on site. Most likely to be more	Likely to be present along the southern Spiral Arm in

			common in the south.	the rocky hills habitat.
Amphibians				
Pyxicephalus adspersus	Giant Bull Frog	NT	Possibly present in some of the non-saline pans with fringing riparian vegetation.	Likely present on higher-lying ground where there are non-saline pans present.

Broad-Scale Vegetation Types

The baseline study for the Core Area (Todd 2017) indicates that there are four vegetation types within the SKA Core Area, namely Bushmanland Basin Shrubland, Upper Karoo Hardeveld, Western Upper Karoo and Bushmanland Vloere. The VEGMAP has however been updated since that study was conducted and a newer 2018 beta version is currently available from the BGIS website. Interrogation of the 2018 VegMap indicates that vegetation mapping for the SKA Core area has not been affected by the update to the VegMap with the result that the previous study is still relevant and accurate for the SKA Core Area. The broad-scale descriptions of these vegetation types is available both in Mucina & Rutherford (2006) as well as the Todd (2017) study and are not repeated here. The 2017 study does however highlight the fact that the drainage systems of the area have not been mapped as a distinct unit in the VegMap. This is still an issue on the most recent version and represents a significant gap in the VegMap for the study area. There is not currently an appropriate designation for the drainage lines of the study area and the Upper Karoo in general, but they can be considered to be most similar to the Southern Karoo Riviere vegetation type.

A gap in the existing baseline studies is that they do not provide an understanding of how the impact of the SKA development footprint would be distributed across the affected vegetation types. This has been calculated below (Table 2) and indicates that close on 90% of the footprint within the SKA Core Area would be within the Bushmanland Basin Shrubland vegetation type with the remaining 10% distributed between Western Upper Karoo and Upper Karoo Hardeveld. Within the Spiral Arms, Bushmanland Basin Shrubland is also the main vegetation type affected, but only 64% of the footprint is within this vegetation type with significant areas also within Western Upper Karoo and Northern Upper Karoo and relatively small areas within Bushmanland Sandy Grassland, Bushmanland Vloere, Upper Karoo Hardeveld, and Bushmanland Arid Grassland.

Table 2. Extent of the SKA development footprint within the different affected vegetation types, broken down according to the footprint within the core area and the spiral arms.

Name	Veg Type Extent (km^2)	Core Impact (Ha)	Arms Impact (Ha)	Total Loss (Ha)
Bushmanland Arid Grassland	45 479	0	8.62	8.62
Bushmanland Basin Shrubland	34 690	333.24	394.17	727.41
Bushmanland Sandy Grassland	2 283	0	15.40	15.40
Bushmanland Vloere	4 706	0.81	11.86	12.67
Northern Upper Karoo	41 829	0	69.15	69.15
Upper Karoo Hardeveld	11 734	12	10.67	22.69
Western Upper Karoo	17 149	24.23	106.14	130.37
Total		**370.28**	**616.02**	**986.3**

In terms of the broad-scale sensitivity of the different vegetation types affected by the SKA, there are some intrinsic differences in sensitivity related to the various associated habitats of each vegetation type. Bushmanland Arid Grassland, Bushmanland Basin Shrubland and Northern Upper Karoo are the least sensitive and tend to have a low abundance of plant and animal species of conservation concern present. Bushmanland Sandy Grassland is potentially sensitive as it is often host to the Red Lark *Calendulauda burra* which is classified as Vulnerable. It is also a relatively restricted habitat with a total extent of 2283 km^2 which is a low extent for an arid vegetation type and it is also often composed of loose sands and low dunes which can be vulnerable to disturbance. The Upper Karoo Hardeveld is considered a relatively sensitive vegetation type for several reasons including the high levels of plant diversity and endemism that are usually associated with these areas as well as the structure the rocky outcrops associated with this unit usually provide for fauna. Finally, the Bushlandland Vloere vegetation type represents the pans of the Bushmanland area and as these are important for fauna as well as hydrological processes, they are considered sensitive and due to their low slope are considered vulnerable to disruption and should not be disturbed.

The Milton (2017) SEA Ecology Report provides an indication of the number of red-listed plant species within each quarter degree square that fall within the KCAAA1 area. While this highlights areas with a greater number of such species observed, it should be interpreted with caution, as many of the quarter degree squares within the KCAAA1 area have been very poorly sampled and some of them have no records at all. As such, these numbers provide a better indication of the sampling intensity within these different areas rather than a true indication of the number of species of concern present. However, at a broad level, these can be interpreted to suggest that the Succulent Karoo vegetation types in the south of the KCAAA1 area have more such species than the Nama Karoo vegetation types of the rest of the KCAAA1. This is consistent with our understanding of diversity and endemism differences between the Nama and Succulent Karoo biomes. It is however important to note that the analysis is for the whole KCAAA1 and not the actual SKA MID 1 footprint area.

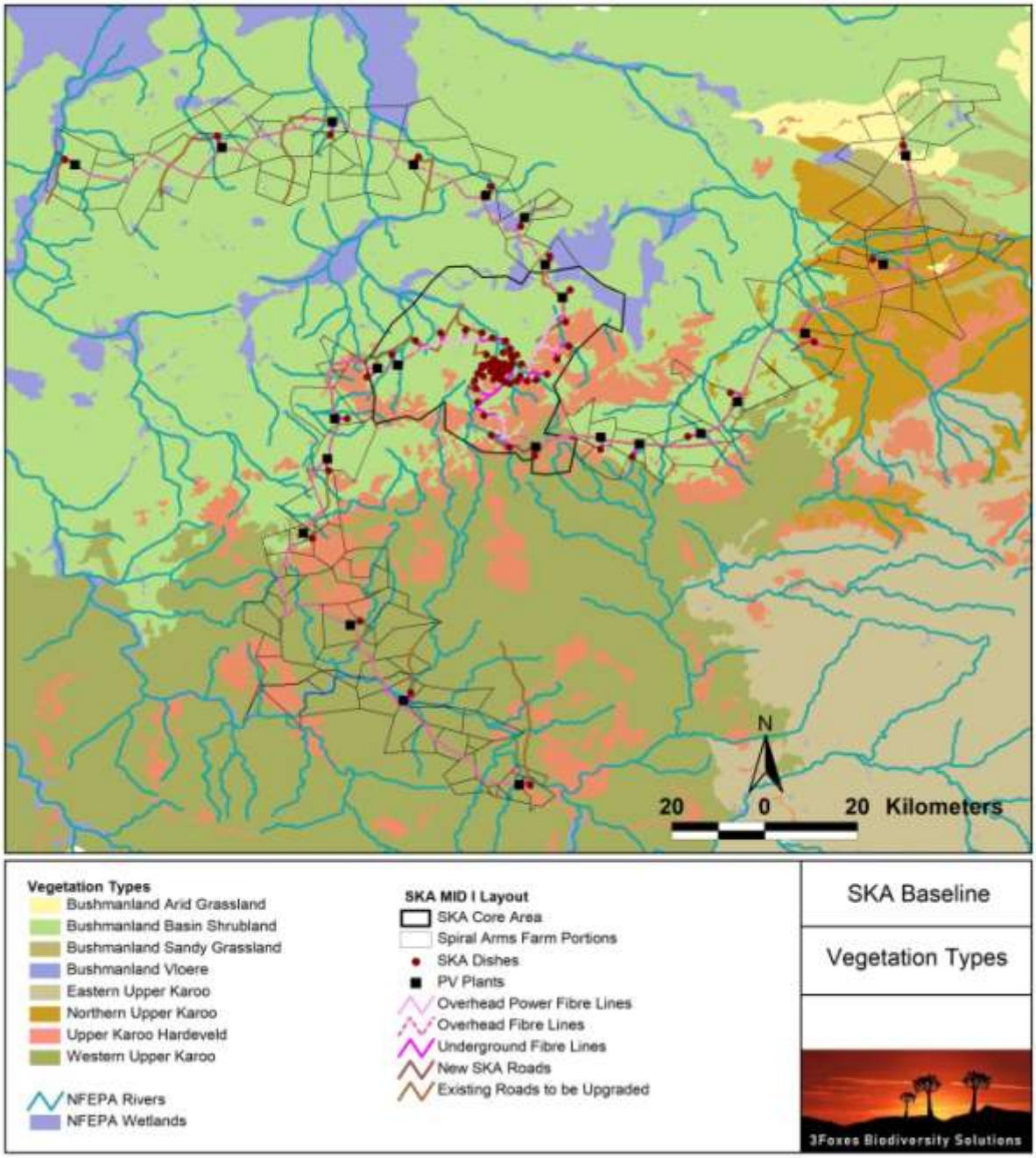

Figure 2. Vegetation map for the SKA and Spiral Arms, showing the SKA MID 1 layout and the NFEPA rivers and wetlands layers. The footprint of the development within each vegetation type has been calculated in Table 1.

Fine-Scale Habitats

In terms of fine-scale habitats of the SKA Core Area and the Spiral Arms, very little detailed work has been done on this aspect of these areas. The only breakdown of habitats is that provided by MacDonald (2011) in an unpublished study for the Meerkat EIA. Milton (2017) presents these as follows:

- Dolerite hills, inselbergs and pediments of exposed dolerite sills and dykes have sparse vegetation cover. Vegetation include a number of protected plant species (*Aloe dichotoma*, *Boscia albitrunca*) as well as *Rhigozum obovatum*
- Silt plains characterised by *Salsola aphylla* with *Lycium cinereum*, *L. oxycarpum* and an understorey of succulents, forbs and a few grasses (*Drosanthemum sp*., *Malephora crocea*, *Ornithogalum* sp., *Setaria verticillata*, *Stipagrostis ciliata, S. obtusa*. *Mesembryanthemum guerichianum*). Invasive alien species present were *Prosopis glandulosa* var*. torreyana* (mesquite), and *Atriplex lindleyi* subsp. *inflata* (spongefruit saltbush);
- Gravel plains below the flat-tipped hills were dominated by *Rhigozum trichotomum* with *Lycium* species*, Salsola aphylla*, and a grassy understorey of *Stipagrostis obtusa* with *Aridaria noctiflora*, *Asparagus retrofractus*, *Drosanthemum* sp., *Lebeckia*, *Leysera* sp., *Lycium cinereum*, *Malephora crocea*, *Osteospermum scariosum*, *Pentzia incana*, *Pteronia* sp., *Ruschia spinescens*, *Salsola tuberculata*, *Zygophyllum microphyllum* and invasive alien *Atriplex lindleyi*;
- Calcrete plains with lower, sparser vegetation similar in composition to gravel plains but with a greater abundance of *Salsola tuberculata*;
- Sand Washes or larger drainage lines are dominated by *Stipagrostis namaquensis* with *Lebeckia spinescens*, *Cenchrus ciliaris* and scattered *Searsia lancea* trees;
- Disturbed areas associated with farm dams and boreholes are characterised by large tree species (mainly invasive alien *Prosopis glandulosa*) and herbaceous indigenous and alien plants.

The above represents a vegetation-based habitat analysis and is very similar to the fine-scale mapping conducted by Todd (2017). Although the above descriptions are included in the Milton (2017) study, she does not use these units for mapping but rather adopts a functional approach based on sensitivity prioritization. According to the description provided, sensitivity prioritization scores consider components of functionality (water provision, dispersal corridor function, climate change resilience) and pattern (uniqueness, rare species, complexity, restoration potential). Although the more detailed habitat and plant community-based approach described above is preferable, for large areas this becomes impractical as the number of habitat and plant community units can be very large. For this reason, the approach taken by Milton (2017) is a logical approach to dealing with sensitivity mapping at large scales and is well validated. The mapping results produced by Milton (2017) are however very coarse and do not provide a useful fine-scale input for planning purposes. For the current study, both approaches as described above are used, with fine-scale community mapping within the SKA Core Area and a somewhat less-detailed approach taken within the Spiral Arms. This is necessitated due to the differences in available information between two areas the large scale of the cadastral units which span the Spiral Arms. However, the result is a much more detailed map than is currently available and has been produced at a scale which as appropriate for development planning.

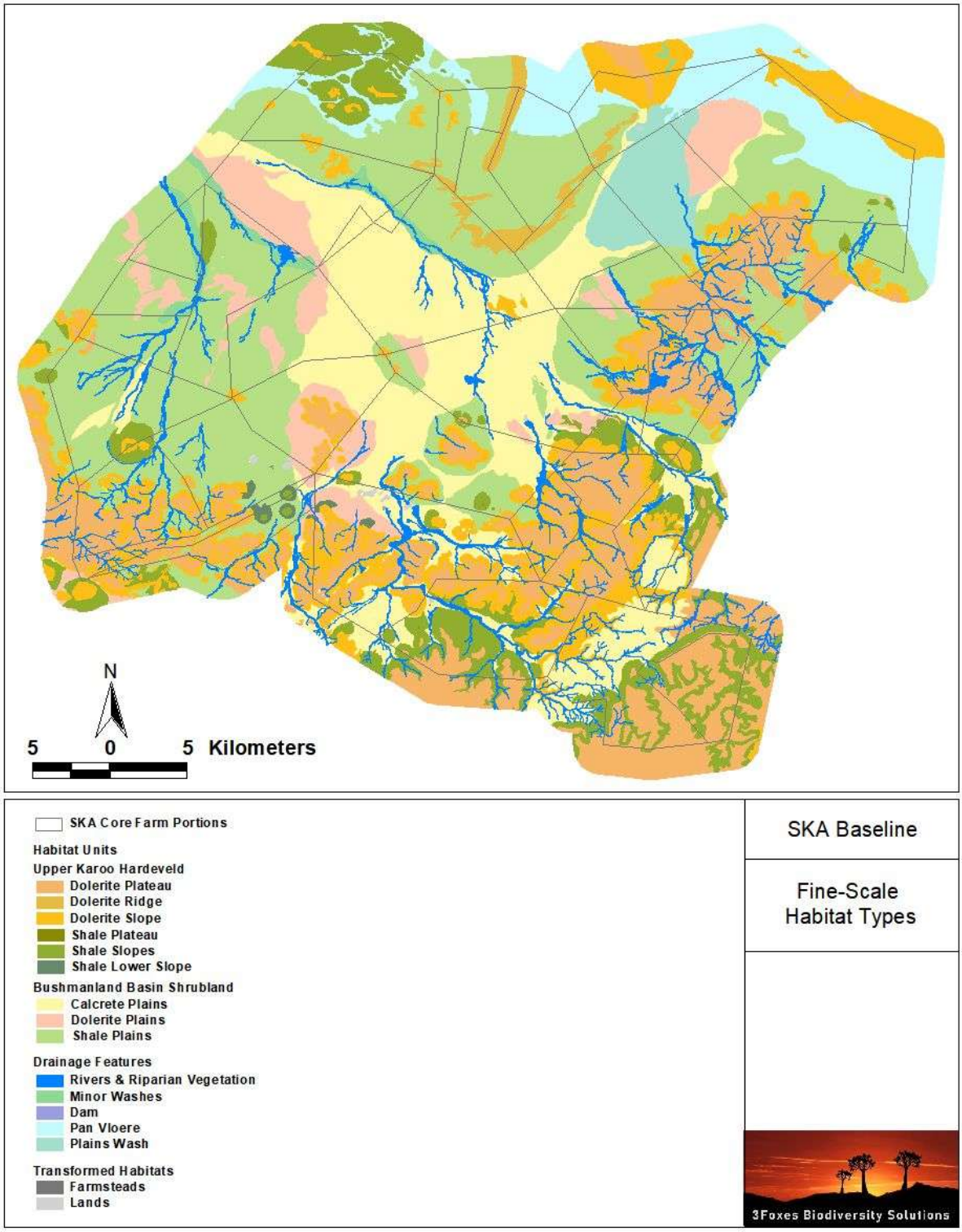

Figure 3. Fine-scale habitat map for the SKA core area and a 2km buffer. The map shows the high habitat diversity and heterogeneity of the southern parts of the SKA Core Area compared to the majority of the central and northern parts of the site.

The fine-scale habitat map for the SKA Core Area illustrated above in Figure 3, represents a significant advance on any currently available habitat map for the SKA Core Area. The map illustrates the high habitat heterogeneity and diversity of the southern parts of the SKA Core Area compared to the central and northern part of the site. The map also illustrates the shift from habitats related to the Upper Karoo Hardeveld in the south and east to the open plains associated with the Bushmanland Basin Shrubland in the central and northern parts of the site. Overall, the habitat map agrees well with observation from the field and the distribution of features and plant species of conservation concern.

In terms of the fine-scale sensitivity mapping within the Spiral Arms, the approach used resulted in more than 500 different planning units distributed across 11 different habitat types as described in Table 3 below. The final habitat map produced for the Spiral Arms is illustrated below in Figure 4. Milton did not produce a habitat map of the SKA area and as such, the current results cannot be directly compared to any previous studies for the area. However, the mapping is significantly more detailed than the VegMap and provides a detailed breakdown of the typical habitats present within the SKA Spiral Arms.

Table 3. Description of the 11 different habitats that where mapped within the SKA Spiral Arms.

Habitat Type	Habitat Description	Habitat Senstivity
Dolerite Hills	Dolerite-capped hills, mountains and inselbergs of the study area. Usually classified as *Upper Karoo Hardeveld*, there are many more of these units than have been mapped under the VegMap.	These areas usually classified as High Sensitivity due to the high plant and animal diversity of these habitats. Steeper slopes and areas of particular apparent significance have been classified as Very High Sensitivity, while some lower less-well developed hills were classified as Medium Sensitivity.
Low Hills	Typical lower hills and more uneven landscapes of the study area, usually with sandstone, and shale underlying geology. Mostly comprised of *Bushmanland Basin Shrubland* I and *Western Upper Karoo*.	These areas have generally been classified as Medium Sensitivity due to their moderate vulnerability to disturbance and the moderate presence of species of conservation concern.
Toeslopes	Lower slopes of the larger mountains of the study area, usually on weathered shale dominated by low shrubs. Mostly consisting of *Bushmanland Basin Shrubland*.	These areas have usually been classified as Medium Sensitivity, based on their vulnerability to disturbance and their plant and animal diversity.
Open Plains	Open plains of the study area, dominated by low shrubs or grasses. These areas may consist of *Bushmanland Basin Shrubland*, *Bushmanland Arid Grassland*, *Bushmanland Sandy Grassland* and *Western Upper Karoo*.	The open plains have been classified as being Low or Medium Sensitivity depending on their context and position in the landscape. Most of the plains are however the lowest sensitivity landscape units of the study area.
Confined Basins	Occasional confined basins surrounded by dolerite hills or similar confinement. These areas are distinct basins usually with a	These basins are usually classified as Medium Sensitivity as they represent important landscape features within a context where

	single drainage exit and as such represent single ecological units.	connectivity and ecological gradients are important.
Sand Dunes	Although the Bushmanland Sandy Grassland usually consists of parallel dune fields, there are also some occasional isolated dunes of Aeolian sands.	These isolated dunes have been classified as High Sensitivity as they are vulnerable to disturbance and usually represent fairly unique features in the landscape.
Alluvial Fans	There are two distinct alluvial fans within the northern spiral arm. As these are uncommon features in the Northern Cape, and appear to have some ecological importance, they have been identified as distinct features.	These are uncommon features related to large-scale hydrological processes and have been classified as High Sensitivity.
Dissected Plains	Plains and gentle slopes dissected by many minor drainage features. Usually associated with the *Western Upper Karoo* of the study area.	Due to the presence of many drainage features, these areas have been usually been classified as High Sensitivity.
Plains Wash	Flat plains with extensive sheetwash, often with salinization. Usually leading into larger pan or drainage systems.	These areas are sensitivity to any activities which can alter the pattern of water flow (eg. Road construction) and are important for hydrological processes. These areas have been classified as High or Very High Sensitivity.
Drainage Lines	The drainage lines of the study area with associated riparian and floodplain vegetation.	These areas are mostly classified as Very High Sensitivity due to their ecological importance and vulnerability to disturbance.
Pans & Vloere	The typical pans and extensive “vloere” of the Bushmanland area.	The pans and vloere have been classified as High and Very High sensitivity depending on their apparent intactness and ecological context.

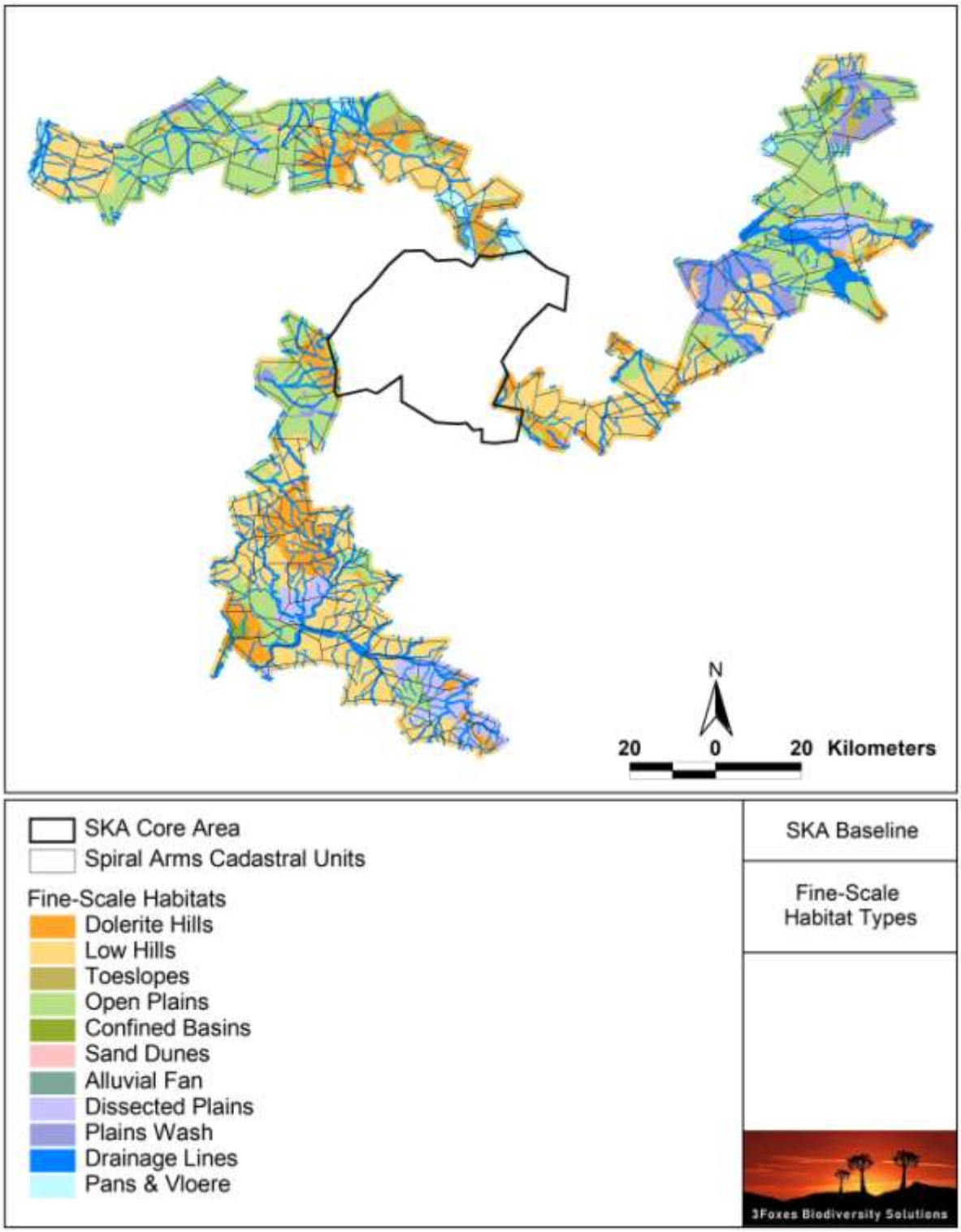

Figure 4. Fine-scale habitat map for the SKA Spiral Arms and a 1km buffer. A description of the various habitats mapped is provided above in Table 1.

Fine-Scale Sensitivity Mapping

Although the fine-scale habitat mapping is not that important for development planning on its' own, it provides a critical step in being able to derive a sensitivity layer for the SKA. Furthermore, the habitats are relatively objective features of the landscape and can be validated in the field. The sensitivity layer is to some degree more subjective and more difficult to validate in the field, although this can also be important especially with regard to calibrating the sensitivity rating as this tends to be a relative scale when derived from desktop-based information. As such, the fine-scale sensitivity maps presented here are based on the detailed habitat mapping as their underlying mapping units, but the sensitivity scale has been informed by the results of the walk-through as well as previous experience in the broader SKA area as well as the inputs from the Milton (2017) study and the SAEON walk-through results. This approach is seen as providing a balance between mapping scale (where finer is better) and the availability of reliable ground-based information (where fine-scale information is hard to get) that can be used to assign sensitivity to the units mapped.

The primary purpose of the four-tier sensitivity maps as well as the associated recommendations for development (Table 4) is to reduce the overall ecological impact of the development through encouraging avoidance of the more sensitive features and parts of the site. However, as it is important to provide a framework that is practical and operational, limits of acceptable change associated with each sensitivity tier are listed in Table 5 and provide for some tolerable impact even within the Very High sensitivity areas. The recommended limits of acceptable change associated with each of the four sensitivity tiers represents the total amount of habitat loss within each tier that is considered acceptable before high ecological impacts are likely to occur. This should be applicable to the SKA Phase 1 MID infrastructure as well as any additional development that occurs within the SKA Core Area or Spiral Arms on a cumulative basis. These limits provide some scope for habitat loss even within the High and Very High sensitivity areas. This is usually necessary as it is frequently not possible to completely avoid some types of high and very high sensitivity features such as drainage lines which must be traversed by roads and other infrastructure. Such limits where not previously provided in the SEA, which is regrettable as this framework also provides for a more objective quantification of the impacts associated with a development and also provides developers with specific limits and tolerances that can included into development planning.

Within the Spiral Arms, the SKA only has access and rights to build infrastructure within the defined servitudes that accommodate the layout of the SKA and not the full portions of the affected farms. As such, the total extent of habitat within the four tiers of the sensitivity map are not fully available to the SKA for planning. This has implications for the limits of acceptable change as the total extent of habitat within the spiral arms is considerably larger than that within the proclaimed servitudes and the servitudes may not represent a representative sample of the availability of the different habitats across these areas. In order to accommodate these technicalities, the limits of acceptable change have been set based on the full extent of each tier of sensitivity across the whole of the spiral arms. From an ecological perspective, this is necessary as it is the full extent of the different habitats and associated sensitivities that provides the ecological context of the development and determines how much impact these features can tolerate before generating significant ecological damage.

Table 4. The associated planning-level mitigation and avoidance that should be implemented with regards to the different sensitivity categories.

Sensitivity	Recommended Mitigation & Avoidance
Very High	Areas classified as Very High are considered to be areas unsuitable for development except where it is not possible to avoid these features. As such, no telescopes, PV facilities or other moveable infrastructure should be located in these areas. Some roads, overhead and underground cabling can be allowed in these areas subject to the specified limits of acceptable change. Where possible, existing disturbance footprints such as existing farm should be used for crossing these features.
High	These areas should be avoided as much as possible. Preferably, to telescope dishes or PV plants should be located in these areas. Roads, underground and overhead cabling can traverse these areas subject to the specified limits of acceptable change. Existing disturbance footprints should be used as much as possible.
Medium	Development infrastructure of all kinds is acceptable in these areas subject to site inspection and preconstruction walk-through as there may be localised features or species of concern present. The total footprint of development should be kept within the limits of acceptable change.
Low	Development infrastructure of all kinds is acceptable in these areas subject to site inspection and preconstruction walk-through as there may be localised features or species of conservation concern present. As much of the development footprint as possible should be located in these areas.

The four-tier sensitivity map of the SKA Core Area is presented below in Figure 5. The map illustrates the high sensitivity of the south, southeast and north of the SKA Core Area. This results from the presence of several large pans and vloere in the north of the site and the rugged, mountainous terrain of the south. The four-tier sensitivity map of the SKA Spiral Arms is presented below in Figure 6. The major drivers of sensitive features within the Spiral Arms is the presence of dolerite hills, rugged terrain and various drainage features, pans and 'vloere' across the study area. Overall, the western spiral arm has the largest extent of low sensitivity habitat. The total extent of the SKA Core area and Spiral Arms within each of the four tiers of the sensitivity mapping is provided below in Table 5. In both cases, the majority of habitat is located within the Medium and Low sensitivity categories.

Table 5. The total extent of habitat within the four tiers of the sensitivity map within the SKA Core Area and Spiral Arms. The recommended limits of acceptable change that should be allowed within each sensitivity category, within each area due to the construction of the SKA Phase 1 MID as well as any addition development in this area on a cumulative basis has also been provided.

Sensitivity	Total Extent (Ha)	Limit of Acceptable Change (% loss)	Limit of Acceptable Change (Ha loss)	Footprint (Ha)			% of Limit Currently Used
				Temporary	Permanent	Total	
SKA Core Area							
Very High	3 009	0.25	7.52	6.42	2.61	9.02	119.93
High	28 465	0.5	142.33	41.02	15.17	56.19	39.48
Medium	38 852	2	777.04	62.50	28.57	91.07	11.72
Low	61 243	3	1 837.29	104.79	137.11	241.90	13.17
SKA Spiral Arms							
Very High	30 012	0.2	60.02	25.23	10.21	35.43	59.03
High	137 744	0.5	688.72	112.38	28.56	140.94	20.46
Medium	284 441	1	2 844.41	655.02	182.95	837.97	29.46
Low	180 547	2	3 610.94	329.37	90.77	420.13	11.64

In terms of the estimated development footprint within these different tiers, the footprint within the SKA Core area is well below the recommended threshold for all sensitivity classes except for the Very High Sensitivity areas, in which the current loss stands at about 9ha which exceeds the recommended limit of 7.52ha. This has occurred as a result of the large number of river crossings the roads must make in order to service all the dishes. Given that this loss has already occurred under an authorised development, it is recommended that a new limit of 15ha maximum loss is used for future planning. It is considered justified to provide an adjusted limit because the extent of habitat loss within these areas has been somewhat ever-estimated due to the presence of numerous existing tracks along the proposed routes as well as the conservation-orientated management of the SKA Core area, which in effect offsets the negative impacts of the development due to the increase in habitat quality that should occur within the core under SKA management. Within the Spiral Arms, none of the recommended limits have been exceeded under the assessed layout. For the Very High Sensitivity category which is of greatest concern, the estimated loss due to the construction of the SKA MID 1 would be 35.43ha compared to the recommended limit of acceptable loss of 60.02 ha. Consequently, within the Spiral Arms, the current layout is considered to result in acceptable loss within the High and Very High Sensitivity areas and as such no additional mitigation or avoidance of these features is required to bring the development to within acceptable levels of impact.

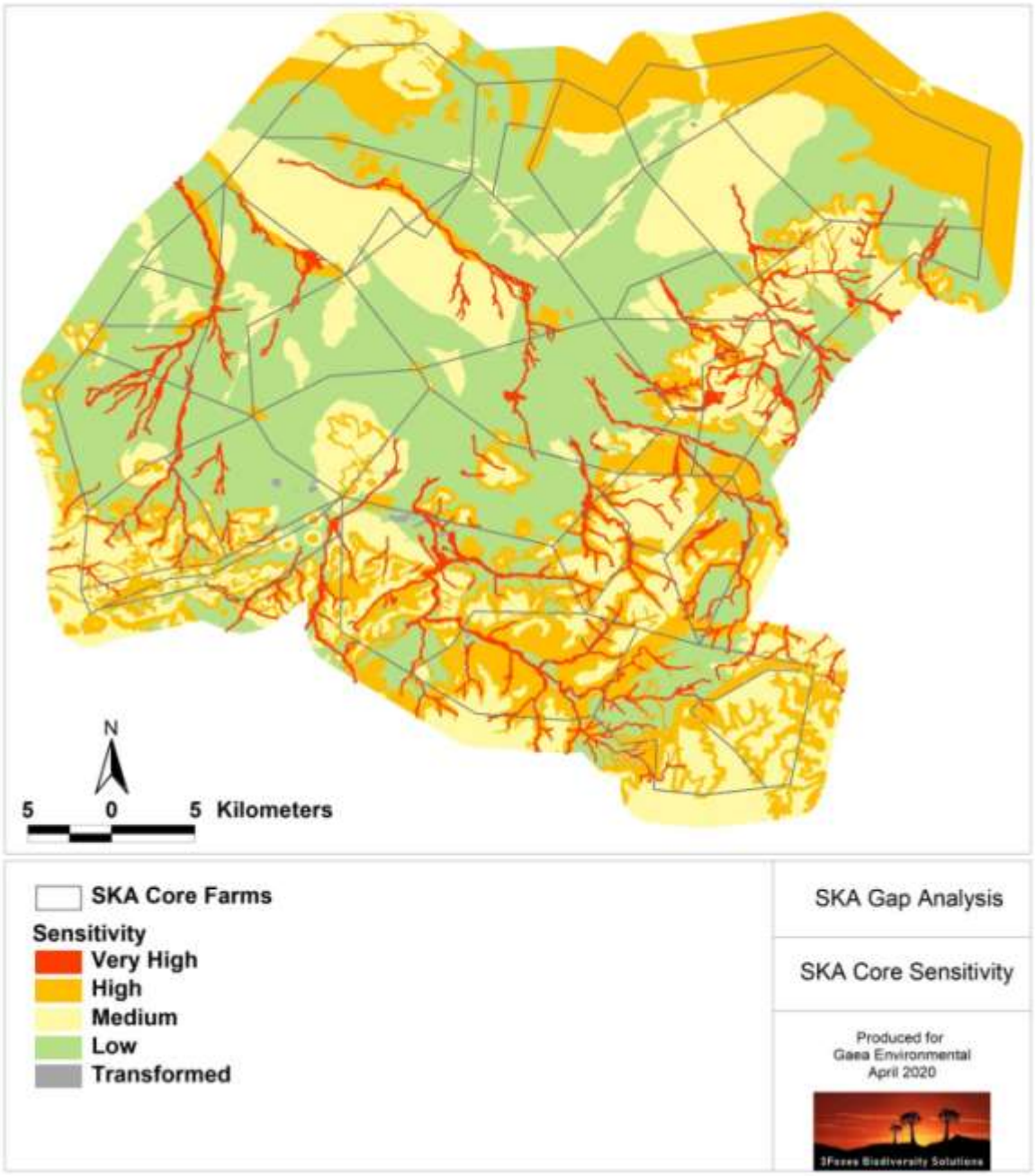

Figure 5. Fine-scale, four-tier sensitivity map for the SKA Core Area. Showing the high average sensitivity of the south and east of the site as well as the farm northern boundaries of the SKA Core Area where there are several large pans present.

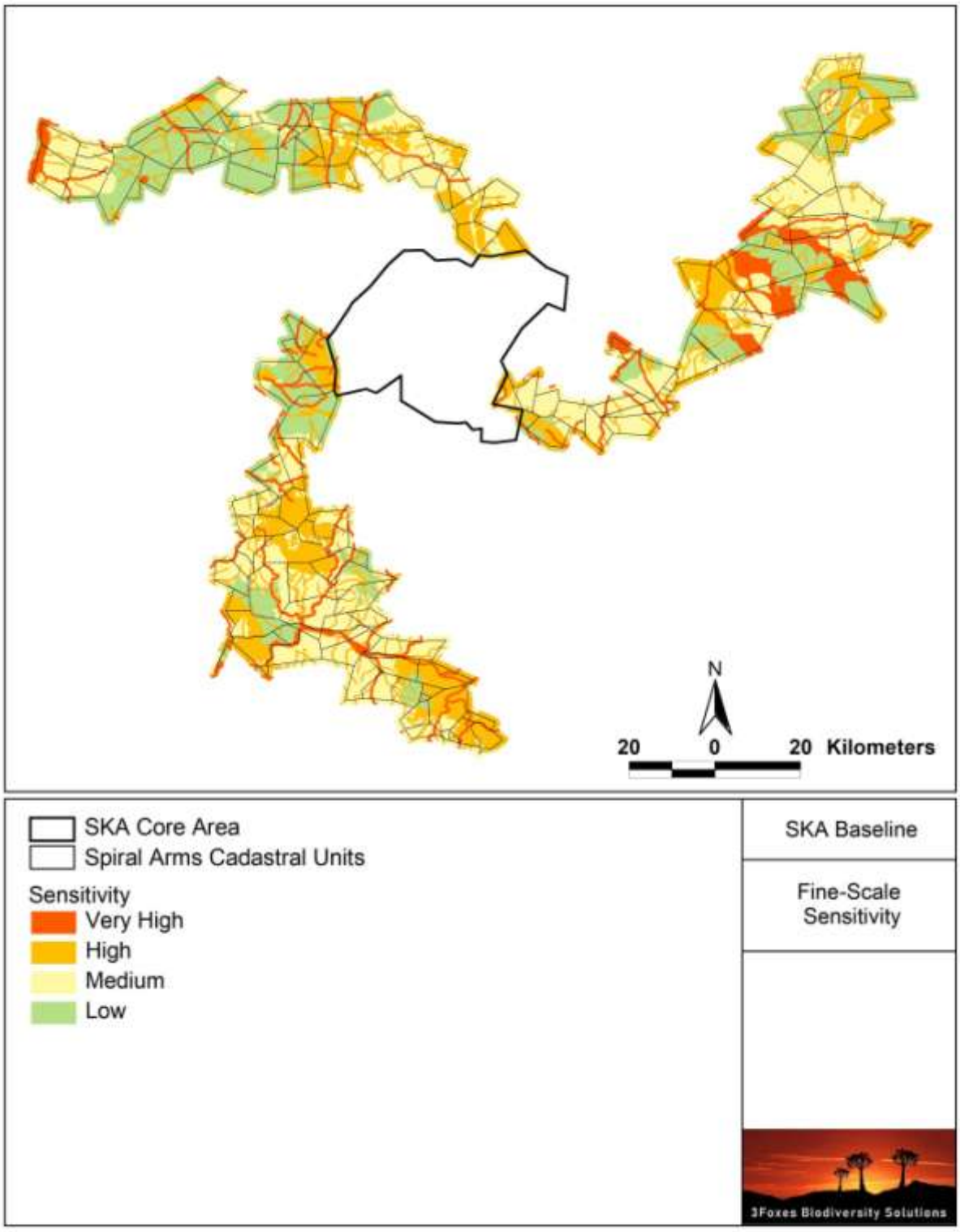

Figure 6. Fine-scale, four-tier sensitivity map for the SKA Spiral Arms and a 1km buffer around these areas.

Under the layout provided, there are no dishes or PV Plants located within the Very High sensitivity areas, either within the SKA Core or Within the SKA Spiral Arms. This is accordance within the recommended mitigation measures as provided in Table 5 above. A few dishes in the SKA Core Area (Dish SKA106, Dish SKA108 and Dish SKA031) are located in close proximity to Very High Sensitivity areas and the boundaries of the sensitive areas should be demarcated in the field before construction to ensure that the footprint can be shaped so as to avoid impact to these areas as much as possible. Within the Spiral Arms, there are also a few dishes and PV plants (Dish SKA011, Dish SKA132 and PV at SKA132) that are in close proximity to Very High Sensitivity areas and as within the core area, the sensitive features should be demarcated in the field prior to the commencement of construction so that the impact on the features of concern can be minimised. An additional area of potential concern, is that there is some discrepancy between the existing development footprints as observed from GoogleEarth imagery and the stated extent of infrastructure as provided by SKA. Certain features appear to be larger or smaller than that provided by SKA for this analysis; for example, the final width of access roads is estimated to be 4m but the current footprint of these features currently exceeds 15m. While some of this discrepancy can be attributed to temporary disturbance, the temporary road width as provided is 10m, which is still short of the observed road width for many of the existing newly built roads. There are numerous factors that can explain this such as contractors clearing beyond the required road margins to facilitate the construction of ditches or drains to support the road as well as cabling and other infrastructure running adjacent to the road. However, to ensure that the estimated footprint and the actual footprint remain aligned and within the limits of acceptable change, it is recommended that the development footprint is periodically verified using satellite imagery, aerial photography or ground-truthing to provide an indication of the actual footprint and that this is within the specifications as estimated.

In terms of detailed mitigation and avoidance associated with the development, the thorough review and descriptions provided by Milton (2017) are seen as being comprehensive and sufficiently detailed to provide effective implementation as part of the IEMP. As such, no additional detailed mitigation and avoidance in addition to those provided by Milton (2017) are recommended here. However, the sensitivity information presented here is significantly more detailed than that provided by Milton (2017) and represents a significant improvement on the coarse mapping presented there and as such should take precedence with regards to future development planning within the SKA.

Walk-Through

Identification of areas to be walked

Due to time, budget and practical constraints, it was not considered necessary to walk the entire SKA Phase 1 footprint again for the current study, as this has already been done by SAEON. In addition, large parts of the affected area have very low abundance of species of conservation concern and hence it is not considered cost-effective to walk these areas where the rate and number of observations of species is concern is very low. As a result a number of priority areas were identified for the current walk-through based on the results of the SAEON walk-through, personal experience in the area and interrogation of satellite imagery of the site. Through this process a total of 17 areas were identified for walk-through.

An initial walk-through of some of the priority areas within the SKA core area was conducted in November 2019. However, it quickly became apparent that the dry conditions were not optimal for the walk-through and the walk-through was terminated after 3 of the identified areas had been covered. It was very dry at the time due to the prevailing drought that has characterised the Northern Cape over the past few years and as a result only longer-lived perennials were observed to be present. As a result of the poor conditions, the walk-through was then put on hold until after the rains that fell over December 2019/January 2020. The remaining areas were walked from 10th to 14th February 2020. At this time, conditions were considered favourable and considerably less limited than during 2019, and the delay in walk-through was thus clearly justified.

Identification of Listed and Protected Species

Plant species of conservation concern which may occur in the area were identified a priori as far as possible, based on a species list for the broad area extracted from the SANBI SIBIS database for the area. Species of conservation concern were extracted from the list based on their status according to Red List of South African plants version 2020 (http://redlist.sanbi.org/) as well as species listed as endangered or protected under the Northern Cape Nature Conservation Act (No. 9 of 2009). In some cases species are listed under both, but in general the provincial legislation is more inclusive and attempts to provide some protection for species, genera and families likely to vulnerable to illegal plant collection and other similar threats. Of particular relevance to the current study are the following, which are extracted from the legislation and are not intended to provide a comprehensive list of all protected species, only those which are likely to be encountered in the area. The reader is referred to the schedules of the Act for a full list of species listed under the act.

Schedule 1: Specially Protected Flora

- Family GERANIACEAE - Pelargonium spp. all species

Schedule 2 Protected Flora

- *Amaryllidaceae* – All species
- *Apiaceae* – All Species
- *Apocynaceae* – All Species
- *Asphodelaceae* – All species except Aloe ferox
- *Iridaceae* – All species
- *Mesembryanthemaceae* – All species
- *Capparaceae* - Boscia spp. Sheperd's trees, all species
- *Androcymbium* spp. - All species
- *Crassulaceae* - All species except those listed in Schedule 1
- *Euphorbiaceae* - Euphorbia spp. All species
- *Oxalidaceae* - Oxalis spp All species
- *Portulacaceae* - Anacampseros spp. All species

In terms of fauna the following are species which potentially occur at the site and are listed as protected species:

Schedule 1. Specially Protected Fauna

- *Felis nigripes* - Black-footed cat/Miershooptier
- *Felis silvestris* - African wild cat/Afrika wildekat
- *Ictonyx striatus* - Striped polecat/Stinkmuishond
- *Mellivora capensis* - Honey badger/Ratel
- *Otocyon megalotis* - Bat-eared fox/Bakoorvos
- *Proteles cristatus* – Aardwolf/Maanhaarjakkals
- *Vulpes chama* - Cape fox / Silver jackal Silwervos
- *Orycteropus afer* - Aardvark / Ant-bear Erdvark / Aardvark
- Family: *Chamaeleonidae* - Chamaeleons, all species
- Family: *Cordylidae* Girdled lizards, all species
- *Pyxicephalus adspersus* Giant Bullfrog / Giant Pyxie Brulpadda

Schedule 2. Protected Species

Virtually all indigenous fauna which do not fall under Schedule 1 are classified under Schedule 2, except those species classified as pests. In terms of mammals most rodents, shrews, elephant shrews, bats, hares and rabbits, carnivores such as mongoose, genets, and meerkat, antelope such as klipspringer, steenbok and duiker are included. In terms of other vertebrates, all tortoises, lizards, most harmless snakes and all frogs are listed under Schedule 2. The full list is contained within the Schedule and it not repeated here.

In terms of fauna, the following *inter alia* are protected and may not be hunted, captured or harmed without a permit:

- All tortoises
- All lizards
- All frogs
- Most snakes
- All indigenous antelope
- Aardvark
- Most small carnivores such as Honey Badger, Cape Fox, Bat-eared Fox, Large Grey Mongoose etc.
- Most birds except pest species

Of relevance to the current study would be burrows of any of the above species within the development footprint, specialized habitat home to red-listed fauna, or nesting and roosting sites of birds such as raptors or cranes.

Study Limitations

The conditions at the time of the initial site visit were extremely dry and followed an extended drought in the area. As a result, the perennial grasses were heavily grazed and their cover much

reduced, while there were virtually no forbs, geophytes or annuals present. As a result, the results of the walk-through for these areas are restricted to trees and perennial forbs such as *Aloe*, *Hoodia* and *Pachypodium*. The majority of areas walked were however walked in the summer of 2020 following good rains across large parts of the study area. As a result, the vegetation was generally in a more favourable condition for the assessment and while geophytes were still not very common, some species had emerged and were present. Nevertheless, it is impossible to ensure that all species of concern are present and visible at any one time due to natural differences in phenology. As such, there is always a proportion of the vegetation that is likely to be absent at a single sampling period and this represents an unavoidable limitation associated with most walk-through studies. However, the larger more ecologically significant species were present and as such the limitations present in the later sampling period are considered acceptable. In terms of the different areas identified for the current walk-through, some land-owners refused access to their properties, with the result that it was not possible to survey these sections of the development footprint.

As per the recommendation of SAEON and which is supported here, an ECO or Environmental Officer should be present during construction and vegetation clearing in areas identified in the SAEON walk-through as being of High or Very High sensitivity.

Walk-Through Results

Although some areas identified as being potentially sensitive had very few species of concern, there were other areas that had a relatively high abundance of nationally and provincially protected plant species. In line with the sensitivity mapping conducted by SAEON, it is largely the stony flats dominated by *Rhigozum trichotomum* that had a very low abundance of species of concern (Figure 2). In addition, areas heavily invaded by *Prosopis* also had a low abundance of species of concern, despite the fact that these are often the wetter parts of the landscape where protected species such as some geophytes are usually common. Overall, the rocky areas had generally the highest abundance and diversity of species of concern (Figure 3). Parts of the development footprint is within areas with a high abundance of *Boscia albitrunca* and any trees that cannot be avoided will need a permit from DEFF for their destruction. Some provincially protected species such as *Aloe claviflora* are also very common in places and it will not be possible to avoid all individuals of this species and some translocation of affected individuals will be required prior to construction. A vegetation destruction and clearing permit from DENC will be required prior to the commencement of construction.

Figure 2. The typical *Rhigozum trichotomum* plains which dominate large tracts of the SKA footprint have a low plant diversity and a low abundance of species of concern.

Figure 3. The rocky hills, here pictured near to SKA014, have high plant diversity and the highest abundance of species of concern, with species such as *Aloe claviflora* and *Boscia albitrunca* being particularly common.

In terms of the sensitivity mapping by SAEON and the congruence with the current study, there are two particular areas that warrant mention. The first is at SKA133, where there is a very high

abundance of species of concern associated with the shale hills of the area. It will not be possible to avoid the species of concern as their density is very high and moving the infrastructure will simply result in other individuals being affected. Although these are relatively common species such as *Aloe claviflora*, *Pleiospilos compactus* and *Stomatium mustellinum*, these are all provincially protected species. As these are all succulents with a high probability of surviving translocation, the recommendation is that all individuals within the development footprint should be translocated on-site to a safe area outside of the development footprint. The second area is the road to SKA005, which traverses a wetland floodplain area adjacent to a pan. The routing of the road across the flow path will certainly disrupt the natural flow of water across the landscape and will result in the degradation of the dense floodplain vegetation. The current routing is not considered acceptable and the road should follow the existing farm access road through this area towards SKA005. The affected area and the recommended road access route is illustrated below in Figure 4 and Figure 5.

Figure 4. Image showing the dense riparian floodplain vegetation along the road to SKA005. This area is vulnerable to changes in the pattern of overland flow and a road should not be built through this area.

Figure 5. Map showing the current road routing to SKA005 in orange and the new preferred alignment which follows the existing farm road, illustrated in green. The alternative alignment will reduce the impact of the road on sensitive floodplain vegetation above the pan.

Conclusions and Recommendations

The baseline study of the SKA Core Area and SKA Spiral Arms provides detailed four-tier sensitivity maps that should be used for development planning to ensure that ecological impacts associated with the SKA and any other developments in this area remain within acceptable levels. In addition, limits of acceptable change associated with each sensitivity category have been indicated and provide planners with limits of change that should be allowed within each area. The sensitivity and habitat maps produced as part of this study are orders of magnitude more detailed than anything produced previously as part of the SEA of other study in the SKA area. As such, these maps represent our currently available best knowledge and should be used as the basis for future development planning in the area. As there was a separate freshwater study in addition to the current study, these maps should be integrated to create an overall sensitivity map for the SKA Core Area and Spiral Arms. The current study was focused on terrestrial ecology and as such the freshwater study should provide greater resolution around the hydrological features of the study area. The following major outcomes and recommendations can be drawn from the baseline study:

- The fine-scale mapping produced for this study represents the current best available information for the SKA Core and Spiral Arms and should be used for development planning going forward.
- Limits of acceptable change for each of the 4 tiers of the ecological sensitivity map have been provided to ensure that the development impact remains within the assessed

parameters. The limits within the Very High and High sensitivity categories are seen as being of most importance and should not be exceeded.

- As the limit of acceptable change for Very High sensitivity areas within the SKA Core has already been exceeded, an adjusted limit, which accounts for the fact that not all of the footprint is within previously undisturbed areas as well as the conservation-orientated management of the SKA Core area, which in-effect offsets the negative impacts of the development due to the increase in habitat quality that should occur within the core under SKA management.
- There is some discrepancy between the existing development footprints as observed from GoogleEarth and the stated extent of infrastructure as provided by SKA. To ensure that the estimated footprint and the actual footprint remain aligned and within the limits of acceptable change, it is recommended that the actual development footprint is periodically verified using satellite imagery, aerial photography or ground-truthing to provide an indication of the actual footprint and that this is within the specifications as estimated.

In terms of the results of walk-through, the final layout as provided for this study is a mitigated layout in which the major sensitive features present within the development footprint have already been avoided as a result of the SAEON Walk-through Study. Large tracts of the SKA Phase 1 footprint are on *Rhigozum trichotomum* plains with a low plant diversity and low abundance of species of conservation concern. There are however numerous rocky hills within the site and the development footprint that have much higher diversity and also contain relatively large numbers of provincially and nationally protected plant species. In many instances, it will be possible to avoid these features through micro-siting of the infrastructure. However in some instances it will not be possible to avoid these individuals and some loss of individuals of protected plants is inevitable. However, wherever possible, such species that cannot be avoided should be translocated out of the development footprint if they have a reasonable probability of surviving translocation. This would include most succulents such as aloes, dwarf succulents such as *Pleiospilos* and geophytes. The woody species are generally not tolerant of translocation and it is not recommended to translocate species such as *Boscia* as survival will be very low.

The following specific recommendations are made with regards to the search and rescue operation that should precede the construction phase:

- As per the recommendation of SAEON and which is supported here, an ECO or Environmental Officer should be present during construction and vegetation clearing in areas identified in the SAEON walk-through as being of High or Very High sensitivity.
- Woody species such as *Boscia albitrunca* should be avoided where possible. Any individuals that cannot be avoided will need to be destructed and a permit for this will be required from DEFF. If large numbers of *Boscia albitrunca* are impacted DEFF may require that some sort of offset is implemented to reduce the impact on this species.
- For general vegetation clearing and translocation of provincially protected species, a translocation and destruction permit from DENC will be required. Where possible all species that are able to survive translocation should be moved out of the development footprint where these are present. The area around SKA133 is highlighted as an area with a particularly high abundance of protected species and where avoidance will not be effective at reducing impacts on these species.

- In terms of the sensitivity mapping conducted by SAEON, the results of this study largely concur with and support the results of the final SAEON mapping. However, the access road to SKA005 is highlighted as an area that is not considered suitable for development. An alternative access route that makes use of the existing farm access track through this area has been identified as being acceptable and is recommended as the new route for the road.

Annex 1. List of Coordinates

Coordinates of faunal features and listed and protected plant species observed during the walk-through. The table also indicates the preferred action and an alternative option for how to deal with the affected species.

Location & Feature	Count/Size	Latitude	Longitude	Recommended Action	Alternative Action
Near SKA020					
Animal Burrow	Burrow	-30.66	21.45379	Avoid	
Underground Cable to SKA027					
Aloe claviflora	1	-30.6887	21.54877	Avoid	Translocate
Aloe claviflora	1	-30.6895	21.54913	Avoid	Translocate
Aloe claviflora	1	-30.6896	21.54903	Avoid	Translocate
Aloe claviflora	1	-30.6896	21.549	Avoid	Translocate
Aloe claviflora	1	-30.6896	21.54901	Avoid	Translocate
Aloe claviflora	1	-30.6896	21.54895	Avoid	Translocate
Aloe claviflora	1	-30.6908	21.54948	Avoid	Translocate
Aloe claviflora	1	-30.6913	21.54958	Avoid	Translocate
Aloe claviflora	1	-30.6913	21.54952	Avoid	Translocate
Aloe claviflora	1	-30.6934	21.5502	Avoid	Translocate
Aloe claviflora	1	-30.6937	21.55035	Avoid	Translocate
Aloe claviflora	1	-30.6765	21.57776	Avoid	Translocate
Boscia albitrunca	2x2m	-30.6699	21.55199	Avoid	Destroy
Boscia albitrunca	2x2m	-30.6762	21.54771	Avoid	Destroy
Road to SKA005					
Nerine laticoma	1	-30.2661	20.88259	Translocate	Avoid
Nerine laticoma	1	-30.2645	20.88706	Translocate	Avoid
Road and underground MV Cable to PV at SKA005					
Nerine laticoma	1	-30.2741	20.89466	Translocate	Avoid
Nerine laticoma	1	-30.2742	20.89474	Translocate	Avoid
Nerine laticoma	1	-30.2758	20.8987	Translocate	Avoid
Nerine laticoma	1	-30.2747	20.89827	Translocate	Avoid
Nerine laticoma	1	-30.2701	20.89664	Translocate	Avoid
Underground Cable to SKA014					
Boscia albitrunca	1x1m	-30.6214	21.56762	Avoid	Destroy
Hoodia gordonii	1	-30.6211	21.56798	Avoid	Translocate
Boscia albitrunca	0.5x05m	-30.62	21.56775	Avoid	Destroy
Boscia albitrunca	1x1m	-30.62	21.56771	Avoid	Destroy
Boscia albitrunca	1x2m	-30.6188	21.56743	Avoid	Destroy
Hoodia gordonii	1	-30.6172	21.56721	Avoid	Translocate
Boscia albitrunca	2x4m	-30.6152	21.56723	Avoid	Destroy
Aloe claviflora	1	-30.6138	21.56678	Avoid	Translocate
Boscia albitrunca	05x2m	-30.6138	21.56678	Avoid	Destroy

Aloe claviflora	1	-30.6138	21.56679	Avoid	Translocate
Aloe claviflora	1	-30.6138	21.56672	Avoid	Translocate
Boscia albitrunca	0.5x1m	-30.6117	21.56569	Avoid	Destroy
Boscia albitrunca	1x4m	-30.6095	21.56467	Avoid	Destroy
Boscia albitrunca	1x2m	-30.6079	21.56376	Avoid	Destroy
Boscia albitrunca	2x5m	-30.6067	21.56332	Avoid	Destroy
Road to SKA133					
Boscia albitrunca	1.5x2m	-30.8415	21.42376	Avoid	Destroy
Aloe claviflora	1	-31.5188	21.50003	Avoid	Translocate
Aloe claviflora	1	-31.5188	21.49994	Avoid	Translocate
Aloe claviflora	1	-31.5192	21.49992	Avoid	Translocate
Aloe claviflora	1	-31.5198	21.49953	Avoid	Translocate
Aloe claviflora	1	-31.5201	21.49934	Avoid	Translocate
Aloe claviflora	1	-31.5199	21.49908	Avoid	Translocate
Aloe claviflora	1	-31.5195	21.49846	Avoid	Translocate
Aloe claviflora	1	-31.5196	21.49886	Avoid	Translocate
Underground Cable to SKA 133					
Aloe claviflora	1	-31.5195	21.49866	Translocate	
Pleiospilos compactus	2	-31.5194	21.49766	Translocate	
Aloe claviflora	1	-31.5193	21.49733	Translocate	
Aloe claviflora	1	-31.5193	21.4973	Translocate	
Aloe claviflora	1	-31.5194	21.4973	Translocate	
Aloe claviflora	1	-31.5194	21.49728	Translocate	
Pleiospilos compactus	1	-31.5194	21.4973	Translocate	
Aloe claviflora	1	-31.5194	21.49732	Translocate	
Aloe claviflora	1	-31.5194	21.4974	Translocate	
Pleiospilos compactus	1	-31.5194	21.4974	Translocate	
Aloe claviflora	1	-31.5193	21.49718	Translocate	
Stomatium mustellinum	10	-31.5192	21.49698	Translocate	
Aloe claviflora	1	-31.5192	21.49695	Translocate	
Aloe claviflora	1	-31.5192	21.49671	Translocate	
Aloe claviflora	1	-31.519	21.49573	Translocate	
Aloe claviflora	1	-31.5189	21.4951	Translocate	
Aloe claviflora	1	-31.5188	21.49481	Translocate	
Aloe claviflora	1	-31.5187	21.49442	Translocate	
Aloe claviflora	1	-31.5187	21.49438	Translocate	
Aloe claviflora	1	-31.5186	21.49419	Translocate	
Aloe claviflora	1	-31.5186	21.49399	Translocate	
Aloe claviflora	1	-31.5186	21.49396	Translocate	
Boophone disticha	1	-31.5186	21.49384	Translocate	
Aloe claviflora	1	-31.5185	21.49371	Translocate	
Aloe claviflora	1	-31.5185	21.49371	Translocate	
Aloe claviflora	1	-31.5185	21.49371	Translocate	
Aloe claviflora	1	-31.5185	21.49366	Translocate	
Aloe claviflora	1	-31.5183	21.49266	Translocate	
Aloe claviflora	1	-31.5183	21.49255	Translocate	

Aloe claviflora	1	-31.5182	21.49188	Translocate
Aloe claviflora	1	-31.5178	21.49001	Translocate
Aloe claviflora	1	-31.5177	21.48931	Translocate
Aloe claviflora	1	-31.5176	21.48904	Translocate
Aloe claviflora	1	-31.5175	21.48855	Translocate
Aloe claviflora	1	-31.5174	21.48799	Translocate
Aloe claviflora	1	-31.5177	21.48954	Translocate
Aloe claviflora	1	-31.5177	21.48975	Translocate
Stomatium mustellinum	10	-31.5192	21.49692	Translocate
Aloe claviflora	1	-31.5193	21.49731	Translocate
Aloe claviflora	1	-31.5194	21.4974	Translocate
Aloe claviflora	1	-31.5195	21.49789	Translocate

Annex 2. Review of SAEON SKA Phase 1 Baseline Study

This is a review of the study entitled "Ecological Sensitivity Assessment of Terrestrial and Aquatic Environments Impacted by SKA Phase 1 Infrastructure in the Nama-Karoo, South Africa" produced by SAEON. The purpose of the review is to "to refine the Environmental Baseline Study of the SKA Site and three spiral arms prepared during the SEA and updated by SAEON, based on fieldwork as reference for future observations and comparative study; and refine the fine-scale habitat map of the core area for the SKA1_MID and produce fine-scale habitat map for the spiral arms."

The report uses a "Biotope Classification" as the basis for the sensitivity mapping where a biotope is classified as follows: "A biotope is defined as an area or region with similar abiotic characteristics and associated with a particular biotic community". Ideally, the actual features or plant communities present should be mapped and the diversity, rarity or presence of species of concern used as metrics for sensitivity classification. However, in the SKA Phase 1 study area, the existing baseline information is exceeding poor and any mapping based on existing data would be fatally flawed. As a result, the approach adopted by SAEON is seen as a reasonable approach to avoid these constraints and provide a surrogate for the actual features present and their likely sensitivity. However, no actual wall to wall map of the SKA Core or Spiral Arms was actually produced and the sensitivity mapping is confined to the immediate vicinity of the development footprint.

In terms of the mitigation and avoidance implemented, areas where the infrastructure was within areas classified as "Unsuitable for development" were verified in the field and where these were found to be less sensitive than predicted, the sensitivity was decreased. Alternatively, where there were existing roads present, the routing of the infrastructure was altered to match the existing disturbance footprints. This is adequate mitigation and avoidance within such areas where alternative routing options are available. Ultimately, the revised fine-scale sensitivity mapping should be considered to represent the best-available information for the area as it has been ground-truthed and verified in the field.

Overall, the SAEON study is considered adequate in terms of a walk-through and no significant updates are recommended apart from those recommended in the current walk-through. The approach with regards to assessing sensitivity is considered to be justified given the paucity of reliable baseline information and the ground-truthing that was conducted as part of the study is seen as being a critical step in validating and refining the final mapping. However, no wall-to-wall mapping was conducted as part of the SAEON mapping with the result that it cannot be used for development planning. This has been rectified in the current study and detailed maps covering the whole SKA Core and SKA Spiral Arms have been included in this report.

In terms of updating the mapping, the only change suggested at this point would be to update the sensitivity of the floodplain environment next to the pan at SKA005 to "Unsuitable for development" as indicated in this report.

Annex 3. Review of the SAEON Plant Protection Plan

The SAEON Plant Protection Plan was produced with the following stated purpose: "*This report will provide SARAO and the future employed environmental compliance officer the necessary background on selected target species to focus on for protection during construction, either for removal, translocation or destruction, but for which specific destruction permits are to be obtained beforehand in any case*."

A total of 148 plant species were detected during the SAEON walk-through. This seems reasonable, but is also likely an under-estimate of the actual total number of plant species present within the development footprint as not all species are observable at any one time. In addition, it was reasonably dry at the time of the walk-through with the result that not all geophytes and annuals were likely present at the time. There are however no obvious omissions from the list and it is considered reasonably comprehensive and provides an adequate representation of the plant species of the area. The report highlights *Boscia albitrunca* and *Aloidendron dichotomum* as species of specific significance for protection given their protection or threat status. This is seen as a justified and impacts on these two species should be minimized as far as possible.

The plant protection plan assumes that individuals of *Boscia albitrunca* and *Aloidendron dichotomum* can be avoided through planning. This is however naïve and it is almost certain that some individuals of *Boscia albitrunca* will not be able to be avoided and will be lost to the development. Only individuals of *Aloidendron dichotomum* should be translocated. It would be more practical to obtain seedlings of the woody species from the DEFF nursery in Upington to replace affected plants and plant these in areas where they can be monitored.

The SAEON Plant Protection Plan is deficient in that it does not identify which species that were encountered within the footprint are protected and secondly does not provide recommendations for any species other than of *Boscia albitrunca* and *Aloidendron dichotomum*. The full list of species that are protected under provincial legislation is available from the Northern Cape Conservation Bill of 2009 and a summary of the main genera and species is provided in this report. In terms of the other protected species encountered in the walk-through, these are mostly various geophytes and succulents. Apart from common succulent shrubs such as *Ruschia spinosa*, all the dwarf succulents, geophytes and aloes encountered within the development footprint should be translocated within the site to a safe area outside of the development footprint. All individuals translocated should be recorded and survival monitored a year after translocation. The ecological study of Milton (2017) provides a thorough review of potential impacts associated with the development of the SKA and the detailed mitigation and avoidance measures contained therein should be included in the IEMP and used to guide search and rescue at the site and revegetation of disturbed areas.

Annex 4. Photographic guide to protected plant species at SKA

A short photographic guide to the main protected species likely to be encountered at the SKA site is provided below. This is not intended to provide a comprehensive guide to all protected species, only those species which are commonly encountered. It is up to the environmental officer on-site to familiarize themselves with the full list of protected plant species as listed in the Northern Cape Nature Conservation Act (No. 9 of 2009).

Aloidendron *dichotomum* – Kokerboom
Provincially Protected

Aloe claviflora – Kanon Alwyn
Provincially Protected

Boscia albitrunca - Witgat Tree
Nationally Protected Tree

Hoodia gordonii – Ghaap
Provincially Protected

Nerine laticoma – Vleilelie/gifbol
Provincially Protected

Pleiospilos compactus – kwaggavy
Provincially Protected

Stomatium mustellinum - kussingvygie
Provincially Protected

Annex 5. List of Mammals

List of mammals for the broad vicinity of the SKA Core and Spiral Arms, with the probability that each species is either Confirmed present, Likely Present, Possibly Present or Unlikely to be Present. The List is derived from the ADU Virtual Museum http://vmus.adu.org.za. Introduced species which have been introduced for game farming and which are dependent on landowners for their maintenance have been removed from the list.

Family	*Scientific name*	Common name	Red list category	Number of QDSs	Number of records	Probability of Occurrence	
						Core	Arms
Bathyergidae	*Cryptomys hottentotus*	Southern African Mole-rat	LC (2016)	3	11	Likely	Likely
Bathyergidae	*Georychus capensis*	Cape Mole-rat	LC (2016)	1	3	Unlikely	Unlikely
Bovidae	*Ammotragus lervia*	Barbary Sheep	Introduced	2	3	Confirmed	Confirmed
Bovidae	*Antidorcas marsupialis*	Springbok	LC (2016)	16	20	Confirmed	Confirmed
Bovidae	*Oreotragus oreotragus*	Klipspringer	LC (2016)	3	4	Confirmed	Confirmed
Bovidae	*Oryx gazella*	Gemsbok	LC (2016)	5	5	Likely	Confirmed
Bovidae	*Pelea capreolus*	Vaal Rhebok	NT (2016)	3	10	Likely	Likely
Bovidae	*Raphicerus campestris*	Steenbok	LC (2016)	31	48	Confirmed	Confirmed
Bovidae	*Sylvicapra grimmia*	Bush Duiker	LC (2016)	5	6	Confirmed	Confirmed
Bovidae	*Taurotragus oryx*	Common Eland	LC (2016)	2	2	Unlikely	Conservation Dependent
Bovidae	*Tragelaphus strepsiceros*	Greater Kudu	LC (2016)	7	7	Confirmed	Confirmed
Canidae	*Canis mesomelas*	Black-backed Jackal	LC (2016)	10	13	Confirmed	Confirmed
Canidae	*Otocyon megalotis*	Bat-eared Fox	LC (2016)	22	35	Confirmed	Confirmed
Canidae	*Vulpes chama*	Cape Fox	LC (2016)	9	12	Confirmed	Confirmed
Cercopithecidae	*Chlorocebus pygerythrus*	Vervet Monkey	LC (2016)	2	2	Unlikely	Moderate
Cercopithecidae	*Papio ursinus*	Chacma Baboon	LC (2016)	3	3	Confirmed	Confirmed
Erinaceidae	*Atelerix frontalis*	Southern African Hedgehog	NT (2016)	2	3	Unlikely	Unlikely
Felidae	*Caracal caracal*	Caracal	LC (2016)	7	9	Confirmed	Confirmed
Felidae	*Felis nigripes*	Black-footed Cat	VU (2016)	22	46	Moderate	Likely
Felidae	*Felis silvestris*	Wildcat	LC (2016)	5	8	Confirmed	Confirmed
Felidae	*Panthera pardus*	Leopard	VU (2016)	2	2	Unlikely	Unlikely
Herpestidae	*Atilax paludinosus*	Marsh Mongoose	LC (2016)	4	4	Likely	Likely
Herpestidae	*Cynictis penicillata*	Yellow Mongoose	LC (2016)	10	11	Confirmed	Confirmed
Herpestidae	*Herpestes pulverulentus*	Cape Gray Mongoose	LC (2016)	11	21	Confirmed	Confirmed
Herpestidae	*Herpestes sanguineus*	Slender Mongoose	LC (2016)	1	2	Unlikely	Likely
Herpestidae	*Suricata suricatta*	Meerkat	LC (2016)	8	11	Confirmed	Confirmed
Hyaenidae	*Hyaena brunnea*	Brown Hyena	NT (2015)	3	4	Unlikely	Possible
Hyaenidae	*Proteles cristata*	Aardwolf	LC (2016)	9	12	Confirmed	Confirmed
Hystricidae	*Hystrix africaeaustralis*	Cape Porcupine	LC	7	8	Confirmed	Confirmed
Leporidae	*Bunolagus monticularis*	Riverine Rabbit	CR (2016)	14	260	Unlikely	Possible
Leporidae	*Lepus capensis*	Cape Hare	LC	8	15	Confirmed	Confirmed
Leporidae	*Lepus saxatilis*	Scrub Hare	LC	7	11	Confirmed	Confirmed
Leporidae	*Pronolagus rupestris*	Smith's Red Rock Hare	LC (2016)	2	2	Confirmed	Confirmed
Macroscelididae	*Elephantulus edwardii*	Cape Elephant Shrew	LC (2016)	6	15	Likely	Likely

Macroscelididae	*Elephantulus rupestris*	Western Rock Elephant Shrew	LC (2016)	2	6	Likely	Likely
Macroscelididae	*Macroscelides proboscideus*	Short-eared Elephant Shrew	LC (2016)	8	16	Confirmed	Confirmed
Muridae	*Aethomys granti*	Grant's Rock Mouse	LC	3	16	Possible	Possible
Muridae	*Aethomys namaquensis*	Namaqua Rock Mouse	LC	4	5	Confirmed	Confirmed
Muridae	*Desmodillus auricularis*	Cape Short-tailed Gerbil	LC (2016)	4	7	Likely	Likely
Muridae	*Gerbilliscus brantsii*	Highveld Gerbil	LC (2016)	1	1	Unlikely	Unlikely
Muridae	*Gerbilliscus paeba*	Paeba Hairy-footed Gerbil	LC (2016)	4	25	Confirmed	Confirmed
Muridae	*Gerbilliscus vallinus*	Brush-tailed Hairy-footed Gerbil	LC (2016)	2	4	Possible	Possible
Muridae	*Mastomys coucha*	Southern African Mastomys	LC (2016)	2	3	Unlikely	Possible
Muridae	*Mastomys natalensis*	Natal Mastomys	LC (2016)	1	1	Unlikely	Unlikely
Muridae	*Mus (Nannomys) minutoides*	Southern African Pygmy Mouse	LC	1	1	Confirmed	Confirmed
Muridae	*Otomys unisulcatus*	Karoo Bush Rat	LC (2016)	7	101	Confirmed	Confirmed
Muridae	*Parotomys brantsii*	Brants's Whistling Rat	LC (2016)	1	2	Likely	Likely
Muridae	*Rhabdomys pumilio*	Xeric Four-striped Grass Rat	LC (2016)	6	43	Likely	Likely
Mustelidae	*Aonyx capensis*	African Clawless Otter	NT (2016)	1	1	Unlikely	Unlikely
Mustelidae	*Ictonyx striatus*	Striped Polecat	LC (2016)	4	5	Confirmed	Confirmed
Mustelidae	*Mellivora capensis*	Honey Badger	LC (2016)	7	10	Possible	Likely
Mustelidae	*Poecilogale albinucha*	African Striped Weasel	NT (2016)	1	1	Unlikely	Possible
Nesomyidae	*Malacothrix typica*	Large-eared African Desert Mouse	LC (2016)	1	2	Likely	Likely
Nesomyidae	*Petromyscus collinus*	Pygmy Rock Mouse	LC (2016)	1	1	Likely	Likely
Orycteropodidae	*Orycteropus afer*	Aardvark	LC (2016)	12	18	Confirmed	Confirmed
Pedetidae	*Pedetes capensis*	South African Spring Hare	LC (2016)	2	4	Likely	Likely
Procaviidae	*Procavia capensis*	Cape Rock Hyrax	LC (2016)	23	54	Confirmed	Confirmed
Sciuridae	*Xerus inauris*	South African Ground Squirrel	LC	11	15	Confirmed	Confirmed
Soricidae	*Crocidura cyanea*	Reddish-gray Musk Shrew	LC (2016)	8	9	Likely	Likely
Soricidae	*Crocidura fuscomurina*	Bicolored Musk Shrew	LC (2016)	3	3	Possible	Possible
Soricidae	*Crocidura hirta*	Lesser Red Musk Shrew	LC (2016)	2	2	Possible	Possible
Soricidae	*Myosorex varius*	Forest Shrew	LC (2016)	6	18	Likely	Likely
Viverridae	*Genetta genetta*	Common Genet	LC (2016)	5	5	Confirmed	Confirmed
Viverridae	*Genetta tigrina*	Cape Genet (Cape Large-spotted Genet)	LC (2016)	5	5	Likely	Likely

Annex 6. List of Reptiles

List of reptiles for the broad vicinity of the SKA Core and Spiral Arms, with the probability that each species is either: Confirmed present, Likely Present, Possibly Present or Unlikely to be Present. The List is derived from the ADU Virtual Museum http://vmus.adu.org.za.

Family	Scientific name	Common name	Red list category	Number of QDSs	Number of records	Likelihood of Occurrence	
						Core	Arms
Agamidae	*Agama aculeata aculeata*	Common Ground Agama	LC (2014)	19	33	Confirmed	Confirmed
Agamidae	*Agama anchietae*	Anchieta's Agama	LC (2014)	1	1	Unlikely	Possible
Agamidae	*Agama atra*	Southern Rock Agama	LC (2014)	7	10	Confirmed	Confirmed
Chamaeleonidae	*Chamaeleo namaquensis*	Namaqua Chameleon	LC (2014)	1	2	Likely	Likely
Colubridae	*Dasypeltis scabra*	Rhombic Egg-eater	LC (2014)	2	2	Possible	Possible
Colubridae	*Dipsina multimaculata*	Dwarf Beaked Snake	LC (2014)	4	4	Likely	Confirmed
Colubridae	*Telescopus beetzii*	Beetz's Tiger Snake	LC (2014)	2	3	Possible	Possible
Cordylidae	*Karusasaurus polyzonus*	Karoo Girdled Lizard	LC (2014)	14	21	Confirmed	Confirmed
Elapidae	*Aspidelaps lubricus lubricus*	Coral Shield Cobra		1	1	Possible	Likely
Elapidae	*Naja nivea*	Cape Cobra	LC (2014)	3	4	Likely	Likely
Gekkonidae	*Afroedura karroica*	Karoo Flat Gecko	LC (2014)	1	1	Unlikely	Unlikely
Gekkonidae	*Chondrodactylus angulifer angulifer*	Common Giant Ground Gecko	LC (2014)	4	12	Confirmed	Confirmed
Gekkonidae	*Chondrodactylus bibronii*	Bibron's Gecko	LC (2014)	10	19	Confirmed	Confirmed
Gekkonidae	*Pachydactylus capensis*	Cape Gecko	LC (2014)	2	2	Likely	Likely
Gekkonidae	*Pachydactylus kladaroderma*	Thin-skinned Gecko	LC (2014)	1	2	Unlikely	Unlikely
Gekkonidae	*Pachydactylus latirostris*	Quartz Gecko	LC (2014)	4	12	Likely	Likely
Gekkonidae	*Pachydactylus mariquensis*	Marico Gecko	LC (2014)	4	5	Likely	Likely
Gekkonidae	*Pachydactylus oculatus*	Golden Spotted Gecko	LC (2014)	2	4	Unlikely	Possible
Gekkonidae	*Pachydactylus purcelli*	Purcell's Gecko	LC (2014)	4	10	Likely	Likely
Gekkonidae	*Pachydactylus rugosus*	Common Rough Gecko	LC (2014)	2	2	Unlikely	Possible
Gekkonidae	*Ptenopus garrulus maculatus*	Spotted Barking Gecko	LC (2014)	1	1	Possible	Likely
Lacertidae	*Meroles suborbitalis*	Spotted Desert Lizard	LC (2014)	7	9	Confirmed	Confirmed
Lacertidae	*Pedioplanis laticeps*	Karoo Sand Lizard	LC (2014)	1	1	Likely	Likely
Lacertidae	*Pedioplanis lineoocellata lineoocellata*	Spotted Sand Lizard	LC (2014)	1	1	Unlikely	Unlikely
Lacertidae	*Pedioplanis lineoocellata pulchella*	Common Sand Lizard	LC (2014)	12	26	Confirmed	Confirmed
Lacertidae	*Pedioplanis namaquensis*	Namaqua Sand Lizard	LC (2014)	14	24	Confirmed	Confirmed
Lamprophiidae	*Boaedon capensis*	Brown House Snake	LC (2014)	2	2	Likely	Likely
Lamprophiidae	*Psammophis notostictus*	Karoo Sand Snake	LC (2014)	7	9	Likely	Likely
Lamprophiidae	*Pseudaspis cana*	Mole Snake	LC (2014)	1	1	Likely	Likely
Pelomedusidae	*Pelomedusa galeata*	South African Marsh Terrapin	Not evaluated	2	3	Likely	Likely
Scincidae	*Acontias lineatus*	Striped Dwarf Legless Skink	LC (2014)	1	2	Possible	Possible
Scincidae	*Trachylepis occidentalis*	Western Three-striped Skink	LC (2014)	3	3	Confirmed	Confirmed
Scincidae	*Trachylepis sulcata sulcata*	Western Rock Skink	LC (2014)	3	5	Confirmed	Confirmed

Scincidae	*Trachylepis variegata*	Variegated Skink	LC (2014)	7	7	Confirmed	Confirmed
Testudinidae	*Chersobius boulengeri*	Karoo Padloper	NT (2014)	1	2	Possible	Likely
Testudinidae	*Homopus femoralis*	Greater Padloper	LC (2014)	1	2	Unlikely	Unlikely
Testudinidae	*Psammobates tentorius tentorius*	Karoo Tent Tortoise		8	48	Possible	Likely
Testudinidae	*Psammobates tentorius trimeni*	Namaqua Tent Tortoise		1	1	Unlikely	Possible
Testudinidae	*Psammobates tentorius verroxii*	Verrox's Tent Tortoise		19	31	Likely	Likely
Testudinidae	*Stigmochelys pardalis*	Leopard Tortoise	LC (2014)	8	10	Likely	Confirmed
Typhlopidae	*Rhinotyphlops schinzi*	Schinz's Beaked Blind Snake	LC (2014)	2	4	Likely	Confirmed
Varanidae	*Varanus albigularis albigularis*	Rock Monitor	LC (2014)	5	7	Confirmed	Confirmed
Viperidae	*Bitis arietans arietans*	Puff Adder	LC (2014)	3	3	Confirmed	Confirmed

Annex 7 List of Amphibians

List of amphibians for the broad vicinity of the SKA Core and Spiral Arms, with the probability that each species is either: Confirmed present, Likely Present, Possibly Present or Unlikely to be Present. The List is derived from the ADU Virtual Museum http://vmus.adu.org.za.

Family	Scientific name	Common name	Red list category	Number of QDSs	Number of records	Likelihood of Occurrence	
						SKA Core	Arms
Bufonidae	*Poyntonophrynus vertebralis*	Southern Pygmy Toad	Least Concern	15	21	Likely	Likely
Bufonidae	*Sclerophrys gutturalis*	Guttural Toad	Least Concern	1	1	Unlikely	Possible
Bufonidae	*Vandijkophrynus gariepensis gariepensis*	Karoo Toad (subsp. gariepensis)	Least Concern	26	43	Likely	Confirmed
Pipidae	*Xenopus laevis*	Common Platanna	Least Concern	19	22	Likely	Likely
Pyxicephalidae	*Amietia delalandii*	Delalande's River Frog	Least Concern (2017)	3	3	Unlikely	Unlikely
Pyxicephalidae	*Amietia fuscigula*	Cape River Frog	Least Concern (2017)	37	56	Likely	Likely
Pyxicephalidae	*Amietia poyntoni*	Poynton's River Frog	Least Concern (2017)	2	4	Possible	Possible
Pyxicephalidae	*Cacosternum boettgeri*	Common Caco	Least Concern (2013)	37	63	Likely	Likely
Pyxicephalidae	*Pyxicephalus adspersus*	Giant Bull Frog	Near Threatened	9	11	Unlikely	Possible
Pyxicephalidae	*Tomopterna cryptotis*	Tremelo Sand Frog	Least Concern	4	4	Unlikely	Possible
Pyxicephalidae	*Tomopterna delalandii*	Cape Sand Frog	Least Concern	3	3	Unlikely	Unlikely
Pyxicephalidae	*Tomopterna tandyi*	Tandy's Sand Frog	Least Concern	11	17	Likely	Likely