STRATEGIC ENVIRONMENTAL ASSESSMENT FOR EXPANSION OF ELECTRICITY GRID INFRASTRUCTURE IN SOUTH AFRICA

# Integrated Biodiversity and Ecology (Terrestrial and Aquatic Ecosystems, and Species) Assessment Report

# STRATEGIC ENVIRONMENTAL ASSESSMENT FOR THE EXPANSION OF ELECTRICITY GRID INFRASTRUCTURE IN SOUTH AFRICA

**Draft v3 Specialist Assessment Report for Stakeholder Review**

# BIODIVERSITY AND ECOLOGY

## TERRESTRIAL AND AQUATIC ECOSYSTEMS, AND SPECIES


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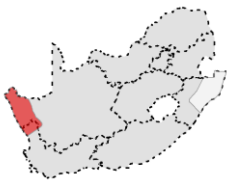
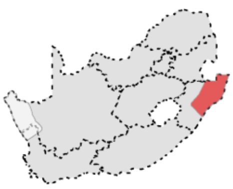
# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AoO | Area of Occupancy |
| BFD | Bird Flight Diverters |
| BLSA | Bird Life South Africa |
| CARA | Conservation of Agricultural Resources Act (43/1983) |
| CBA | Critical Biodiversity Area |
| CR | Critically Endangered |
| DEA | Department of Environmental Affairs |
| ECO | Environmental Control Officer |
| EFZ | Estuary Functional Zone |
| EGI | Electricity Grid Infrastructure |
| EIA | Environmental Impact Assessment |
| EMPr | Environmental Management Programme |
| EN | Endangered |
| EoO | Extent of Occurrence |
| ESA | Ecological Support Area |
| EWT | Endangered Wildlife Trust |
| GIS | Geographic Information Systems |
| IAP | Invasive Alien Plant |
| IBA | Important Bird Area |
| IDP | Integrated Development Plan |
| IUCN | International Union for Conservation of Nature |
| KZN | Kwa-Zulu Natal |
| LED | Light Emitting Diode |
| LT | Least Threatened |
| MAP | Mean Annual Precipitation |
| NEM:BA | National Environmental Management: Biodiversity Act (10/2004) |
| NEM:ICMA | National Environmental Management: Integrated Coastal Management Act (24/2008) |
| NEM:PAA | National Environmental Management: Protected Areas Act (57/2003) |
| NEMA | National Environmental Management Act (107/1998) |
| NFA | National Forest Act (84/1998) |
| NFEPA | National Freshwater Ecosystem Priority Areas |
| NGO | Non-Government Organisation |
| NP | National Park |
| NPAES | National Protected Area Expansion Strategy |
| NT | Near Threatened |
| NWA | National Water Act (36/998) |
| PA | Protected Area |
| PES | Present Ecological State |
| QDGC | Quarter Degree Grid Cell |
| RQO | Resource Quality Objectives |
| SABAP | Southern African Bird Atlas Project |
| SACAD | South African Conservation Areas Database |
| SACNASP | South African Council for Natural Scientific Professions |
| SANParks | South African National Parks |
| SAPAD | South African Protected Areas Database |
| SCC | Species of Conservation Concern |
| SDF | Spatial Development Frameworks |
| SEA | Strategic Environmental Assessment |
| SPLUMA | Spatial Planning and Land Use Management Act (16/2013) |
| SWSA | Strategic Water Source Areas |
| ToPS | hreatened or Protected Species Regulations (2013) |
| VU | Vulnerable |
| WCBSP | Western Cape Biodiversity Spatial Plan |
| WHS | World Heritage Site |
| WUL | Water Use License |

# 1 SUMMARY

This chapter consolidates the potential impacts from the development of Electricity Grid Infrastructure (EGI) on terrestrial and aquatic ecology and biodiversity in two proposed expanded EGI corridors in South Africa (Table i). The ecological and biodiversity environmental aspects of the proposed expanded EGI corridors have been grouped according to the biomes that are found within the corridors, which act as the point of departure for terrestrial ecosystems and the fauna that inhabit these systems. The aquatic ecosystems considered include freshwater and estuarine habitats, and associated species.

Table i: Summary of key environmental features of the proposed expanded EGI corridors. Section references for the environmental description and sensitivity mapping for each corridor is indicated in the last column.

| Site | Brief description | § |
|---|---|---|
| Expanded Western EGI corridor  | • This proposed corridor is situated within Fynbos, Succulent Karoo, Nama Karoo, and Desert vegetation types in the Northern Cape and Western Cape Provinces.<br>• Mostly arid environment, with prominent protected areas that include the Richtersveld and Namaqua National Parks, with extensive areas earmarked as potential National Protected Areas Expansion Strategy (NPAES) focus areas.<br>• Relatively untransformed when compared to the proposed expanded Eastern EGI corridor. | 6.1<br>7.2.1 |
| Expanded Eastern EGI corridor  | • This proposed corridor is situated within Savanna, Grassland and Indian Ocean Coastal Belt vegetation types in the KwaZulu-Natal Province.<br>• Transformed by urban settlement and agriculture, especially in the vicinity of Richards Bay.<br>• The dense human population has resulted in large-scale transformation of the natural habitat, resulting in large sections of the corridor rated as low sensitivity for birds. However, the remaining natural areas support a wide variety of power line sensitive Red Data bird species.<br>• Many protected areas associated with large wetlands are present. | 6.2<br>7.2.2 |

Highly sensitive ecological features exist in both corridors, and are mainly related to protected areas and areas identified in Provincial Conservation Plans as Critical Biodiversity Areas (areas characterised by key ecological processes, ecosystems and species required to meet conservation targets and protect South Africa's biodiversity) (Figures i and ii). Areas that have already been transformed by anthropogenic activities such as urbanisation and agriculture are mainly of low sensitivity (Figure i). Aligning the proposed EGI routings to follow existing disturbance corridors presents an (environmental) opportunity.

Overall low human population, with most of the natural habitat relatively untransformed, results in the proposed expanded Western EGI corridor to be more sensitive for birds (Figure i). This, coupled with the occurrence of several high-risk species, has resulted in the majority of the habitat receiving a High Sensitivity rating. Conversely the dense human population in the proposed expanded Eastern EGI corridor has resulted in large-scale transformation of the natural habitat, resulting in large sections of the corridor rated as low sensitivity for birds (Figure ii). However, the remaining natural areas support a wide variety of power line sensitive Red Data bird species.

A number of Red Data Bat species occur in the proposed expanded Eastern EGI corridor - fruit bats and large insectivorous bats in particular could be affected by EGI development.

The proposed Expanded Western EGI corridor is situated in more arid areas and are less sensitive from an aquatic ecology perspective due to the relatively limited presence of aquatic features (Figure i). Due to existing pressures from other anthropogenic activities many of the aquatic ecosystems in the rest of the country are threatened and are resultantly highly sensitive to new development (Figure ii). The most sensitive aquatic ecosystems must be avoided as far as reasonably possible, else mitigated using engineering solutions (e.g. increased power line spanning distance across watercourses) and best practice to reduce potential impact.

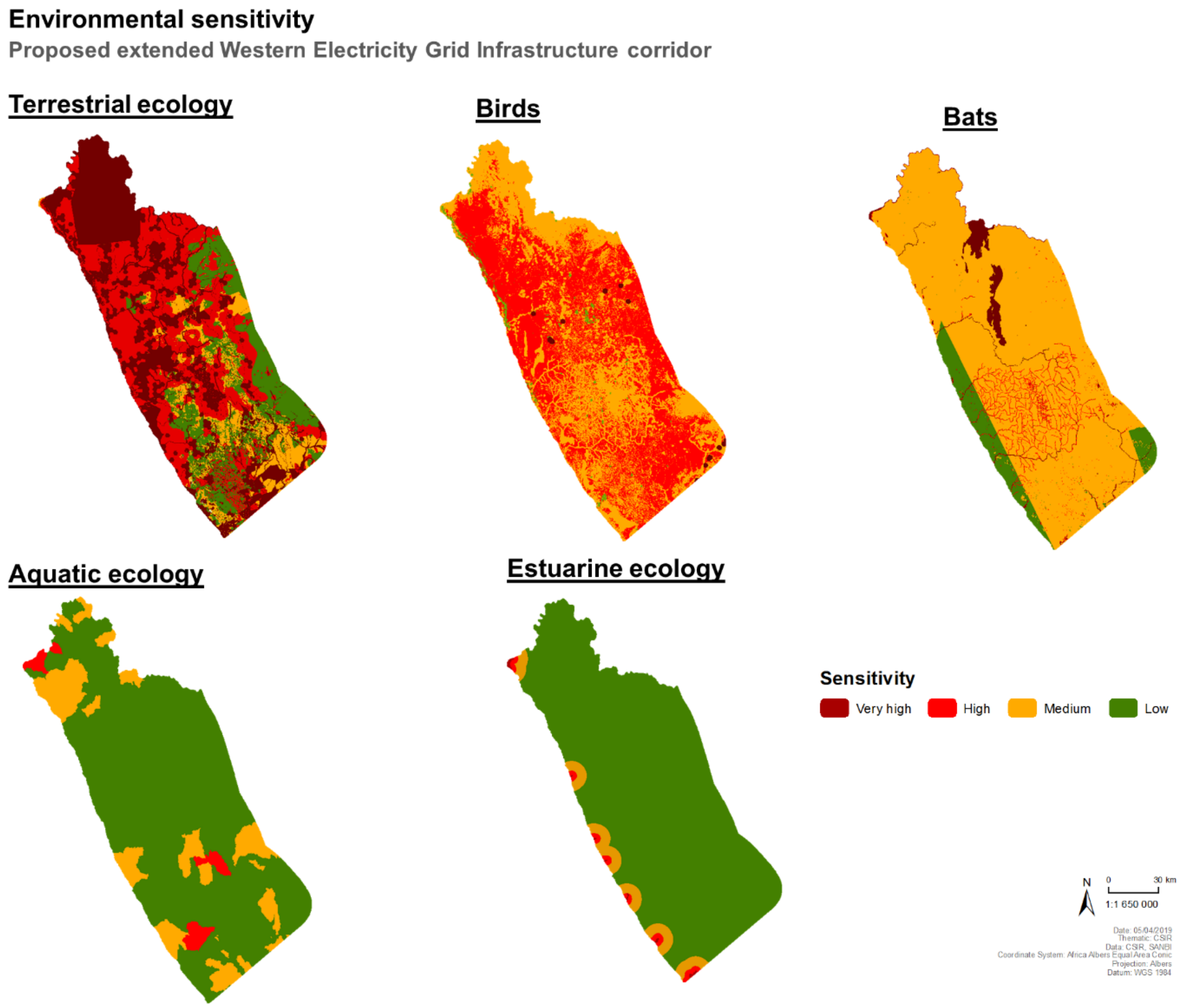



Figure i: Environmental sensitivity of terrestrial and aquatic ecosystems and species in the proposed expanded Western EGI corridor.


Figure ii: Environmental sensitivity of terrestrial and aquatic ecosystems and species in the proposed expanded Eastern EGI corridor.

Key potential impacts of proposed EGI development to terrestrial and aquatic ecosystems and biodiversity are mainly related to vegetation clearance during construction, which may have consequences for terrestrial fauna directly (e.g. habitat loss). Potential impacts to birds include collision and electrocution, whilst bats may also be impacted mainly via habitat alteration and loss and, to a lesser degree, potential electrocution and electromagnetic interference (Figure iii) (Section 5).

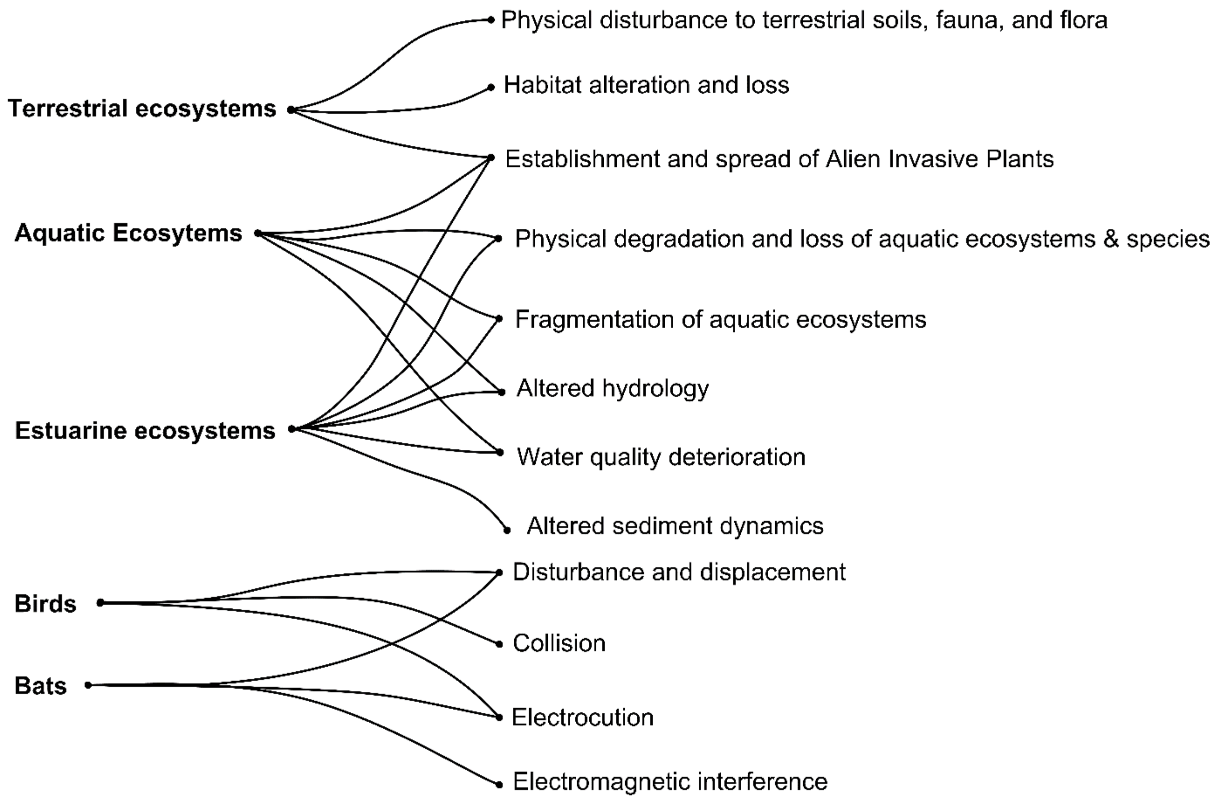



Figure iii: Key potential impacts of proposed EGI development to terrestrial and aquatic ecosystems and species.

The mitigation hierarchy must be applied during all development phases of the proposed EGI. Key mitigation measures include (Section 8):

- Avoid, as far as possible, the most sensitive areas identified in this assessment and areas identified by specialists in the field during subsequent project level assessments (as required);
- Minimise footprint and construction duration;
- Minimise new development footprints through utilising existing infrastructure and disturbance corridors as far as possible;
- Manage and continuously control Invasive Alien Plants;
- Manage and continuously control soil erosion;
- Manage construction and operational personnel and vehicles on- and around the site through proper induction, environmental awareness and monitoring of their activity; and
- Rehabilitate to a near-natural state as far as possible.

# 2 INTRODUCTION

This chapter consolidates and summarises the key findings from several independent specialist investigations (Annexures to this chapter) as part of a Strategic Environmental Assessment (SEA) of the potential impacts from the development of Electricity Grid Infrastructure (EGI) in two proposed corridors (study areas) (Figure 1) on terrestrial and aquatic biodiversity and ecology (Figure 2). The proposed corridors aim to expand the EGI corridors promulgated under the National Environmental Management Act (104 of 1998, as amended) (NEMA) in February 2018 in Government Gazette 41445, Government Notice 113 (South Africa, 2018). This assessment also recommends management actions and best practice mechanisms to avoid and minimise any potential negative impacts to sensitive ecosystems, the ecological processes that underpin their functioning, and the plant and animal species inhabiting the ecosystems.

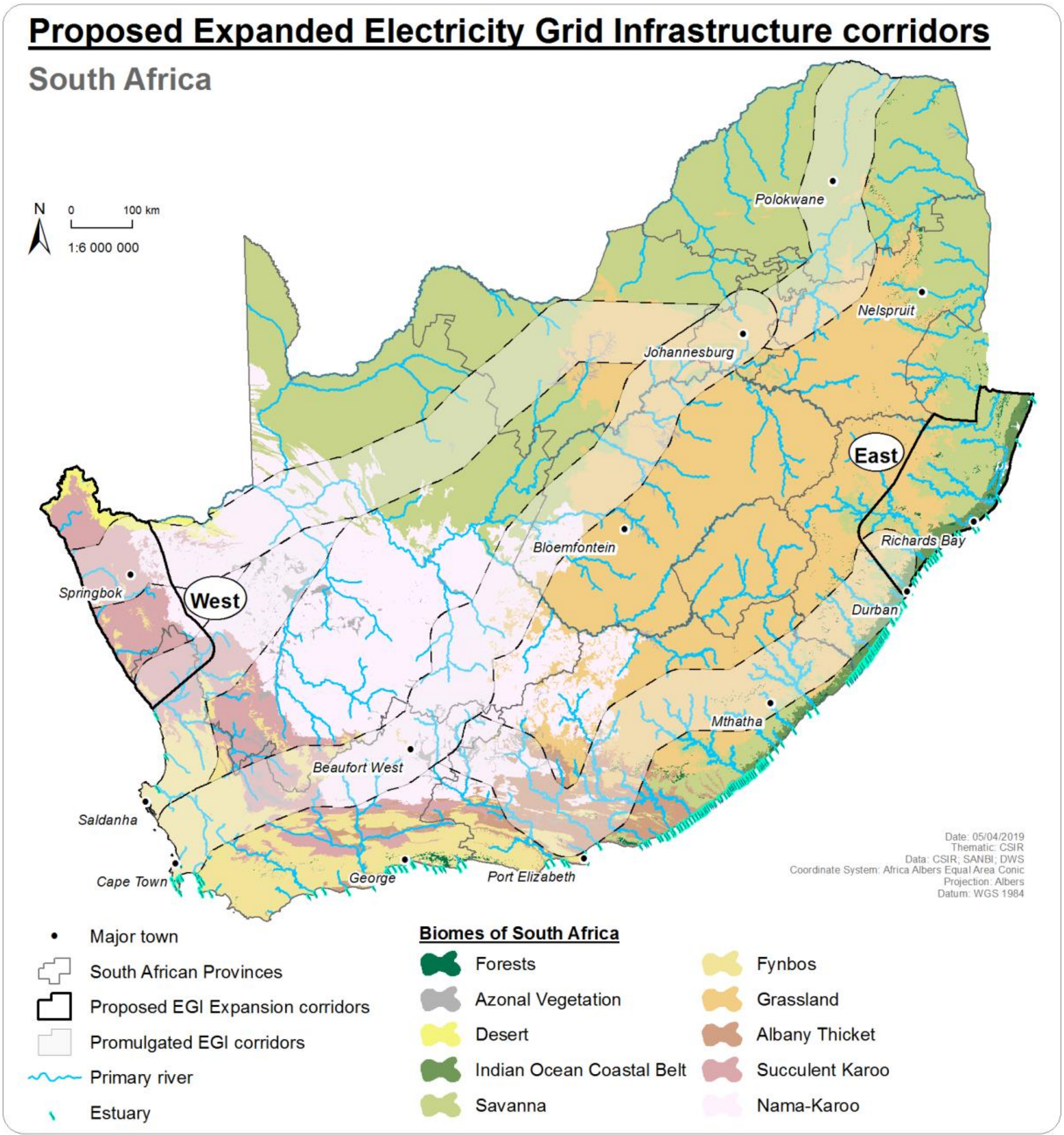



Figure 1: Location of the proposed Expanded Electricity Grid Infrastructure corridors, in relation to the promulgated corridors (South Africa, 2018), with the main terrestrial and aquatic ecosystem components considered in this assessment.

# 3 SCOPE OF BIODIVERSITY AND ECOLOGY FOR THIS ASSESSMENT

The ecological and biodiversity environmental aspects for the proposed expanded EGI corridors have been grouped according to the biomes that are found within the EGI corridors (Figure 2). These act as the point of departure for terrestrial ecosystems and the fauna that inhabit them. Aquatic ecosystems considered include freshwater and estuarine habitats, and associated species (Figure 2). The Forest biome has not been included in this assessment (see Section 4.3 for all assumptions and limitations underpinning this assessment). The Albany Thicket biome is not situated within either of the proposed expanded EGI corridors, and thus not included in this assessment.

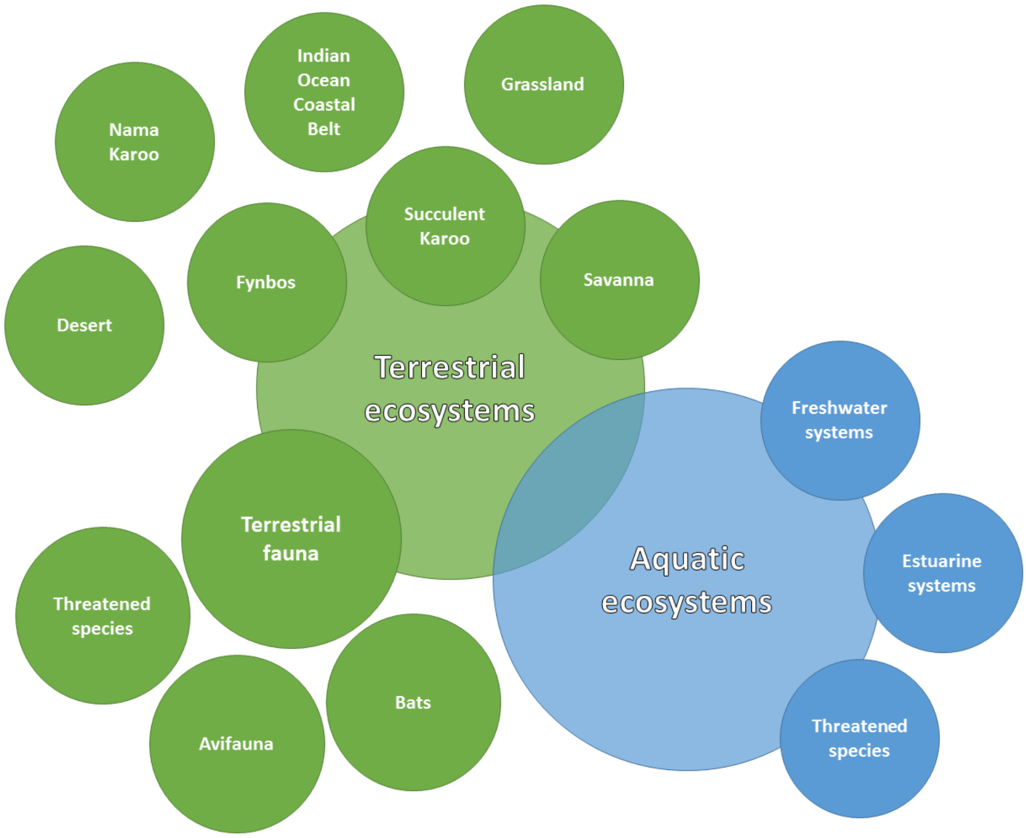



Figure 2: Overview of the terrestrial and aquatic ecosystem topics forming part of this strategic assessment, focusing on biomes, sensitive ecosystems, the ecological processes that underpin their functioning, and the plant and animal species inhabiting those ecosystems.

# 4 APPROACH AND METHODOLOGY

## 4.1 Study Methodology

The assessment used existing information to describe the ecosystems and species in the proposed expanded EGI corridors (Section 6), as well as the key potential impacts (Section 5) to these ecosystems that may be caused by EGI development. Existing spatial data, representing terrestrial and aquatic ecosystems (including species) (Section 4.2), were assigned sensitivity classes (Section 7). Recommendations are made in terms of avoiding, minimising and mitigating potential impacts (Sections 8 and 9).

## 4.2 Spatial Data Sources

This analysis has made extensive use of data resources arising from the following datasets listed in Table 1 - Table 6.

### 4.2.1 Terrestrial ecology

Table 1: Available spatial data pertaining to terrestrial ecological features used in this assessment.

| Feature | Source | Summary |
|---|---|---|
| TERRESTRIAL ECOSYSTEMS | | |
| **Provincial conservation planning** | Northern Cape<br>DENC. 2016. Critical Biodiversity Areas of the Northern Cape. http://bgis.sanbi.org/. | The Northern Cape Critical Biodiversity Area (CBA) Map identifies biodiversity priority areas, called CBAs and Ecological Support Areas (ESAs), which, together with protected areas, are important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of the landscape as a whole. |
| | Western Cape<br>CapeNature. 2017. Western Cape Biodiversity Spatial Plan 2017. http://bgis.sanbi.org/. | The Western Cape Biodiversity Spatial Plan (WCBSP) is the product of a systematic biodiversity planning assessment that delineates, on a map (via a Geographic Information System (GIS)), CBAs and ESAs which require safeguarding to ensure the continued existence and functioning of species and ecosystems, including the delivery of ecosystem services, across terrestrial and freshwater realms. These spatial priorities are used to inform sustainable development in the Western Cape Province. This product replaces all previous systematic biodiversity planning products and sector plans with updated layers and features. |
| | KwaZulu-Natal<br>Ezemvelo KZN Wildlife. 2016. KwaZulu-Natal Biodiversity Sector Plans. http://bgis.sanbi.org/. | Critical biodiversity assets in KwaZulu-Natal District Municipalities with associated management guidelines which aim to maintain the integrity of these biodiversity features. The key purpose is to assist and guide land use planners and managers within various district and local municipalities, to account for biodiversity conservation priorities in all land use planning and management decisions, thereby promoting sustainable development and the protection of biodiversity, and in turn the protection of ecological infrastructure and associated ecosystem services. |
| **Aquatic components of provincial conservation plans were also considered in the spatial sensitivity analysis for freshwater ecosystems* | | |
| **Protected and Conservation Areas** | DEA. 2018a. South African Protected Areas Database (SAPAD). Q2, 2018. https://egis.environment.gov.za/.<br><br>DEA. 2018b. South African Conservation Areas Database (SACAD). Q2, 2018. https://egis.environment.gov.za/. | Protected areas as defined in the National Environmental Management: Protected Areas Act, (Act 57 of 2003) (NEM:PAA).<br>Protected areas:<br>• Special nature reserves;<br>• National parks; |

| Feature | Source | Summary |
|---|---|---|
| TERRESTRIAL ECOSYSTEMS | | |
| | | • Nature reserves;<br>• Protected environments (1-4 declared in terms of the National Environmental Management: Protected Areas Act, 2003);<br>• World heritage sites declared in terms of the World Heritage Convention Act;<br>• Marine protected areas declared in terms of the Marine Living Resources Act;<br>• Specially protected forest areas, forest nature reserves, and forest wilderness areas declared in terms of the National Forests Act, 1998 (Act 84 of 1998);<br>• Mountain catchment areas declared in terms of the Mountain Catchment Areas Act, 1970 (Act 63 of 1970).<br>Conservation Areas:<br>• Biosphere reserves;<br>• Ramsar sites;<br>• Stewardship agreements (other than nature reserves and protected environments);<br>• Botanical gardens;<br>• Transfrontier conservation areas;<br>• Transfrontier parks;<br>• Military conservation areas;<br>• Conservancies. |
| **Protected and conservation areas were considered used in the spatial sensitivity analysis for avifauna* | | |
| **National Protected Area Expansion Strategy (NPAES) focus areas** | SANParks. 2010. National Protected Areas Expansion Strategy: Focus areas for protected area Expansion. http://bgis.sanbi.org/. | Focus areas for land-based protected area expansion are large, intact and unfragmented areas of high importance for biodiversity representation and ecological persistence, suitable for the creation or expansion of large protected areas. Representative of opportunities for meeting the ecosystem-specific protected area targets set in the NPAES, and were designed with strong emphasis on climate change resilience and requirements for protecting freshwater ecosystems. |
| **Vegetation of South Africa** | SANBI. 2018. Vegetation Map of South Africa, Lesotho and Swaziland. http://bgis.sanbi.org/. | Update of the Vegetation Map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006; SANBI, 2012) based on decisions made by the National Vegetation map Committee and contributions by various partners. |
| **Threatened ecosystems** | DEA (2011). South African Government Gazette. National Environmental Management: Biodiversity Act: National list of ecosystems that are threatened and in need of protection. Government Gazette, 558(34809). http://bgis.sanbi.org/. | The Biodiversity Act (Act 10 of 2004) provides for listing of threatened or protected ecosystems, in one of four categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or protected. The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction. This includes preventing further degradation and loss of structure, function and composition of threatened ecosystems. The |

| Feature | Source | Summary |
|---|---|---|
| TERRESTRIAL ECOSYSTEMS | | |
| | | purpose of listing protected ecosystems is primarily to preserve sites of exceptionally high conservation value. |
| **Vegetation of South Africa was also considered in the spatial sensitivity analysis for avifauna.* | | |
| **National Land Cover** | Geoterraimage. 2015. 2013-2014 South African National Land-Cover. Department of Environmental Affairs. Geospatial Data. https://egis.environment.gov.za/. | Recent global availability of Landsat 8 satellite imagery enabled the generation of new, national land-cover dataset1 for South Africa, circa 2013-14, replacing and updating the previous 1994 and 2000 South African National Landcover datasets. The 2013-14 national land-cover dataset is based on 30x30m raster cells, and is ideally suited for ± 1:75,000 - 1:250,000 scale GIS-based mapping and modelling applications.<br>Land cover are categorised into different classes, which broadly include:<br>• Bare none vegetated<br>• Cultivated<br>• Erosion<br>• Grassland<br>• Indigenous Forest<br>• Low shrubland<br>• Mines/mining<br>• Plantation<br>• Shrubland fynbos<br>• Thicket /Dense bush<br>• Urban<br>• Water<br>• Woodland/Open bush |
| **National Land Cover was also considered in the spatial sensitivity analysis for avifauna and bats.* | | |
| **Ecoregions** | Burgess et al. 2004. Terrestrial ecoregions of Africa and Madagascar: A conservation Assessment. Island Press: Washington DC. Geospatial data by SANBI. | Biodiversity patterns, threats to biodiversity, and resulting conservation priorities of biological units (rather than political units). |
| **National Forests** | DAFF. 2016. National Forest Inventory. https://www.daff.gov.za/daffweb3/Branches/Forestry-Natural-Resources-Management/Forestry-Regulation-Oversight/Forests/Urban-Forests/Forestry-Maps | Indigenous forest patches protected in terms of the NFA. |
| **Karoo ecological and biodiversity sensitivity** | Skowno et al. 2015. Terrestrial and Aquatic Biodiversity Scoping Assessment. In: Van der Westhuizen, C., Cape-Ducluzeau, L. and Lochner, P. (eds.). (2015). Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy in South Africa. | Terrestrial and aquatic ecosystems sensitivities specific to Karoo ecology and biodiversity, including fauna and flora that were mapped in the Wind and Solar SEA (REDZ) are specific to that SEA and renewable energy development as such, and these are not considered directly transferrable to the current expanded western EGI corridor study. But areas that |

| Feature | Source | Summary |
|---|---|---|
| **TERRESTRIAL ECOSYSTEMS** | | |
| | Department of Environmental Affairs, 2015. CSIR Report Number: CSIR/CAS/EMS/ER/2015/0001/B. Stellenbosch. Available athttps://redzs.csir.co.za/wp-content/uploads/2017/04/ Wind-and-Solar-SEA-Report-Appendix-C-Specialist-Studies.pdf | were mapped as Very High sensitivity are considered in this study to represent biodiversity priority areas and are also used here within the area of overlap of these two assessments. |
| **Field crop boundaries** | DAFF. 2014. Field Crop Boundaries. Available at: http://bea.dirisa.org/resources/metadata-sheets/WP03_00_META_FIELDCROP.pdf | Data on field crop extent and type of cultivation DAFF for South Africa. |

## 4.2.2 Aquatic ecosystems

### *4.2.2.1 Freshwater ecology*

Table 2: Available spatial data pertaining to freshwater ecological features used in this assessment.

| Feature | Source | Summary |
|---|---|---|
| **FRESHWATER** | | |
| SQ4 sub-quaternary drainage regions (referred to as SQ4 catchments) | DWS. 2009. Working copies of sub-quaternary catchments for delineation of management areas for the National Freshwater Ecosystem Priority Areas (NFEPA) in South Africa project - 2009 draft version. http://www.dwa.gov.za/iwqs/gis_data/. | Catchment areas that define the drainage regions of the NEFPA river reaches, which include 9 433 catchments ranging from 0.25 to 400 000 hectares. These catchment areas are used as the primary spatial unit for analysis in the freshwater component. |
| River Ecoregions (Level 1 and 2) | Kleynhans, C.J., Thirion, C. & Moolman, J., 2005. A level I river ecoregion classification system for South Africa, Lesotho and Swaziland. Pretoria: Department of Water Affairs and Forestry. | A delineation of ecoregions for South Africa as derived from terrain, vegetation, altitude, geomorphology, rainfall, runoff variability, air temperature, geology and soil. There are 31 Level 1 and 219 Level 2 River Ecoregions in South Africa, of which 12 Level 1 and 29 Level 2 River Ecoregions occur within the proposed expanded EGI corridors. |
| River Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) | DWS. 2014. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx. | A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa conducted in 2013. |
| NFEPA rivers and wetlands | Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, | The NFEPA coverages provide specific spatial information for rivers according to the DWS 1:500 000 rivers coverage, including river condition, river ecosystem types, fish sanctuaries, |

| Feature | Source | Summary |
|---|---|---|
| **FRESHWATER** | | |
| | E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. and Nienaber, S. 2011. Technical Report for the National Freshwater Ecosystem Priority Areas project. Pretoria: Water Research Commission, WRC Report No. K5/1801. | and flagship/free-flowing rivers. The NFEPA coverages also provide specific information for wetlands such as wetland ecosystem types and condition (note: wetland delineations were based largely on remotely-sensed imagery and therefore did not include historic wetlands lost through transformation and land use activities). |
| Ramsar Sites | Ramsar Convention. 2018. Convention on Wetlands of International Importance especially as Waterfowl Habitat. https://www.ramsar.org/ | Distribution and extent of areas that contain wetlands of international importance in South Africa. |
| National Wetland Vegetation Groups | Nel, J.L. and Driver, A. 2012. South African National Biodiversity Assessment 2011: Technical Report. Volume 2: Freshwater Component. Stellenbosch: Council for Scientific and Industrial Research. CSIR Report Number: CSIR/NRE/ECO/IR/2012/0022/A. | A vector layer developed during the 2011 NBA to define wetland vegetation groups to classify wetlands according to Level 2 of the national wetland classification system. The wetland vegetation groups provide the regional context within which wetlands occur, and is the latest available classification of threat status of wetlands that are broadly defined by the associated wetland vegetation group. This is considered more practical level of classification to the Level 4 wetland types owing to the inherent low confidence in the desktop classification of hydrogeomorphic units (HGM) that was used at the time of the 2011 NBA. |
| Provincial Wetland Probability Mapping | Collins, N. 2017. National Biodiversity Assessment (NBA) 2018. Wetland Probability Map. https://csir.maps.arcgis.com/apps/MapJournal/index.html?appid=8832bd2cbc0d4a5486a52c843daebcba# | Mapping of wetland areas based on a concept of water accumulation in the lowest position of the landscape, which is likely to support wetlands assuming sufficient availability water to allow for the development of the indicators and criteria used for identifying and delineating wetlands. This method of predicting wetlands in a landscape setting is more suitable for certain regions of the country than in others. |
| **Wetlands and rivers were also considered in the spatial sensitivity analysis for bats.*<br>**Coastal rivers, wetlands and seeps above or adjacent to estuaries were also considered in the spatial sensitivity analysis for estuaries.* | | |

#### *4.2.2.2 Estuarine ecology*

Table 3: Available spatial data pertaining to estuarine ecological features used in this assessment.

| Feature | Source | Summary |
|---|---|---|
| **ESTUARINE** | | |
| Estuarine health | Van Niekerk, L. & Turpie, J.K. (Eds). 2012. National Biodiversity Assessment 2011: Technical Report. Volume 3: Estuary Component. CSIR Report Number CSIR/NRE/ECOS/ER/2011/0045/B. Council for Scientific and Industrial Research, Stellenbosch. http://bgis.sanbi.org/nba/project.asp. | A desktop national health assessment for nearly 300 estuaries in South Africa. Estuary health assessment was based on the Estuarine Health Index developed for South African ecological water requirement studies that has been applied systematically to over 30 estuaries at various levels of data richness and confidence. |
| | Van Niekerk, L. et al. 2013. Country-wide assessment of estuary health: An approach for integrating pressures and ecosystem response in a data limited environment. Estuarine, Coastal and Shelf Science, 130: 239-251. | A country-wide assessment of the ~300 functional South African estuaries examined both key pressures (freshwater inflow modification, water quality, artificial breaching of temporarily open/closed systems, habitat modification and exploitation of living resources) and health status. |
| | SANBI. 2018. Interim findings of the National Biodiversity Assessment (work in progress). As available. | Assessment of the state of South Africa's estuarine biodiversity based on best available science, with a view to understanding trends over time and informing policy and decision-making. In progress – to be published in 2019. |
| Estuary ecological classification | Van Niekerk, L. et al. 2015. Desktop Provisional Ecoclassification of the Temperate Estuaries of South Africa. Water Research Commission Report No K5/2187. | EcoClassification for estuaries that provided a comparative, regional scale assessment. The Provisional EcoClassification refers to the Present Ecological Status (PES), the ecological importance and protection status, a Provisional Recommended Ecological Category (REC), as well as mitigation measures towards achieving the Provisional REC. |
| Estuaries in Formally /desired protected areas | Turpie, J.K. et al. 2012. National Biodiversity Assessment 2011: National Estuary Biodiversity Plan for South Africa. Anchor Environmental Consulting Cape Town. Report produced for the Council for Scientific and Industrial Research and the South African National Biodiversity Institute. | Marine, estuarine and terrestrial areas that are under formal protection or estuaries identified as desired protected areas in the National Estuaries Biodiversity Plan. |
| Estuaries of high biodiversity importance | Turpie, J.K., Adams, J.B., Joubert, A., Harrison, T.D., Colloty, B.M., Maree, R.C., Whitfield, A.K., Wooldridge, T.H., Lamberth, S.J., Taljaard, S., & Van Niekerk, L. 2002. Assessment of the conservation priority status of South African estuaries for use in management and water allocation. *Water SA,* 28: 191-206. | In South Africa, estuary biodiversity importance is based on the importance of an estuary for plants, invertebrates, fish and birds, using rarity indices. The Estuary Importance Rating takes size, the rarity of the estuary type within its biographical zone, habitat and the biodiversity importance of the estuary into account. |

| Feature | Source | Summary |
|---|---|---|
| **ESTUARINE** | | |
| Important nurseries | Van Niekerk, L. et al. 2017. A multi-sector Resource Planning Platform for South Africa's estuaries. Water Research Commission Report No K5/2464<br><br>Lamberth, S.J. & Turpie, J.K. 2003. The role of estuaries in South African fisheries: economic importance and management implications. *African Journal of Marine Science*, 25: 131-157. | Estuaries that are critically important nursery areas for fish and invertebrates and make an important contribution towards estuarine and coastal fisheries. |
| Important estuarine habitats | | Estuaries that support important rare or sensitive habitats (saltmarsh, mangroves, swamp forest) that provide important ecosystem services. |
| Natural or near natural condition estuaries | | Estuaries in good condition (designated by an A or B health category are more sensitive to development (likely to degrade in overall condition). |
| **Estuaries were also considered in the spatial sensitivity analysis for avifauna* | | |

### 4.2.3 Species

#### *4.2.3.1 Terrestrial and aquatic fauna*

Table 4: Available spatial data pertaining to terrestrial and aquatic species used in this assessment.

| Feature | Source | Summary |
|---|---|---|
| **TERRESTRIAL AND AQUATIC FAUNA** | | |
| **Red Data species** | <u>Mammals</u><br>Child et al. (*Eds*). 2016. The 2016 Red List of Mammals of South Africa, Swaziland and Lesotho. SANBI & EWT: South Africa | Known spatial locations for recorded Red Listed mammals in South Africa. |
| | <u>Reptiles</u><br>Bates et al. (*Eds*). Atlas and red data list of the reptiles of South Africa, Lesotho and Swaziland. SANBI: Pretoria (Suricata series; no. 1). | Known spatial locations for recorded Red Listed reptiles in South Africa. |

| Feature | Source | Summary |
|---|---|---|
| TERRESTRIAL AND AQUATIC FAUNA | | |
| | Amphibians<br>Minter, L.R. 2004. Atlas and red data book of the frogs of South Africa, Lesotho, and Swaziland. Avian Demography Unit: UCT. | Known spatial locations for recorded Red Listed amphibians in South Africa. |
| | Plants<br>Raimondo et al. 2009 (as updated in 2018). Red list of South African plants 2009, 2018 update. South African National Biodiversity Institute. | Known spatial locations for recorded Red Listed terrestrial and aquatic plants in South Africa. |
| | Fish distributions<br>IUCN. 2017. The IUCN Red List of Threatened Species, 2017. http://www.iucnredlist.org/ | Distribution data for selected fish species where point data was found to be lacking/insufficient was obtained from the IUCN Red List of Threatened Species Map Viewer with data presented as catchment distributions. The IUCN distributions were spatially inferred using the SQ4 catchments for three of the selected fish species. |
| | Freshwater fish<br>Coetzer, W. 2017. Occurrence records of southern African aquatic biodiversity. Version 1.10. The South African Institute for Aquatic Biodiversity. https://doi.org/10.15468/pv7vds | Known spatial locations for recorded Red Listed freshwater fish in South Africa. |
| | Aquatic macro-invertebrates<br>DWS. 2015. Invertebrate Distribution Records. [online] Department of Water and Sanitation RQIS-RDM, Pretoria. Available at: http://www.dwa.gov.za/iwqs/biomon/inverts/invertmaps.htm/ and http://www.dwa.gov.za/iwqs/biomon/inverts/invertmaps_other.htm/ | Known spatial locations for recorded aquatic macro-invertebrate Families from 359 monitoring sites on South African rivers. |
| | Butterflies<br>Henning, G.A., Terblanche, R.F. and Ball, J.B., 2009. South African red data book: butterflies. Mecenero S, Ball JB, Edge DA, Hamer ML, Henning GA, Kruger M, Pringle EL, Terblanche RF, Williams MC (*Eds*). 2013. Conservation assessment of butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas. Saftronics, Johannesburg and Animal | Known spatial locations for recorded Red Listed butterflies in South Africa. |

| Feature | Source | Summary |
|---|---|---|
| **TERRESTRIAL AND AQUATIC FAUNA** | | |
| | Demography Unit, Cape Town. | |
| | Dragonflies and damselflies (Odonata)<br>IUCN. 2017. The IUCN Red List of Threatened Species, 2017.3. http://www.iucnredlist.org/<br><br>Samways, M.J. & Simaika, J.P. 2016. Manual of Freshwater Assessment for South Africa: Dragonfly Biotic Index. SANBI: Pretoria: Suricata 2, p. 224. | Known spatial locations for recorded dragonflies and damselflies taken from a total of 164 records for these selected species within South Africa. This data includes records of the conservation important Odonata selected for this assessment. |

#### *4.2.3.2 Birds*

Table 5: Available spatial data pertaining to avifauna species and their environment used in this assessment.

| Feature | Source | Summary |
|---|---|---|
| **AVIFAUNA** | | |
| The Southern African Bird Atlas 1 (SABAP1) | UCT.1997. The Southern African Bird Atlas 1 (SABAP1). Animal Demography Unit, UCT. | The Southern African Bird Atlas Project (SABAP) was conducted between 1987 and 1991. Because a new bird atlas was started in southern Africa in 2007, the earlier project is now referred to as SABAP1. SABAP1 covered six countries: Botswana, Lesotho, Namibia, South Africa, Swaziland and Zimbabwe. At the time, Mozambique was engulfed in a civil war, and had to be excluded. The resolution for SABAP1 was the quarter degree grid cell (QDGC), 15 minutes of latitude by 15 minutes of longitude, 27.4 km north-south and about 25 km east-west, an area of about 700 km². Fieldwork was conducted mainly in the five-year period 1987–1991, but the project coordinators included all suitable data collected from 1980–1987. In some areas, particularly those that were remote and inaccessible, data collection continued until 1993.<br><br>Fieldwork was undertaken mainly by birders, and most of it was done on a volunteer basis. Fieldwork consisted of compiling bird lists for the QDGCs. All the checklists were fully captured into a database. The final dataset consisted of 147 605 checklists, containing a total of 7.3 million records of bird distribution. Of the total 3973 QDGCs, only 88 had no checklists (2.2% of the total). |

| Feature | Source | Summary |
|---|---|---|
| AVIFAUNA | | |
| The Southern African Bird Atlas 2 (SABAP2) | UCT. 2007 - present. The Southern African Bird Atlas 2 (SABAP2). Animal Demography Unit, UCT. | SABAP2 is the follow-up project to the Southern African Bird Atlas Project (for which the acronym was SABAP, and which is now referred to as SABAP1). This first bird atlas project took place from 1987-1991. The second bird atlas project started on 1 July 2007 and plans to run indefinitely. The current project is a joint venture between the Animal Demography Unit at the University of Cape Town, BirdLife South Africa and the South African National Biodiversity Institute (SANBI). The project aims to map the distribution and relative abundance of birds in southern Africa and the atlas area includes South Africa, Lesotho and Swaziland. SABAP2 was launched in Namibia in May 2012. The field work for this project is done by more than one thousand five hundred volunteer birders. The unit of data collection is the pentad, five minutes of latitude by five minutes of longitude, squares with sides of roughly 9km. At the end of June 2017, the SABAP2 database contained more than 189,000 checklists. The milestone of 10 million records of bird distribution in the SABAP2 database was less than 300,000 records away. Nine million records were reached on 29 December 2016, eight months after reaching 8 million on 14 April 2016, which in turn was eight months after reaching seven million on 22 August 2015, and 10 months after the six million record milestone. More than 78% of the original SABAP2 atlas area (i.e. South Africa, Lesotho and Swaziland) has at least one checklist at this stage in the project's development. More than 36% of pentads have four or more lists. |
| Crane, raptor and vulture nests | EWT. 2006a (as supplemented by more recent unpublished data). Nest database for cranes, raptors and vultures. Endangered Wildlife Trust. | Data on crane, vulture and raptor nests collected by the various programmes of the EWT. Absence of records does not imply absence of the species within an area, but simply that this area may not have been surveyed. All recorded nesting sites were included, no verification of current status of nests were conducted. |
| National vulture restaurant database | VulPro 2017. National vulture restaurant database. http://www.vulpro.com/. | The register contains a georeferenced list of vulture restaurants throughout South Africa as compiled by VulPro. All recorded vulture restaurants were included; no verification of current status of vulture restaurants was conducted. |
| Eagle nests on Eskom transmission lines in the Karoo | EWT. 2006b (as supplemented by more recent unpublished data). List of eagle nests on Ekom transmission lines in the Karoo. | The dataset contains a georeferenced list of Tawny Eagle, Martial Eagle and Verreaux's Eagle nests on transmission lines in the Karoo as at 2006. All recorded nesting sites were included, no verification of current status of nests were conducted. |
| Locality of Red Data nests | Unpublished data from pre-construction monitoring at renewable energy projects from 2010 - 2018, obtained from various avifaunal specialists. | Nests of various raptors, including Verreaux's Eagle, Martial Eagle, Tawny Eagle, African Crowned Eagle, Wattled Crane, White-backed Vulture collected in the course of pre-construction monitoring at proposed renewable energy projects in the Western, Northern, and Eastern Cape, and KZN. |
| Cape Vulture colonies | VulPro & EWT. 2018. The national register of Cape Vulture colonies. | The dataset contains a georeferenced list of Cape Vulture colonies, as well as the results of the 2013 aerial survey of Cape Vulture colonies conducted by Eskom, EWT and Birdlife South Africa (BLSA) in the former Transkei, Eastern Cape. |

| Feature | Source | Summary |
|---|---|---|
| **AVIFAUNA** | | |
| Blue Swallow breeding areas | Ezemvelo KZN Wildlife. 2018. Blue Swallow breeding areas. | The KZN Mistbelt Grassland Important Bird Area (IBA) which incorporates all the known patches of grassland where Blue Swallows are known to nest and forage, plus additional nests sites outside the IBA. No verification of current status of nests was conducted. |
| Southern Ground Hornbills nesting areas. | MGHP. 2018. Potential nesting areas of Southern Ground Hornbills. http://ground-hornbill.org.za/ | The data consists of a list of pentads where the species was sighted in KwaZulu-Natal, Mpumalanga and the Eastern Cape. Data was provided in pentad format. The assumption was made that the species would be breeding within the pentad. |
| Various Red Data bird species nests | CSIR. 2015. Information on various Red Data species nests obtained from the SEA for Wind and Solar Photovoltaic Energy in South Africa. | The data comprise nest localities of Black Harrier, Martial Eagle, Verreaux's Eagle, Blue Crane, Lanner Falcon, in the 8 solar and wind focus areas where they overlap with the proposed expanded EGI corridors. |
| Southern Bald Ibis breeding colonies. | BLSA. 2015. Nest localities of Southern Bald Ibis. https://www.birdlife.org.za/ | The data comprises nest localities of Southern Bald Ibis collected by Dr. Kate Henderson as part of her PhD studies. |
| Potential Bush Blackcap, Spotted Ground-Thrush and Orange Ground-Thrush breeding habitat. | BLSA. 2018a. A list of potential Bush Blackcap, Spotted Ground-Thrush and Orange Ground-Thrush breeding habitat. https://www.birdlife.org.za/. | The results of a modelling exercise undertaken by BirdLife South Africa to identify critical breeding habitat for three key forest – dwelling Red Data species. |
| Yellow-breasted Pipit core distribution | BLSA. 2018b. Yellow-breasted Pipit core distribution mapping. https://www.birdlife.org.za/. | Map of core distribution/breeding areas based on the modelling of key aspects of the species' biology. |
| Rudd's Lark core distribution | BLSA. 2018c. Rudd's Lark core distribution mapping. https://www.birdlife.org.za/. | Map of core distribution/breeding areas based on the modelling of key aspects of the species' biology. |
| Botha's Lark core distribution | BLSA. 2018d. Botha's Lark core distribution mapping. https://www.birdlife.org.za/. | Map of core distribution/breeding areas based on the modelling of key aspects of the species' biology. |
| White-winged Flufftail confirmed sightings 2000 – 2014 | BLSA. 2014. White-winged Flufftail confirmed sightings 2000 – 2014. https://www.birdlife.org.za/. | A list of wetlands where this Critically Endangered (CR) species has been recorded in South Africa which includes the locality where the first breeding for the region has recently been confirmed. |
| Red Data nest localities in the KwaZulu-Natal | Ezemvelo KZN Wildlife. 2018. Red data Bird nest localities. | Nests localities of Bateleur, Black Stork, African Crowned Eagle, Lappet-faced Vulture, Marabou Stork, Martial Eagle, Secretarybird, Tawny Eagle, White-backed Vulture and White-headed Vulture. |

#### *4.2.3.3 Bats*

Table 6: Available spatial data pertaining to bat species and their environment used in this assessment.

| Feature | Source | Summary |
| --- | --- | --- |
| **BATS** | | |
| Terrestrial Ecoregions | TNC. 2009. Terrestrial ecoregions. http://maps.tnc.org/gis_data.html | The terrestrial ecoregions for South Africa, Swaziland and Lesotho. From numerous monitoring assessments, Inkululeko Wildlife Services has calculated average bat passes per hour for the seven of the ecoregions to gain an understanding of the bat activity levels in each. |
| Geology | CGS. 1997. 1: 1M geological data. | Four main lithologies were selected as relevant to bats in terms of bat roosting potential: Limestone, Dolomite, Arenite and Sedimentary and Extrusive rock. |
| Bat Roosts | Published and unpublished data obtained from a variety of scientists and bat specialists, including:<br>• Animalia fieldwork database. Obtained from Werner Marais in July 2013.<br>• Bats KZN fieldwork database. Obtained from Leigh Richards and Kate Richardson in July 2017.<br>• David Jacobs fieldwork database. Obtained from David Jacobs in May 2018.<br>• Herselman, J.C. and Norton, P.M. 1985. The distribution and status of bats (Mammalia: Chiroptera) in the Cape Province. Annals of the Cape Province Museum (Natural History) 16: 73-126.<br>• Inkululeko Wildlife Services fieldwork database. Obtained from Kate MacEwan in March 2018.<br>• Rautenbach, I.L. 1982. Mammals of the Transvaal. No. 1, Ecoplan Monograph. Pretoria, South Africa.<br>• Wingate, L. 1983. The population status of five species of Microchiroptera in Natal. M.Sc. Thesis, University of Natal. | A few of the points known to not be true bat roost locations were removed. Some points were moved, as the projection had put them in the ocean. Due to mainly construction phase impacts being the concern for bats, a minimum 500 m radial buffer was placed on each roost, irrespective of size or species. |
| Bat species occurrence data | Database from a collection of scientists and organisations. Collated by SANBI and the EWT in 2016 for use in the National Bat Red Data listings.<br><br>Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D., Davies-Mostert, H.T. (*Eds*). 2016. The 2016 Red List of Mammals of South | Extent of Occurrences (EoOs) were compiled for conservation important and certain high-risk bat species using the Child *et al*. (2016) species point data. These are simply points where one or more individuals from a particular species were confirmed from museum and scientific records. Because bats travel extensive distances nightly and some seasonally, these points are an under-estimation of the area each individual will occupy in their lifetime. |

| Feature | Source | Summary |
|---|---|---|
| BATS | | |
| | Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa. | Therefore, an arbitrary 50 km radius was placed around each confirmed point record to buffer for some or all of the potential movement or habitat spread. Then, a best fit polygon (the tightest possible polygon) was drawn around these radii to create an EoO for each relevant species. This is deemed as the maximum known extent that each species occurs in. However, the process did not exclude areas within the polygon where the bats are unlikely to occur due to disturbance or unfavourable habitat, i.e. the polygons did not represent the true area of occupancy (AoO). AoO is defined as the area within its EoO which is occupied by a taxon, excluding cases of vagrancy. In other words, the AoO is a more refined EoO that takes the detailed life history of each species into account. An AoO reflects the fact that a taxon will not usually occur throughout its entire EoO because the entire area may contain unsuitable or unoccupied habitats. To compile more AoOs per species is a significant task, beyond the scope of this SEA. |

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## 4.3 Assumptions and Limitations

The following assumptions and limitations form the basis for this assessment:

*General*

- This is a strategic-level assessment, aimed to identify potential environmental sensitivities based on existing spatial data at a high-level. The consideration of ecological pattern and process is limited by the resolution and scale of the spatial data. For site-specific routings and siting of EGI, real-world conditions must be verified on the ground.
- Species records are limited to primarily areas which are easy to access and where monitoring is safe to undertake e.g. in Protected Areas (PAs). Datasets used in this study are likely to contain sampling bias. This has not been adjusted for or improved.
- This assessment makes use of information available and in a useable format. No fieldwork was done and no additional raw data were collected and/or processed.

*Terrestrial ecology*

- The scales and spatial resolutions of input data varies (e.g. 30x30 m for land cover to units mapped at approximately 1:250 000 scale such as vegetation types). This heterogeneity is inappropriate for fine-scale analysis and interpretation, but can inform strategic, high-level planning.
- Provinces use separate approaches in their Biodiversity Spatial Plans to determine areas of high biodiversity importance and conservation concern. Sensitivity levels between provinces differ, with some provinces potentially using higher sensitivities than others. Provincial biodiversity conservation plans are used subject to all the assumptions that underpin the creation of those plans.
- Faunal records are limited to primarily areas which are easy to access and where monitoring is safe to undertake e.g. in Protected Areas (PAs).
- The Forest biome has not been included in this assessment as it represents a constraint to the EGI as mature trees will impact on the servicing and maintenance of power lines. Therefore, the forest biome will be avoided for the routing of the EGI. However, where the forest biome cannot be avoided by the power line route, due to the rare and sensitive environments that are associated with the biome, developers would be required to fulfil the requirements of the EIA Regulations at the time.
- Biodiversity value, equates to biodiversity sensitivity, implying that for any given activity (like vegetation clearing) the associated impacts will be higher on areas of 'high biodiversity' value than on areas with 'Moderate' or 'low' value biodiversity. However, it requires the assumption that the same sensitivity designations will respond to impacts in a similar way. This is not always true as there may be different reasons (biodiversity features) for sensitivity classifications, and these biodiversity features may not respond the same to any particular stress.

*Avifauna*

- Due to the relatively coarse resolution of a Quarter Degree Grid Cell (QDGC) (25 x 27.4km), sometimes species were recorded within a QDGC which contains more than one biome, some of which it is unlikely to occur in. In such an instance professional judgment was used to assess the potential for a species to occur in a given habitat and it was taken into account in the risk rating process.
- Field verification will still need to take place on a site by site basis linked to development proposals.

- The recommendations put forward should be seen as generic and not replacing the project-specific recommendations for an individual project.
- The potential impact of EGI development, specifically power lines, on avifauna in South Africa is relatively well studied, but important information is still lacking:
    - It is unclear how some Red Data species will react to the disturbance associated with the construction of power lines - more scientifically verifiable knowledge of the disturbance thresholds of these species would improve predictive capabilities.
    - The actual mortality of power line sensitive Red Data species will always remain unknown. The impact of mortality on these populations is therefore difficult to assess, and needs to be deduced from the available, incomplete data currently available.
    - Published, scientifically verified results from the experiments performed by the Endangered Wildlife Trust (EWT) to test the efficacy of Bird Flappers to prevent collision mortality is eagerly awaited.

*Bats*

- Bat roost data is limited to data voluntarily supplied by bat specialists and published literature. The co-ordinates provided by some of the published sources are old and/ or they are only provided in degrees and minutes, therefore there are potentially accuracy concerns.
- It would be more accurate to map Area of Occupancy (AoO) vs Extent of Occurrence (EoO) for species of conservation importance, but this level of detail was beyond the scope of this high level SEA. Commissioning such a detailed mapping exercise of the AoO for all species of conservation importance, both plants and animals, would be a worthwhile exercise for the DEA to consider for future conservation planning.
- Currently there is a lack of data on the impacts of power lines on bats in South Africa.

*Other species*

- The potential presence of fauna species, in particular terrestrial invertebrate groups in each of the assessed biomes was evaluated based on existing literature and available databases. However, data contained within some of these species databases are coarse and insufficient to be able to identify endemics with any certainty, and the threat status of most invertebrate groups has not been assessed according to the International Union for Conservation of Nature (IUCN) criteria. A further limitation was that some datasets are outdated, or lacking data for certain areas of ecological importance within each biome.

*Freshwater ecosystems*

- Quinary/sub-quaternary catchments were used as the primary unit of scale for analyses allowing for integration of multiple datasets (e.g. points, lines, polygons) to ensure continuity in the output that are also comparable.
- The conservation importance/threat status of wetlands was determined using the national wetland vegetation groups.
- PA layers were not used for the freshwater ecosystems assessment. Freshwater features are inherently less sensitive given the levels of protection. It was assumed that PAs will be accounted for in the main integration of all data layers and development of the cost surface - in this regard all freshwater ecosystems and features will be treated with a high sensitivity.
- Fine-scale GIS layers have been thinned out to make processing more efficient - allowing a suitable fine scale resolution for strategic planning, whilst ensuring efficient processing. It is assumed that Site specific studies will utilise all information available (SEA threat and sensitivity layers) as well as the detailed fine-scale GIS layers. Such fine-scale detail is potentially excessive at the strategic planning phase.

- Only point data for species of conservation concern was used based on current availability and sources.

*Estuaries*

- Due to the strategic nature of the assessment and the expansive area under investigation, a generic approach was applied, selecting a suite of key estuarine attributes considered appropriate, to assess impact and associated risks during the construction and operational phases.
- This assessment provides a broad scale sensitivity rating for estuaries in the various corridors. As all estuaries are sensitive to altered sediment and hydrodynamic processes, more detailed spatially scaled sensitivity demarcation within the study areas will need to be refined during the detailed planning and construction phases.

## 4.4 Relevant Regulatory Instruments

Table 7 presents legislation and legal instrument relating to sustainable development and nature conservation that would have to be taken into account and adhered to (where relevant) for the development of EGI in South Africa.

Table 7: Key international, provincial and local legal instruments that aim to guide and promote sustainable development and nature conservation in South Africa.

| Instrument | Key objective |
|---|---|
| INTERNATIONAL INSTRUMENTS | |
| Ramsar Convention (The Convention of Wetlands of International Importance (1971 and amendments) | Protection and conservation of wetlands, particularly those of importance to waterfowl and waterfowl habitat. |
| Convention concerning the Protection of the World Cultural and Natural Heritage, adopted by UNESCO in 1972 (World Heritage Convention) | Preservation and protection of cultural and natural heritage throughout the world. |
| Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) | Aims to conserve terrestrial, marine and avian migratory species throughout their range. |
| The Agreement on the Conservation of African - Eurasian Migratory Waterbirds, or African- Eurasian Waterbird Agreement (AEWA) | Intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. |
| International Finance Corporation (IFC) Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources | To protect and conserve biodiversity, maintain the benefits from ecosystem services, and promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities through the adoption of practices that integrate conservation needs and development priorities. |
| Convention on Biological Diversity (1993) including the CBD's Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets | The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding. |
| Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA) and associated regulations | This Act provides for, inter alia, restrictions on the cultivation of land, the protection of soils and water courses, the combating and prevention of erosion, and the prevention of the weakening or destruction of water sources on agricultural land. One of the provisions of the Act includes measures to protect wetlands and watercourses by maintaining uncultivated buffers along water courses and around water bodies to reduce sedimentation and for reducing agro-chemical pollution.<br><br>Other key aspects include legislation that allows for: Section 6: Prescription of control measures relating to the utilisation and protection of vleis, marshes, water sponges and water courses. These measures are described in regulations promulgated in terms of the Act, as follows; Regulation 7(1): Subject to the Water Act of 1956 (since |

| Instrument | Key objective |
|---|---|
| | amended to the Water Act 36 of 1998), no land user shall utilise the vegetation of a vlei, marsh or water sponge or within the flood area of a water course or within 10 m horizontally outside such flood area in a manner that causes or may cause the deterioration or damage to the natural agricultural resources. Regulation 7(3) and (4): Unless written permission is obtained, no land user may drain or cultivate any vlei, marsh or water sponge or cultivate any land within the flood area or 10 m outside this area (unless already under cultivation). |
| NEMA Bioregional Planning Regulations (Government Gazette No. 32006, 16 March 2009) | Guideline regarding the Determination of Bioregions and the Preparation and Publication of Bioregional Plans. Sets out the standards for Bioregional Planning including systematic conservation plans such as those consulted for this assessment. |
| Spatial Planning and Land Use Management Act (No 16 of 2013) (SPLUMA) | Provides for a uniform, effective and comprehensive system of spatial planning and land use management. The Act recognizes that development be sustainable and aligned with everyone's right to have their environment protected. It also requires all levels of government to work together to realise these outcomes. |
| REGIONAL INSTRUMENTS | |
| Southern African Development Community (SADC) Protocol on Shared Watercourse Systems (1995) | The protocol provides for the utilisation of a shared watercourse system for the purpose of agricultural, domestic and industrial use and navigation within the SADC region. The protocol established river basin management institutions for shared watercourse systems and provides for all matters relating to the regulation of shared watercourse systems |
| NATIONAL INSTRUMENTS | |
| National Environmental Management: Protected Areas Act (57 of 2003) (NEM:PAA) | No development, construction or farming may be permitted in a nature reserve without the prior written approval of the management authority (Section 50 (5)). Also in a 'protected environment' the Minister or Member of the Executive Committee may restrict or regulate development that may be inappropriate for the area given the purpose for which the area was declared (Section 5). |
| National Environmental Management Act (107 of 1998) (NEMA) | Restrict and control development and potential harmful activities through the Environmental Impact Assessment (EIA) regulations and the undertaking of relevant assessments prior to commencement of listed activities (Section 24 (5) and 44). Imposes "duty of care" (Section 28) which means that all persons undertaking any activity that may potentially harm the environment must undertake measures to prevent pollution and environmental degradation. |
| National Environmental Management Act, EIA 2014 Regulations, as amended in 2017 | These regulations provide listed activities that require environmental authorisation prior to development because they are identified as having a potentially detrimental effect on natural ecosystems. Different sorts of activities are listed as environmental triggers that determine different levels of impact assessment and planning required. The regulations detail the procedures and timeframes to be followed for a Basic Assessment or full Scoping and EIA. |
| National Water Act (36 of 1998) (NWA) | This act provides the legal framework for the effect and sustainable management of water resources. It provides for the protection, use, development, conservation, management and control of water resources as a whole. Water use pertains to the consumption of water and activities that may affect water quality and condition of the resource such as alteration of a watercourse. Water use requires authorisation in terms of a Water use licence (WUL) or General Authorisation (GA), irrespective of the condition of the affected watercourse. Includes international management of water. |

| Instrument | Key objective |
|---|---|
| National Environmental Management: Integrated Coastal Management Act (24 of 2008) (NEM:ICM) | To determine the coastal zone of South Africa and to preserve and protect coastal public property. To control use of coastal property (Section 62, 63 and 65) and limitation of marine pollution (Chapter 8).<br><br>Recreational waters. Water quality guidelines for the coastal environment: Recreational use (DEA, 2012). Set water quality targets for recreational waters to protect bathers.<br><br>Protection of aquatic ecosystems. Water quality guidelines for protection of natural coastal environment (DWAF, 1995, in process of being reviewed by DEA). This will set targets for use of specific chemicals in marine waters and sediments to protect ecosystems. |
| National Forest Act (84 of 1998) (NFA) | Protection of natural forests and indigenous trees species through gazetted lists of Natural Forests and Protected Trees (Sections 7 (2) and 15 (3) respectively). Disturbance of areas constituting natural forest or the disturbance of a protected tree species requires authorisation from the relevant authority. |
| National Environmental Management: Biodiversity Act (10 of 2004) (NEM:BA) | Protection of national biodiversity through the regulation of activities that may affect biodiversity including habitat disturbance, culture of and trade in organisms, both exotic and indigenous. Lists of alien invasive organisms, threatened and protected species and threatened ecosystems published and maintained (Sections 97 (1), 56 (1) and 52 (1) (a) respectively). The NEMBA provides for listing threatened or protected ecosystems, in one of four categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Protected. Activity 12 in Listing Notice 3 (Government Notice R324 of April 2017 as per the 2014 EIA Regulations, as amended) relates to the clearance of 300 $m^2$ or more of vegetation, within Critical Biodiversity Areas. |
| National Environmental Management: Waste Act (59 of 2008) (NEM:WA) | Minimising the consumption of natural resources; avoiding and minimising the generation of waste; reducing, re-using, recycling and recovering waste; treating and safely disposing of waste as a last resort; preventing pollution and ecological degradation; securing ecologically sustainable development while promoting justifiable economic and social development; promoting and ensuring the effective delivery of waste services; remediating land where contamination presents, or may present, a significant risk of harm to health or the environment: and achieving integrated waste management reporting and planning; to ensure that people are aware of the impact of waste on their health, well-being and the environment; to provide for compliance with the measures set out in paragraph (a) and generally, to give effect to section 24 of the Constitution in order to secure an environment that is not harmful to health and well-being. |
| Threatened or Protected Species Regulations of 2013 (ToPS) | The TOPs relates to Section 56 of NEMBA. Species categorised as CR, EN, VU or Protected require permits for activities relating to:<br>i. Hunt / catch / capture / kill<br>ii. Gather / collect / pluck<br>iii. Pick parts of / cut / chop off / uproot / damage / destroy<br>iv. Import into South Africa / introduce from the sea<br>v. Export (re-export) from South Africa<br>vi. Possess / exercise physical control<br>vii. Grow / breed / propagate |

| Instrument | Key objective |
|---|---|
| | viii. Convey / move/ translocate<br>ix. Sell / trade in / buy / receive / give / donate/ accept as a gift / acquire /dispose of<br>x. Any other prescribed activity |
| Draft National Biodiversity Offset Policy | A Draft National Biodiversity Offset Policy was gazetted in March 2017 (NEMBA, 2017), and is in the process of being finalised. The offset policy is intended to establish the foundation for establishing an offset for biodiversity (including river and wetland ecosystems), ensuring that offset procedures are properly integrated into the EIA process to make sure that the mitigation hierarchy is exhausted. Should it be determined in the EIA that there will be residual impact that cannot be avoided and/or mitigate, then an offset will need to be established to account for the loss of biodiversity. The core principles for offsetting, as set out in the policy, should be used to guide the process of evaluating, designing and implementing an offset. It is essential that the offset process is introduced from the outset of the EIA |
| National Water Resource Strategy (NWRS) 2004 and NWRS 2013 | Facilitate the proper management of the nation's water resources; provide a framework for the protection, use, development, conservation, management and control of water resources for the country as a whole; provide a framework within which water will be managed at regional or catchment level, in defined water management areas; provide information about all aspects of water resource management; identify water-related development opportunities and constraints |
| The Water Services Act (108 of 1997) | The right of access to basic water supply and the right to basic sanitation necessary to secure sufficient water and an environment not harmful to human health or well-being; the setting of national standards and norms and standards for tariffs in respect of water services; the preparation and adoption of water services development plans by water services authorities; a regulatory framework for water services institutions and water services intermediaries; the establishment and disestablishment of water boards and water services committees and their duties and powers; the monitoring of water services and intervention by the Minister or by the 5 relevant Province; financial assistance to water services institutions; the gathering of information in a national information system and the distribution of that information; the accountability of water services providers: and the promotion of effective water resource management and conservation.<br><br>Water supply services in an efficient equitable manner, as well as measures to promote water conservation and demand management which through Water Conservation and Water Demand Management (WC/WDM) strategies |
| Marine Living Resources Act (18 of 1998) (MLRA) | Marine Living Resources Act. The management and control of exploited living resources in estuaries fall primarily under the Marine Living Resources Act (MLRA) (No. 18 of 1998). The primary purpose of the act is to protect marine living resources (including those of estuaries) through establishing sustainable limits for the exploitation of resources; declaring fisheries management areas for the management of species; approving plans for their conservation, management and development; prohibit and control destructive fishing methods and the declaration of Marine Protected Areas (MPAs) (a function currently delegated to the DEA). The MLRA overrides all other conflicting legislation relating to marine living resources. |
| National Estuarine Management Protocol | National Estuary Management Protocol sets the standards for Estuarine Management in South Africa (Regulation No. 341 of 2013 promulgated in support of section 33 of the ICM Act). |

| Instrument | Key objective |
|---|---|
| National Port Act (12 of 2005) | Legal requirements as stipulated in terms of the National Ports Act (No. 12 of 2005) must be complied with in commercial ports – relevant to estuaries which have ports in them. |
| PROVINCIAL INSTRUMENTS | |
| Catchment Management Strategies applicable to all provinces | Progressively develop a catchment management strategy for the water resources within its water management area. Catchment management strategies must be in harmony with the national water resource strategy. CMA must seek cooperation and agreement on water -related matters from the various stakeholders and interested persons. CMA must be reviewed and include a water allocation plan, set principles for allocating water to existing and prospective users, taking into account all matters relevant to the protection use, development conservation, management and control of resources |
| KwaZulu-Natal | |
| Natal Nature Conservation Ordinance No. 15 of 1974 and KwaZulu-Natal Nature Conservation Management Act, (Act 9 of 1997) | According to the Natal Nature Conservation Ordinance No. 15 of 1974 and the KwaZulu-Natal Nature Conservation Management Act, 1992 (Act 9 of 1997), no person shall, among others: damage, destroy, or relocate any specially protected indigenous plant, except under the authority and in accordance with a permit from Ezemvelo KZN Wildlife (EKZNW). A list of protected species has been published in terms of both acts. |
| The KwaZulu-Natal Environmental, Biodiversity and Protected Areas Management Bill, 2014 | The Management Bill, 2014 was passed to provide for the establishment, functions and powers of Ezemvelo KZN Wildlife; the protection and management of the environment and biodiversity; the protection and conservation of indigenous species, ecological communities, habitats and ecosystems; the management of the impact of certain activities on the environment; the sustainable use of indigenous biological resources; the declaration and management of protected areas; and to provide for matters connected therewith. The Bill includes lists of provincial protected animal and plant species, and it sets rules for activities in protected areas, as well as for the protection of biodiversity. |
| Various KZN Ordinances (e.g. South Barrow Loan and Ext Powers Ordinance 12 of 1920; South Shepstone Loan and Extended Powers Ordinance 20 of 1920; Water Services Ordinance 27 of 1963; Kloof Loan and Extended Powers Ordinance 16 of 1967; Umhlanga Extended Powers and Loan Ordinance 17 of 1975; Durban Extended Powers Cons Ordinance 18 of 1976; Kwa-Zulu and Natal Joint Services Act 84 of 1990) | Regulation of matters relating to water, water pollution and sewage in various areas in Kwa-Zulu Natal. |
| Mpumalanga | |
| Mpumalanga Nature Conservation Act, No. 10 of 1998 | This Act relates to the establishment and management of conservation areas, and provides legislation relating to protected animals and plants |
| Northern Cape | |
| Northern Cape Nature Conservation Act, 2009 (Act 10 of 2009). | To provide for the sustainable utilization of wild animals, aquatic biota and plants: to provide for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; to provide for offences |

| Instrument | Key objective |
|---|---|
| | and penalties for contravention of the Act: to provide for the issuing of permits and other authorisations: and provide for the matter connected therewith. |
| Divisional Councils Ordinance 18 of 1976 | Provides for the regulation and control of effluents refuse and storm water |
| **Western Cape** | |
| Western Cape Nature Conservation Board Act, 1998 (Act 15 of 1998) | To provide for the establishment, powers, functions and funding of the Western Cape Nature Conservation Board and the establishment, funding a control of a Western Cape Nature Conservation Fund, and to provide for matters incidental thereto. The object of the board shall be, (a) promote and ensure nature conservation and related matter in the Province. |
| Western Cape Nature Conservation Laws Amendment Act, 2000. (Act 3 of 2000) | To provide for the amendment of various laws on nature conservation in order to transfer the administration of the provisions of those laws to the Western Cape Nature Conservation Board; to amend the Western Cape Nature Conservation Board Act, 1998 to provide for a new definition of Department and the deletion of a definition; to provide for an increase in the number of members of the Board; to provide for additional powers of the Board; to amend the provisions regarding the appointment and secondment of persons to the Board; and to provide for matters incidental thereto. |
| **LOCAL INSTRUMENTS** | |
| Local Government: Municipal Systems Act (Act 32 of 2000) | Requires municipalities to develop Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs). The IDP is a comprehensive five-year plan for a municipal area that gives an overall framework for development, land use and environmental protection. The SDF is a compulsory core component of an IDP that must guide and inform land development and management by providing future spatial plans for a municipal area. The SDF should be the spatial depiction of the IDP, and should be the tool that integrates spatial plans from a range of sectors. |
| Regulations 21 (published in terms of section 120 of the Municipal Systems Act) | Municipal Planning and Performance Management standards require SDFs to include a Strategic Environmental Assessment (SEA) which must be aligned with those of neighbouring municipalities. A municipal SEA identifies spatial constraints on developments and highlights sensitive areas for inclusion of detailed spatial information and policy guidelines for incorporation into a Strategic Environmental Assessment map. |
| Municipal Bylaws | Numerous municipalities have promulgated bylaws that relate to conservation of the environment and these may include the application of land uses through the town planning scheme. E.g. eThekwini Municipality's Open Space System as well as the iLembe and uMhlathuze Municipal bylaws. These will need to be considered in more detail during the detailed planning and EIA phases. |
| **OTHER** | |
| Cape Nature Conservation Ordinance, No. 19 of 1974 (still in force) | Provides for the protection of fauna and flora in parts of the North-West Province and the Northern, Western and Eastern Cape Provinces (former Cape Province). |
| Water Resource Directed Measures including: the Ecological Reserve, National Water Resource Classification System and | The main objective of the Chief Directorate: Resource Directed Measures is to ensure protection of water resources, as described in Chapter 3 of NWA and other related water management legislation and policies. The role of |

| Instrument | Key objective |
|---|---|
| Resource Quality Objectives | Resource Directed Measures is to provide a framework to ensure sustainable utilization of water resources to meet ecological, social and economic objectives and to audit the state of South Africa's water resources against these objectives<br><br>The aim of Water Resource Quality Objectives is to delineate units of analysis and describe the status quo of water resources, initiate stakeholder process and catchment visioning, quantify ecological water requirements and changes in ecosystem services, identify scenarios within IWRM, draft management classes, produce Resource Quality Objectives (EcoSpecs, water quality). |

# 5 IMPACT CHARACTERISATION

The potential impacts of EGI development are summarised as three key impacts to each terrestrial ecosystems (Section 5.1), birds (Sections 5.2.1 - 5.2.3,) bats (Sections 5.2.4 - 5.2.6), and five potential impacts to aquatic ecosystems (Section 5.3) (Table 8).

Table 8: Summary of the key impacts from EGI development, and the development phase in which the consequences of the impacts are expected to manifest.

| Impact | Phase | | | |
|---|---|---|---|---|
| | Planning & design | Construction | Operation & maintenance | Post-closure & rehabilitation |
| TERRESTRIAL ECOSYSTEMS | | | | |
| Physical disturbance to soils, fauna and flora | x | x | x | |
| Establishment and spread of IAPs | | x | x | |
| Ecosystem alteration and loss | | x | x | x |
| BIRDS | | | | |
| Electrocution | | | x | |
| Collision | | | x | |
| Displacement | x | x | x | x |
| BATS | | | | |
| Disturbance and displacement | x | x | x | x |
| Electrocution | | | x | |
| Electromagnetic interference | | | x | |
| AQUATIC ECOSYSTEMS | | | | |
| Degradation, fragmentation and loss | x | x | x | |
| Hydrological alteration | | x | x | x |
| Water quality deterioration | | x | x | x |
| Altered sediment dynamics | | x | x | x |
| Establishment and spread of IAPs | | x | x | |

## 5.1 Terrestrial ecosystems

### 5.1.1 Physical disturbance to soils, fauna and flora

EGI, specifically power lines, require a wide servitude that is regularly maintained and kept clear of significant woody or larger plant species to better facilitate the management and maintenance of the infrastructure. This entails that natural vegetation within the servitudes are kept at an early seral stage, preventing secondary and more advanced seral processes (Figure 3). Under some situations, such vegetation clearance may serve to bisect habitats and changes in vegetation form and structure may extend beyond the servitude boundary.

**Box 1: Vegetation management under power lines**

Vegetation management under powerlines generally entails the removal of tree species where they occur in a pylon corridor; and the cutting back of taller plant species to 500 mm high. In the more arid Desert, Karoo and Fynbos biomes trees are only likely to occur along water courses or in the Kamiesberg area. Otherwise they are expected to be scattered individuals or small clumps. Where these cannot be avoided, the impact of the removal of a few trees is unlikely to be significant. Since the shrubs in the Desert, Karoo and Fynbos biomes vegetation in the corridor rarely ever exceed 1.5 m tall it would seem that cutting is not necessary. However, this would be required in the proposed expanded Eastern EGI corridor where the IOCB and Savanna biomes are associated with taller woody vegetation.

Eskom generally practices clearing under its powerlines to avoid the electrical shorts that can happen when soot accumulates on the isolators or reaches sufficient concentrations to cause flash overs. Should Eskom deem it necessary to maintain cleared 80 m wide belts under the powerlines this is likely to have significant impacts on ecosystem structure, biodiversity and function, at least at the local level and where remnants become further fragmented into smaller remnants (Pool-Stanvliet et al., 2017; Rouget et al., 2014, 2006, 2003). This outcome should be avoided if at all possible given the potentially significant loss of habitat this would entail, the potential loss of species unable to survive the clearing, and the formation of a linear barrier that may affect faunal migration and movements. Since the EGI corridor is generally routed across the altitudinal and climatic gradients between the coast and the inland highlands in this area, the clearing also could affect the viability of climate adaptation corridors that have been planned in the area.

The consequences of physical disturbance to soils, fauna and flora include:

- Establishment and invasion by IAPs (also see Section 0);
- Loss of faunal habitat and consequently Species of Conservation Concern (SCC);
- Nuisance, especially during construction, which may cause changes to fauna behaviour and movement:
  - Noise;
  - Dust; and
  - Vibration.
- Increased human activities may cause animals to migrate away from their natural habitat;
- Poaching, collection of plants and animals that are collectable or have indigenous/medicinal uses;
- Entrapment of animals open excavations (which could then have fatal consequences as a result of drowning in pools of collected water, dehydration, or starvation);
- Road mortalities;
- Reduced movement and mortalities of sub-surface fauna (e.g. moles) due to soil compaction;
- Electrocution on ground as tortoises and other small fauna that become trapped underneath or against electrical fences, should such electrified fencing be installed;
- Electrocution of fauna that climb or perch on pylons;
- Altered hydrological patterns, drainage and runoff movements;
- Loss of topsoil and changes in terrain morphology;
- Habitat fragmentation;
- Disrupted ecosystem services; and
- Declined ecosystem resilience.

With a loss of habitat and/or its transformation within both the servitude and areas immediately adjacent to them, such change is likely to affect faunal populations within particular areas, or alternatively give rise to change in species' behaviour. Thus the clearance of large swathes of land is likely to affect faunal populations both directly and indirectly and in the medium to long term lead to the ousting of specific faunal populations or alternatively promote the establishment of others. A case in point, may be the clearance of forest and establishment of a scrub or graminoid veld form within a servitude that will favour grazers but may lead to the ousting of frugivorous species that were reliant upon fruiting species. In addition, such transformation may also alter transitory niche or migratory routes of certain species or act as physical barriers to others.

**Box 2: Fire-dependant ecosystems and EGI.**

Fires under powerlines can be a hazard but management of fuel loads by carrying out fires at ecologically acceptable times of the year and in weather that will minimise the hazard should allow ecologically acceptable fire regimes to be maintained. The Environmental Management Programme should include measures to reduce fire hazards in accordance with the relevant specifications.

The area of the servitude within 5 m from the outside conductors is critical for clearing any dense bushes (e.g. due to bush encroachment in the Savanna biome) or any other plants that pose a fire risk. The areas closer to the power line pylons carry a lower fire risk than the mid-span area (Eskom, 2009).

Vegetation management in power line servitudes are dependent on the vegetation type and atmospheric conditions. Not all plants in the pose equal fire risk. Excessive removal of plants may increase the risk of soil erosion in certain soils and generates large quantities of unwanted plant material, but will also have an impact on the plant species composition in the modified habitat in the servitude. Larger trees, bushes, and shrubs, as well as high-growing grasses will typically be removed to reduce fuel availability for veld fires that may cause damage to electricity power lines (Eskom, 2009).

Hot, dry conditions in summer dry out plant litter and dead fuels, creating high-fire danger conditions in the west, but in the east, large fires can occur at any time of the year (Kraaij et al., 2013b; Kraaij and Wilgen, 2014). Fynbos requires fires at intervals of 10-30 years to maintain biodiversity and ecosystem functioning (Kraaij and Wilgen, 2014; Le Maitre et al., 2014) but fires in arid Fynbos are rare and may not be essential for regeneration. Many species’ seeds may only germinate after fires and many species require fires to flower, produce seed and reproduce. The fire-ecology of Renosterveld is less well understood than that of Fynbos. Fires occur in and do regenerate Renosterveld, which is dominated by sprouting species, lacks slow-maturing species, and has some species whose seeds require fire to germinate (Kraaij, 2010; Kraaij and Wilgen, 2014), but it is able to persist for decades without fires, especially in the drier areas such as the inland slopes of the mountains and the Roggeveld escarpment. Strandveld rarely burns but can do so under extreme weather conditions and regeneration apparently is not fire-dependent.

Both savanna and grassland are fire dependent environments. Fire frequency is dependent on mean annual precipitation, with fire return intervals being once every two to three years in moist areas, but reducing in dry areas. Maintaining a fire frequency on the restored land is important for maintaining biological integrity of the vegetation type (Mucina and Rutherford 2006; O’Connor and Bredenkamp, 2006; Scholes, 1997). Power lines, can on occasion, also be a direct cause of fire due to sparking and can therefore create unwanted fires. Consideration will need to be given as to how vegetation under the powerlines can be maintained given that fire exclusion under powerlines is a common management practice (O’Connor and Bredenkamp 1997, Scholes, 1997).

### 5.1.2 Establishment and spread of invasive alien plants

Power line servitudes are areas of high physical disturbance, subject to regular vehicular traffic and periodic clearance. This sustained level of disturbance presents suitable conditions for the establishment and spread of Invasive Alien Plants (IAPs). Servitudes often act as repositories and vector corridors of exotic plant propagules and thereby promote and facilitate the spread of IAPs. This is also relevant to aquatic ecosystems (see Section 5.3).

### 5.1.3 Ecosystem alteration and loss

Physical disturbance to soils, fauna and flora, and IAP establishment and spread can ultimately manifest as ecosystem alteration and loss. It is also associated with the introduction of non-local genetic stock, Partial or complete failure to achieve effective rehabilitation.

Consequences of ecosystem alteration and loss include:

- Changes in local habitat features and ecological processes;
- Changes in habitat suitability for local species;
- Reduction/loss in endemic and rare species populations;
- Transformation of intact habitat within a CBA. CBAs are areas required to meet biodiversity targets for ecosystems, species or ecological processes, as such development in these areas is discouraged;
- Transformation of habitat within an ESA. ESAs are areas that are not essential for meeting biodiversity targets, but play an important role in supporting the ecological functioning in a CBA;
- May affect the suitability of certain areas for inclusion in NPAES;
- Local or global extinction;
- Changes in species movements, abundance and distribution,
- Changes in ecosystem functions, interactions, and resilience;
- Decline in ecosystem services;
- Soil erosion;
- Habitat fragmentation; and
- Exposure of adjacent communities to unfavourable edge effects (susceptibility to invasions by alien species).

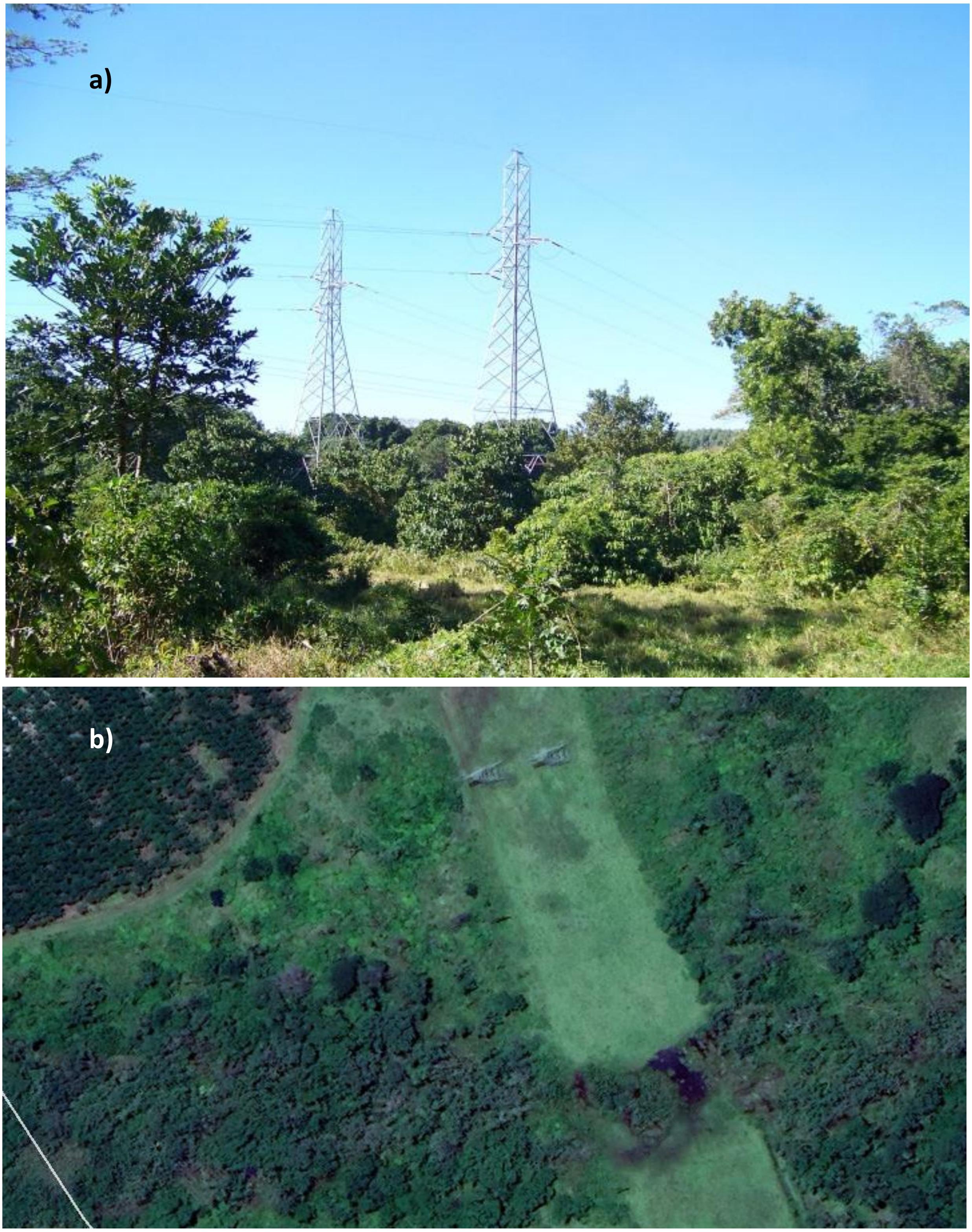



Figure 3: An example of vegetation clearance - a 132 kV line passing through a section of swamp forest vegetation in the Indian Ocean Coastal Belt biome near Port Durnford, south of Richards Bay (Photo: SDP); and B) An aerial image of the same corridor pictured in (a), indicating extent of the cleared vegetation (Google Earth, 2018).

## 5.2 Birds and bats

### 5.2.1 Bird electrocution

When a large bird makes contact with two live components simultaneously, or a live and earthed component, a short circuit is created, which electrocutes the bird. Electrocution risk is a function of the pole configuration and the size of the bird. In South Africa, large raptors and vultures are most vulnerable to electrocutions, on voltages of 11 kV up to 132 kV (Van Rooyen, 1998).

### 5.2.2 Bird collision

Bird injury or death can be caused by the bird colliding at high speed with the power line infrastructure, usually the earthwire of transmission and sub-transmission lines (> 66kV), or the conductors themselves in the case of reticulation lines (11 – 33 kV). In South Africa, most heavily impacted upon are bustards, storks, cranes and various species of waterbirds (Jenkins et al*.,* 2010).

### 5.2.3 Bird displacement due to habitat destruction and disturbance

During the construction and maintenance of power lines and substations, some habitat destruction and transformation inevitably takes place. This happens with the construction of access roads, the clearing of servitudes and the levelling of substation yards. These activities have an impact on birds breeding, foraging and roosting in or in close proximity of the servitude through transformation of habitat, which could result in temporary or permanent displacement.

Apart from direct habitat destruction, the above-mentioned construction and maintenance activities also impact on birds through disturbance, particularly during breeding activities. Disturbance of breeding individuals could lead to breeding failure through abandonment of the nest or through exposing the eggs and nestlings to predation when the adult birds temporarily leave the nest area.

### 5.2.4 Displacement of and disturbance to bats

During the construction phase, particularly the erection of pylons, the clearance of vegetation, digging and drilling of foundations, noise and vibrations from construction activities may cause disturbance to bats and displace them from their original habitat.

Southern Africa has eleven genera of fruit bats, comprising 21 species (Simmons, 2005). Three of these species commonly occur in South Africa. These species may potentially be affected by the development; however, no record of bat fatalities due to power line infrastructure exists to date in South Africa.

Whether or not electromagnetic radiation will affect flying bats or interfere with the echolocation of insectivorous bats during foraging is unknown. Options for mitigating the effects of electromagnetic radiation is limited, but will be best achieved by avoiding the areas where bats may congregate for prolonged periods such at roost sites or around surface water and irrigated croplands.

Construction activities, such as digging and blasting for pylon foundations and vehicle movement could cause noise, dust and vibrational disturbances to roosting colonies, especially during the breeding season from approximately October to March. The best measure to avoid potential negative consequences for bats would be to avoid placing infrastructure in the vicinity of known and potential roosts, especially known large maternity roosts and near areas utilized by bats of conservation importance. While species differ in their preferences, the following act as ideal habitats for bats to roost:

- Large trees or bush clumps;
- Caves and sinkholes;
- Rock crevices;
- Disused or old mining adits;

- Tunnels; and
- Dwellings/buildings with sufficient roosting space under roofs.

Additionally, bats require adequate surface water for feeding and drinking (Sirami et al., 2013; Lisóon and Calvo, 2014), particularly for insectivorous bats which hunt insects congregating above water bodies or wet soil.

### 5.2.5 Electrocution of bats

No record of bat fatalities due to power line electrocution or collisions with infrastructure exists to date in South Africa. Collision related impacts may be compounded if the power line is erected along established migratory pathways. Certain fruit bat species (Pteropodidae) in Asian and Australasian countries have fallen victim to electrocution due to power lines (Martin 2011; Rajeshkumar et al., 2013). This effect was exemplified in a study by Krystufek (2009) on Indian flying foxes (*Pteropus giganteus*) in the Sri Lankan Paradeniya Botanic Garden. The study revealed that dead bats were regularly found hanging on the power lines and that on one particular day as many as 74 carcasses were found over a 3 km stretch of power line.

### 5.2.6 Electromagnetic inteference to bat echolocation

There is limited evidence to suggest that electromagnetic radiation emitted by the power lines will affect flying bats or interfere with the echolocation of insectivorous bats during foraging. An Irish study found that electromagnetic fields from high voltage power lines do not deter bats (Eirgrid, 2015).

## 5.3 Aquatic ecosystems

The impacts associated with EGI range from those that are direct (e.g. pylon construction and clearing areas for servitudes) to those that are more subtle (indirect) and which occur over longer timeframes (e.g. vegetation compositional changes from continued disturbance/clearing, habitat fragmentation, hydrological alteration, and alien plant infestation). The main impacts to aquatic (i.e. freshwater and estuarine) ecosystems associated with EGI were identified and discussed in detail in the freshwater specialist component of the 2016 EGI SEA (Todd et al., 2016b). The majority of the impacts identified in this assessment are relevant to the scope of the present study, and have been contextualised here in relation to the following activities and their associated impacts to aquatic ecosystems and biota.

The activities from EGI development driving impacts to aquatic ecosystems include:

- Access roads – development of new access roads to enable construction, as well as ongoing maintenance during the operational phase;
- Construction of substations, pylons and power line servitudes – direct clearing and/or removal of vegetation to allow for the construction of substations and pylons, as well as to establish servitudes to access the pylons and power lines for on-going maintenance.

**Box 3: EGI development and groundwater**

The majority of EGI is constructed above ground, with the exception of foundations that are required for the pylons and substations, which generally extend to about 3.5 m. The small scale depth of the EGI and associated construction activities are unlikely to significantly impact on ground water and deep aquifers. The Biodiversity Specialists suggest that the consideration of groundwater is not a major concern as aquatic systems are not driven significantly by ground water resources, and the impacts from EGI will be non-existent when considering deep ground water flows.

It is important to note that site specific assessments will be undertaken subsequent to the SEA, and if warranted, Geohydrological and/or Geotechnical Assessments will be commissioned by the EGI Developer once a specific route has been determined.

Strategic Water Source Areas (SWSAs) are defined as "areas of land that either: (a) supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or (b) have high groundwater recharge and where the groundwater forms a nationally important resource; or (c) areas that meet both criteria (a) and (b)" (Le Maitre et al., 2018:1). Changes in the quantity and quality of the water produced by these areas can have adverse effects on economic growth and development in the regions that they support (CSIR, 2017). Thirty-seven groundwater SWSAs have been identified in South Africa and are considered to be strategically important at a national level for water and economic security (Le Maitre et al. 2018). The total area for groundwater SWSAs extends approximately 104 000 km$^2$, and covers approximately 9 % of the land surface of South Africa (Le Maitre et al. 2018). Based on this, the SWSAs have been rated as high sensitivity areas for EGI development.

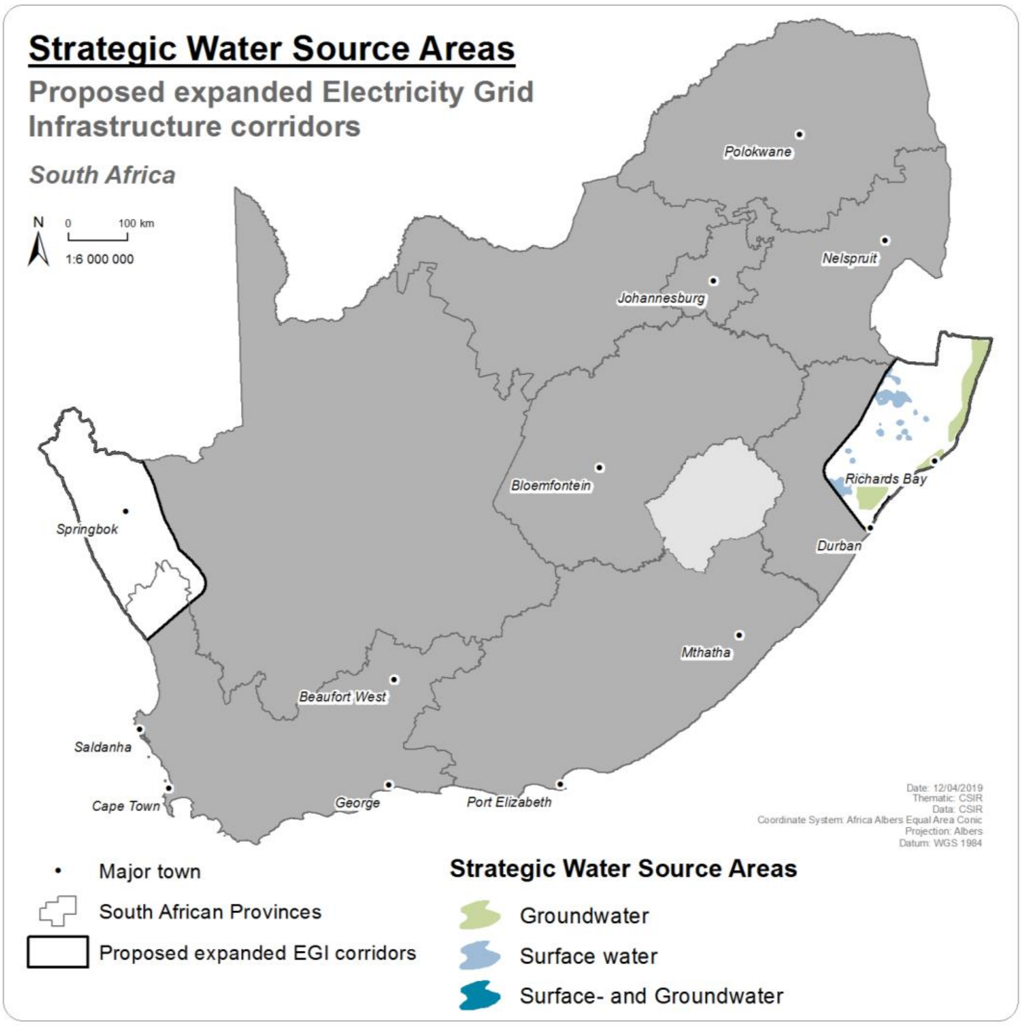



Figure 4 illustrates the proposed expanded EGI corridors, as well as National Surface Water and Ground Water SWSAs. The proposed expanded Eastern EGI Corridor includes the KwaDukuza, Richards Bay Ground Water Fed Estuary and Zululand Coastal Plain Ground Water SWSAs. No SWSAs are located within the proposed expanded Western EGI Corridor.

Figure 4: Strategic Water Source Areas of South Africa.

### 5.3.1 Degradation and loss of aquatic ecosystems and species

Earthworks and excavations would mainly affect fossorial fauna (i.e. animal adapted to living underground), as well as small, less-mobile fauna (e.g. amphibians, as well as freshwater obligate reptiles and shrews/rodents). Mortality of fauna from accidental collisions due to the movement of vehicles/machinery across the site can also be an issue for smaller, less mobile species of fauna. Illegal hunting/poaching could also present a significant impact during the construction phase whereby certain personnel/contractors engage in such activities.

Certain fauna are more susceptible to impacts from increased noise and/or artificial lighting. Artificial lighting in and around substations may for example have a significant impact on normal life cycles of adult forms of aquatic macro-invertebrates, as well as increased mortality rate. Noise impacts will affect noise-sensitive mammals, particularly larger mammals such as Otter species and Servals. Noise and light impacts ultimately result in the displacement of fauna away from the noise impact area, but is expected to be temporary, and restricted to the construction phase.

IAPs that already occur in the area are likely to invade newly disturbed areas, by gradual (or even rapid) encroachment into disturbed areas (e.g. temporary construction camps, borrow pits, vehicle parking, stock pile areas, etc.), transitional habitats, as well as around pylons/substations and along access roads. The spread of existing, and the introduction of new problem, plant species may be facilitated by movement of people and construction vehicles. IAP infestation within freshwater ecosystems will further degrade habitats and habitat availability for associated biota. Secondary impacts (or caused by IAPs) include, but are not limited to:

- Competition with native plant species, especially when considering the severity of allelopathic influences caused by certain IAP (e.g. *Acacia mearnsii*);
- Shading of banks and instream habitats, which in turn impacts on water temperatures and freshwater fauna and flora that are intolerant;
- Shift in allochthonous and autochthonous organic compounds within wetland and river ecosystems;
- Bank instability, erosion and collapse, with exacerbated deposition of sediments and debris; and
- In more severe cases, reduced water availability due to excessive water consumption from most IAPs (in particular, deep-rooted tree species such as *Eucalyptus* species).

### 5.3.2 Fragmentation of aquatic ecosystems

Fragmentation of freshwater ecosystems, estuary mouth dynamics and flow patterns may result in an indirect loss of ecological patterns and processes such as species movement and dispersal, habitat connectivity, increased edge effects and disturbance, establishment of IAPs.

Linear developments, such as transmission lines, cause fragmentation of aquatic ecosystems, especially where areas are permanently impacted. This presents a serious issue particularly to fauna, and leads to populations becoming more isolated, resulting in a reduction of inter-population connectivity and compromised genetic viability. For example, inappropriately designed and constructed river crossings could prevent fish from moving/migrating freely within a river system. Habitat fragmentation also has the potential to exacerbate impacts to freshwater ecosystems, such as through altering micro-climatic conditions (e.g. fire, wind, desiccation, etc.). These alterations in turn affect the perimeter of wetland and riparian habitats resulting in edge effects and development of transitional habitats. This presents a favourable situation for IAPs to establish, with knock-on effects for freshwater ecosystem and associated fauna and flora (as discussed in the following point).

### 5.3.3 Hydrological alteration

Compaction of soils, creation of preferential flow paths and stormwater runoff may result in increased flows (hydrological alteration) within receiving aquatic environments, particularly in relation to runoff discharge points, which in turn has a number of indirect issues such as bank erosion and collapse, scouring and channel incision, headcut erosion, desiccation of wetland/riparian soils and vegetation, increased turbidity, sedimentation and smothering of benthos. Stormwater runoff resulting in increased flows into estuaries may lead to bank erosion and collapse, scouring, channel incision, desiccation of estuarine/wetland/riparian soils and vegetation, increased turbidity, sedimentation and smothering of benthos. The combined effects will negatively affect the ecological integrity and ability of the estuarine and freshwater ecosystems to function properly.

### 5.3.4 Water quality deterioration

Waste pollution and contamination of aquatic environments from foreign materials (e.g. fuels/hydrocarbons, cement, and building materials) being dumped and/or carried into aquatic environments results in deteriorated water quality.

Water quality may deteriorate as a result of sediment disturbance and/or the removal of estuarine and riparian vegetation, or pollution events, resulting in:

- decrease pH as a result of disturbance of the anoxic sediment profiles characteristic of estuaries;
- increase the Total Dissolved Solids (TDS);
- increase the Total Suspended Solids (TSS);
- increase the organic matter content; and/or
- Increase the nutrient content.

This can have knock-on effects on aquatic biota. It can result in algal blooms/eutrophication, can cause anoxia or hypoxia and fish and invertebrate mortalities. Increased turbidity in clear water systems can lead to smothering of primary producers and disrupted predator-prey relationships.

# 6 CORRIDORS DESCRIPTION

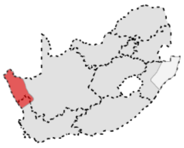
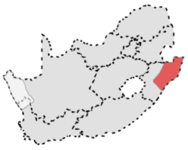
All of the biomes of South Africa, except for Albany Thicket, are within either the proposed expanded Eastern or Western EGI corridor (Table 9).

Table 9: Extent of the biome within each of the proposed expanded EGI corridors.

| Biome | Extent (% of each proposed expanded EGI corridor) | |
|---|---|---|
| | Expanded Western EGI corridor | Expanded Eastern EGI corridor |
| Succulent Karoo | 75 | |
| Nama-Karoo | 11 | |
| Fynbos | 3 | |
| Azonal Vegetation | 2 | 2 |
| Albany Thicket | | |
| Grassland | | 25 |
| Indian Ocean Coastal Belt | | 14 |
| Savanna | | 55 |
| Desert | 8 | |
| *Forests** | | *3* |

**The forest biome has not been included in this assessment as it represents a constraint to the EGI as mature trees will impact on the servicing and maintenance of power lines. Therefore, the forest biome will be avoided for the routing of the EGI. However, where the forest biome cannot be avoided by the power line route, due to the rare and sensitive environments that are associated with the biome, developers would be required to fulfil the requirements of the EIA Regulations at the time.*

Table 10: Summary of the key environmental features in each of the proposed expanded EGI corridors.

| Site | Brief description |
|---|---|
| Expanded Western EGI corridor  | • This proposed corridor is situated within Fynbos, Succulent Karoo, Nama Karoo, Desert vegetation types in the Northern Cape and Western Cape Provinces.<br>• Mostly arid environment, with prominent protected areas that include the Richtersveld and Namaqua National Parks, with extensive areas earmarked as potential NPAES focus areas.<br>• Relatively untransformed when compared to the proposed expanded Eastern EGI corridor. |
| Expanded Eastern EGI corridor  | • This proposed corridor is situated within Savanna, Grassland and Indian Ocean Coastal Belt vegetation types in the KwaZulu-Natal Province.<br>• Transformed by urban settlement and agriculture, especially in the vicinity of Richards Bay.<br>• Many protected areas associated with large wetlands are present. |

## 6.1 Western Expansion Corridor

### 6.1.1 Desert

The Desert biome of South Africa is broadly divided into two bioregions, namely (i) the Southern Namib Desert bioregion and (ii) the Gariep Desert bioregion. The former comprises the desert areas stretching from the Atlantic coast near the mouth of the Orange River penetrating inland along the course of the lower Orange River to Sendelingsdrift and is characteristic of winter rainfall. The Gariep Desert is characterised by summer rainfall and includes the desert areas from Sendelingsdrift further east to the vicinity of Onseepkans and Pofadder in northern Bushmanland. The Desert biome borders the Nama Karoo biome to the east, and the Succulent Karoo biome in its western parts (Jürgens, 2006).

This arid environment is characteristic of extreme ecological conditions with erratic rainfall across the area (MAP <70 mm), high maximum daily temperatures (>48°C), high incidence of coastal fog, strong winds and frequent sandstorms. The desert landscape is highly dissected ranging from tall, rugged mountains with deep gorges to broad, sloping valley plains. The desert substrate is generally very rocky with little to no soil present. Desert soils, where present, are slow-forming, shallow alluvial sands created from a variety of rock types that are easily eroded by wind and high-impact rainfall from thunderstorms (Jürgens, 2006).

The Southern Namib Desert vegetation is characteristic of stem- and leaf-succulent trees and shrubs such as the Quiver tree (*Aloidendron dichotomum*) and the Giant Quiver tree (*Aloidendron pillansii*), with species from key genera including *Euphorbia, Fenestraria, Mesembryanthemum* (formerly *Brownanthus*), *Monsonia* (formerly *Sarcocaulon*), *Salsola, Stoeberia* and *Tylecodon* dominating the desert plains and rocky hilly landscape. The Gariep Desert, in addition to the presence of stem- and leaf-succulents such as *Aloidendron dichotomum, Commiphora* species, *Euphorbia* species and *Pachypodium namaquanum* ('halfmens'), is typified by non-succulent woody perennials such as *Boscia albitrunca* (Shepherds tree), *Parkinsonia africana* (Green-hair thorn tree) and *Schotia afra* (Karoo boer-bean tree) with grasses like *Stipagostis* and *Enneapogon* species being distinctive of the sandy plains (Jürgens, 2006).

Plant species richness of the vegetation types included in the Desert biome is exceptionally high when compared to other desert environments with similar aridity levels globally (Jürgens, 2006). The most profound feature of the Desert biome is the Gariep Centre of Endemism which covers the northern most part of the biome stretching inland along the Lower Orange River Valley. The Richtersveld forms the core of the centre boasting a total of approximately 2 700 vascular plant species of which more than 560 species are endemic and near-endemic to the Gariep Centre. More than 80% of species among these endemics are succulents (Van Wyk and Smith, 2001). Also, the Orange River Mouth is located at South Africa's coastal border with Namibia and contains two threatened vegetation types which are both highly disturbed, namely the Arid Estuarine Salt Marshes that is a National Freshwater Ecosystem Priority Area (NFEPA) and Endangered Wetland, as well as the Critically Endangered Alexander Bay Coastal Duneveld (SANBI, 2011; Driver et al*.,* 2012; Holness and Oosthuysen, 2016).

Rutherford and Westfall (1986) and Rutherford (1997) have differentiated between arid conditions characteristic of the eastern and western parts of the Karoo biomes, respectively, which led to the recognition of various types of deserts present in north-western South Africa by Jürgens in 1991. The Desert biome was subsequently defined by including a wide arid zone along the lower Orange River stretching from the Richtersveld in the west to the surrounds of the Pofadder region in the east. This biome was further demarcated into two bioregions, namely the Gariep Desert (located mostly within the borders of South Africa) and the Southern Namib Desert (Jürgens, 2006), which further consists of fifteen vegetation types – all of which are wholly or partially present in the proposed expanded western EGI corridor.

The Gariep Desert flora is dominated by ephemeral plants, often annual grasses and non-woody forbs, especially after a good rainy season. Normally the vast desert plains appear barren and desolated with aboveground vegetation persisting underground in the form of seed, but following abundant rainfall in winter the desert plains and lower mountain slopes can be covered with a sea of short annual grasses and striking mass flowering displays of short-lived forbs and succulents in spring. Perennial plants such as stem- and leaf succulent trees and shrubs, including some non-succulent plants, are usually encountered in specialised habitats associated with local concentrations of water, like dry river beds, drainage lines and rock crevices. Lichen fields are also a conspicuous marvel of the open coastal belt utilising the moisture-filled fog originating from the adjoining Atlantic Ocean (Jürgens, 2006).

The Desert biome, interfacing with the highly diverse and species-rich Succulent Karoo biome, is considered to be one of the most biologically diverse and environmentally sensitive deserts in the world. Although the region is sparsely populated with only few small villages, communal livestock farming (mainly sheep and goats) across large areas of the biome has had a significant impact on vegetation cover. Overgrazing due to overstocking, intensified by extended periods of drought, especially surrounding some permanent settlements in the Richtersveld, resulted in severe deterioration of veld condition, and in some places total desertification (Hoffmann et al., 1999; Jürgens, 2006; Hoffmann et al*.,* 2014).

Commercial scale crop farming along the lower Orange River has also substantially increased during the past century now having extensive areas cultivated with inter alia vineyards, dates and subtropical fruit orchards. In addition to irrigation agriculture, open-cast diamond mining and exploration activities, mostly along the lower Orange River from Alexander Bay to Swartwater, have largely scarred the desert landscape adding to the human impact on this sensitive ecosystem. Although alien invasive plants such as *Prosopis* spp., *Nicotiana glauca, Ricinus communis* and *Atriplex lindleyi* are a common phenomenon of dry river beds, drainage lines and around human settlements, its distribution has been limited by the lack of subsurface water in the greater desert area (Milton et al., 1999; Jürgens, 2006). Unfortunately, unique species richness and high levels of endemism associated with the Desert biome have also seen the illegal removal of succulents by collectors and traders (Van Wyk and Smith, 2001).

So far, only approximately 22% of the Desert biome is formally protected in statutory and non-statutory reserves of which the Richtersveld National Park, the Nababieps Provincial Nature Reserve and the Orange River Mouth Provincial Nature Reserve constitute the largest area of conservation (Jürgens, 2006; Taylor and Peacock, 2018). The average conservation target for vegetation types in the Desert biome is 32%. Other efforts to preserve this unique desert ecosystem include the Richtersveld Community Conservancy and two proclaimed National Heritage Sites, namely (i) the lichen field near Alexander Bay and (ii) the renowned population of *Aloidendron pillansii* on Cornellskop (Jürgens, 2006).

Transformation of the Desert biome has so far been relatively limited despite the effect of the aforementioned impacts on desert ecosystems (Jürgens, 2006). However, rising temperatures and decreasing rainfall as a direct result of climate change could intensify and increase further desertification.

The Desert biome is not particularly rich in natural resources, hence providing employment to a relatively small number of people. The main economic drivers in this arid area are commercial scale crop cultivation and mining activities along the Lower Orange River Valley, whereas small stock farming is the main agricultural land use practised in most of the remaining biome. Ecotourism and conservation, as well as collection of plants for the horticultural trade, specifically succulents, add to the economic value of the Desert biome (Hoffmann et al., 1999; Jonas, 2004; Jürgens, 2006).

Due to the ecologically sensitive nature of this biome, not all of the aforementioned land uses are sustainable. Clearance of vegetation and removal of topsoil for irrigated croplands as well as large scale surface mining along the Orange River have resulted in total biodiversity loss and increased soil erosion. In addition to overstocking of small livestock, which leads to overgrazing, unsustainable land use exacerbated by global climate change is causing desertification which could have a negative impact on the socio-economic value of the Desert biome (Hoffmann et al., 1999; Jonas, 2004; Jürgens, 2006; Milton, 2009).

**Box 4: Terrestrial fauna of the Desert Biome.**

More than 60 different mammal species are known to occur in the Desert biome (UCT, 2018a). Three species are considered Vulnerable, namely the Hartmann's zebra (*Equus zebra hartmannae*), the Black-footed cat (*Felis nigripes*) and the Cape leopard (*Panthera pardus*). A further three mammals have a Near-Threatened status including the Brown Hyena (*Hyaena brunnea*), the African Clawless Otter (*Aonyx capensis*) and Littledale's Whistling Rat (*Parotomys littledalei*). Antelope species common to the desert plains include Gemsbok (*Oryx gazella*), Springbok (*Antidorcas marsupialis*), Steenbok (*Raphicerus campestris*) and Kudu (*Tragelaphus strepsiceros*) (Williamson, 2010; Child et al., 2016; Walker et al., 2018).

The reptile diversity of the Desert biome is fairly high with about 84 species (UCT, 2018b), three of which are of conservation concern. These include the Near-Threatened Richtersveld Pygmy Gecko (*Goggia gemmula*), the Critically Endangered Namib Web-footed Gecko (*Pachydactylus rangei*) and the Vulnerable Speckled Padloper (*Chersobius signatus*) (Bates et al., 2014).

A total of 13 frog species can potentially occur in the Desert biome (UCT, 2018d) of which two species are listed as being Vulnerable, namely the Desert Rain Frog (*Breviceps macrops*) and the Namaqua Stream Frog (*Strongylopus springbokensis*) (Minter, 2004).

The Desert Biome includes an abundant insect fauna which includes many Scarabaeidae and Tenebrionidae beetles. Its insect diversity further includes about 69 species of moths and butterflies, 20 species of dragonflies and 32 species of lacewings (Mecenero et al., 2013). Up to 24 scorpion species could potentially be found in this desert environment (UCT, 2018c).

### 6.1.2 Succulent Karoo

The Succulent Karoo biome covers an area of approximately 103 000 km² and extends from the coastal regions of southern Namibia through the western parts of the Northern Cape and Western Cape provinces of South Africa, as well as inland of the Fynbos biome to the Little Karoo in the south (Rundel and Cowling, 2013). The Succulent Karoo biome interfaces with the Albany Thicket to the east, the Nama Karoo to the north and west, and the Desert biome to the north (Jonas, 2004; Mucina et al., 2006a).

The Succulent Karoo biome is a semi-desert region that is characterised by the presence of low winter rainfall, with a mean annual precipitation of between 100 and 200 mm, and daily temperature maxima in summer in excess of 40°C the norm. Fog is a common occurrence in the coastal region and frost is infrequent. Desiccating, hot berg winds may occur throughout the year (Desmet and Cowling, 1999; Jonas, 2004; Mucina et al., 2006b; Walker et al., 2018).

Topographically the Succulent Karoo varies from flat to gently undulating plains at altitudes generally below 800 m that are situated to the west and south of the escarpment and are typical of the Knersvlakte and Hantam/Roggeveld/Tanqua Karoo, towards a more hilly and rugged mountainous terrain characteristic of the Namaqualand, Robertson Karoo and Little Karoo at higher elevations reaching up to 1 500 m in the east. The geology of the Succulent Karoo is ancient and complex with weakly developed, lime-rich sandy soils that easily erode and are derived from weathering of sandstone and quartzite (Allsopp, 1999). An unusual but abundant feature of the Succulent Karoo soils are low, circular mounds called 'heuweltjies' which were created by harvester termites thousands of years ago (McAuliffe et al., 2018; McAuliffe et al., in press). Their rich soils support an entirely different vegetation from the surrounding land cover making them truly unique (Jonas, 2004; Mucina et al., 2006b; Jacobs and Jangle, 2008).

The Doring, Olifants and Tanqua rivers are the major drainage systems in the west, with the Breede and Gouritz rivers and its relevant tributaries in the south-east of the biome, all derived from catchments located within the bordering Fynbos biome. The majority of other river courses are small, short-lived and seasonal west-flowing systems, including a relatively short section of the lower Orange River in the north (Jonas, 2004; Mucina et al., 2006b; Le Maitre et al. 2009).

The Succulent Karoo is an arid to semi-arid biome which is known for its exceptional succulent and bulbous plant species richness, high reptile and invertebrate diversity, as well as its unique bird and mammal life (Rundel and Cowling, 2013). It is also recognised as one of three global biodiversity hotspots in southern Africa with unrivalled levels of diversity and endemism for an arid region (Cowling et al., 1999; Desmet, 2007; Hayes and Crane, 2008). The Succulent Karoo vegetation is dominated by dwarf leaf-succulent shrublands with a matrix of succulent shrubs and very few grasses, except in some sandy areas. Species of the plant families *Aizoaceae* (formerly the *Mesembryanthemaceae*), *Crassulaceae* and *Euphorbiaceae*, as well as succulent members of the *Asteraceae*, *Iridaceae* and *Hyacinthaceae* are particularly prominent. Mass flowering displays of annuals (mainly *Asteraceae* species), often on degraded or fallow agricultural lands are a characteristic occurrence in spring.

The varied Succulent Karoo landscape lends itself to the adaptation of a diversity of plant growth forms, ranging from extensive plains often littered with rocks or pebbles such as the Knersvlakte to rocky areas occasionally dotted with solitary trees and tall bush clumps (e.g. *Ficus ilicina, Pappea capensis, Searsia undulata, Schotia afra* and *Vachellia karroo*) often found in deeper valleys and along drainage lines. In some higher altitude areas of the Succulent Karoo, particularly on rain shadow mountain slopes, the vegetation contains elements similar to an arid daisy-type fynbos (Mucina et al., 2006b; Jacobs and Jangle, 2008).

The Succulent Karoo biome is recognised as one of 25 internationally acclaimed biodiversity hotspots due to its exceptional abundance and rich diversity of unusual succulent plants and animal life (Myers et al., 2000; Jonas, 2004; Noroozi et al., 2018). Nearly 40% (~2 535 species) are considered endemic to the Succulent Karoo vegetation of which the majority are either succulents or geophytes (Jonas, 2004; Mucina et al., 2006b). Some 269 endemic taxa are threatened and a further 536 endemic species are of conservation concern (SANBI, 2017). Many endemics have very limited spatial ranges and are vulnerable to extinction through localised habitat damage. Also noteworthy is the occurrence of approximately 16% (~1 590 species) of the world's 10 000 succulent species within this biome (Cowling and Hilton-Taylor, 1999; Mucina et al., 2006b).

Species of the plant families *Aizoaceae* (formerly the *Mesembryanthemaceae*), *Crassulaceae* and *Euphorbiaceae,* as well as succulent members of the *Asteraceae*, *Iridaceae* and *Hyacinthaceae* are particularly prominent in this biome (Mucina et al., 2006b). This exceptional plant diversity, combined with high levels of endemism and intense land use pressures means the biome is also a recognised conservation priority as per the objectives and conservation targets of the Succulent Karoo Ecosystem Programme (SKEP) (Hayes and Crane, 2008).

**Box 5: Terrestrial fauna of the Succulent Karoo Biome**

The fauna of the Succulent Karoo biome does not reflect the same level of diversity or endemism shown by the flora (Vernon, 1999; Mucina et al., 2006b; Rundel and Cowling, 2013).

Mammal diversity in the Succulent Karoo biome is relatively high with about 75 species of mammals (UCT, 2018a) of which two are endemic, namely the Critically Endangered De Winton's golden mole (*Cryptochloris wintoni*) and the Namaqua dune mole rat (*Bathyergus janetta*). Another important species of conservation concern in the region is the Critically Endangered riverine rabbit (*Bunolagus monticularis*), the Near-Threatened brown hyena (*Hyaena brunnea*), the Vulnerable Hartmann’s mountain zebra (*Equus zebra hartmannae*), the Vulnerable Cape leopard (*Panthera pardus*) and the Vulnerable Grant’s golden mole (*Eremitalpa granti*) (Rundel and Cowling, 2013; Child et al. 2016).

Major concentrations of large mammals, including the African elephant (*Loxodonta africana*), the Critically Endangered black rhinoceros *(Diceros bicornis*), the hippopotamus (*Hippopotamus amphibious*) and the African buffalo (*Syncerus caffer*), used to roam the riverine forests along major rivers in the Succulent Karoo, but these populations have now all disappeared from this hotspot. Today, only smaller herds of gemsbok (*Oryx gazella*), mountain zebra (*Equus zebra*) and springbok (*Antidorcas marsupialis*) are commonly found mainly within the confines of formally protected areas and privately owned game farms (Williamson, 2010; Walker et al., 2018).

Reptile diversity is relatively high in the Succulent Karoo with approximately 94 species of which about 15 are endemic (UCT, 2018b). All of the endemics are geckos and lizards, representing about 25% of the nearly 60 gecko and lizard species in the biome. These endemics include seven species of girdled lizards of the genus *Cordylus*, including the armadillo girdled lizard (*Cordylus cataphractus*) that is endemic to the region. Tortoise diversity is very high in the Succulent Karoo with seven taxa of which two are endemic, namely the Namaqualand tent tortoise (*Psammobates tentorius trimeni*) and the Namaqualand speckled padloper (*Homopus signatus signatus*) (Bates et al*.,* 2014).

Amphibians are poorly represented in the Succulent Karoo with just over 20 species (UCT, 2018d). All of these species are frogs of which one is endemic, namely the Desert Rain Frog (*Breviceps macrops*). This frog species occurs along the Namaqualand coast of South Africa northwards to Lüderitz in the coastal south-west of Namibia. Also noteworthy is the Namaqua Stream Frog (*Strongylopus springbokensis*) that has a Near-Threatened status (Minter, 2004).

Invertebrate diversity is relatively high in the Succulent Karoo biome and evidence suggests that more than half of the species in some insect groups are endemic to this biodiversity hotspot. These include amongst others monkey beetles (*Clania glenlyonensis*), bee flies, long-tongued flies and bees, as well as a variety of masarid and vespid wasps (Rundel and Cowling, 2013). The Succulent Karoo also boasts 50 scorpion species of which nearly 22 species are endemic to the biome (Rundel and Cowling, 2013; UCT, 2018c).

Despite its amazing ecological and socio-economic diversity, the hotspot is a vulnerable ecosystem with about 8% of the Succulent Karoo biome formally protected in statutory and non-statutory reserves, including the Richtersveld, Namaqua and Tankwa Karoo National Parks, as well as the Goegap, Nababeep and Oorlogskloof Provincial Nature Reserves (Mucina et al., 2006b; Hoffmann et al., 2018).

The predominant land use is agriculture with about 90% of the region subjected to livestock grazing (mainly sheep, goats and ostrich farming). Although crop farming is limited due to nutrient-poor soils with low agricultural potential and the lack of sufficient irrigation water, severe overgrazing and unsustainable cultivation practices have contributed to widespread loss of topsoil through sheet erosion and the accelerated degradation of veld condition reducing the overall species diversity in this arid environment (Mucina et al., 2006b; Le Maitre et al., 2009; Walker et al., 2018).

Mining for diamonds, gypsum and heavy metals, although an important economic driver which is only affecting about 1% of the biome, is another major threat to biodiversity in the Succulent Karoo as it irreversibly transforms landscapes making ecological restoration extremely challenging (Jonas, 2004; Milton and Dean, 2012). An increase in urban settlements due to a growing population, in addition to overharvesting of fuel wood and the illegal harvesting of plants for the medicinal and horticultural trades, also threatens conservation efforts of the Succulent Karoo biome (Milton et al., 1999; Walker et al., 2018).

Cropping, mining, linear structures such as fences, roads, railways and power lines, and the eutrophication of water further exacerbate the spread and establishment of alien invasive plant species in the Succulent Karoo such as *Arundo donax*, *Atriplex lindleyi*, *Atriplex nummularia*, *Nerium oleander*, *Pennisetum setaceum*, *Prosopis glandulosa* and *Tamarix ramossissima* (Van Wilgen et al., 2008; Rahlao et al., 2009; Le Maitre et al., 2016; Dean et al., 2018; Walker et al., 2018). The invasion of members of the Cactaceae family such as the Bilberry cactus (*Myrtillocactus geometrizans*) is becoming an increasing conservation concern especially in the southern Karoo (Dean and Milton, 2019).

Furthermore, climate change has been identified as one of the most significant threats to biodiversity as increasing temperature levels and decreasing rainfall over the next five decades could exacerbate desertification of the Succulent Karoo biome (Hoffmann et al., 1999; Rutherford et al., 1999; Walker et al., 2018). Also, a recent increase in renewable energy developments (solar and wind) in the Succulent Karoo has seen approval of about 160 applications for environmental authorisation to date of which another almost 50 are currently in process (DEA, 2019). Notwithstanding the effect of the aforementioned impacts on Succulent Karoo ecosystems, to date approximately 4% of the biome has been transformed (Mucina et al., 2006b).

Historically, the Succulent Karoo biome has mainly supported livestock farming, mostly sheep and goats, but it was not until the late 1700's that land occupation and urban settlement by colonial pioneers expanded throughout most of the area. By late 1800's both cattle and ostrich farming also became an important agricultural revenue stream and today almost 90% of the Succulent Karoo supports commercial and subsistence pastoralism, in addition to cropland farming in areas where irrigation water is readily available (Hoffmann et al., 1999; Smith, 1999; Jonas, 2004; Hoffmann et al., 2018; Walker et al., 2018).
A study by Jonas in 2004 revealed the following economic land uses in the Succulent Karoo:

- Agriculture – Livestock farming (e.g. sheep, goats, cattle and ostrich);
- Agriculture – Cropland farming (barley, lucern, dates, vineyards);
- Conservation (e.g. National Parks and Nature Reserves);
- Fuel wood (e.g. *Prosopis* spp).
- Game farming (e.g. trophy hunting, live game sales, venison sales);
- Horticulture (e.g. succulents);
- Medicinal bioprospecting (e.g. cancer bush and kougoed);
- Mining (e.g. diamonds, copper, zinc); and
- Tourism (including ecotourism).

Recent statistics have shown that wind and solar energy installations cover approximately 5.2% of land in the Succulent Karoo of which the largest percentage of affected areas is situated in the Namaqualand bioregions (Hoffmann et al., 2018).

All life and economic activities occurring within the Succulent Karoo are highly driven by the availability of water. Both surface and groundwater are generally very limited and often of naturally poor quality, especially in the driest regions of the biome. Exacerbated by climate change and compounded by increased pressure from human demand, sufficient water quality and quantity pose serious challenges to current and future land use and development opportunities in the Succulent Karoo (Hoffmann et al., 2009; Le Maitre et al., 2009; Milton, 2009; Hoffmann et al., 2018; Walker et al., 2018).

### 6.1.3 Nama Karoo

The Nama Karoo biome occurs on the central plateau of the western half of South Africa and is the largest of the three biomes that comprise the semi-arid Karoo-Namib Region covering about 23% of the interior of southern Africa (Ndhlovu et al., 2011; Walker et al., 2018). The word 'Karoo' comes from the Khoi-San word *kuru* which means dry, an apt description for this vast, open, arid thirstland. The Nama Karoo interfaces with the Succulent Karoo biome to the west, the Desert biome in the extreme northwest, the Savanna biome to the north and northeast, the Fynbos and Albany Thicket biomes in its southern and south-eastern extremities, and the Grassland biome infringing on its eastern border (Mucina et al., 2006a).

The geology underlying the Nama Karoo biome is exceptionally varied and consists of a 3 km thick succession of millennia old sedimentary rocks rich in fossils (Lloyd, 1999; Mucina et al., 2006a). Shallow, weakly developed lime-rich soils with high erodibility cover more than 80% of the Nama Karoo landscape (Watkeys, 1999). The climate is typically harsh with considerable fluctuations in both seasonal and daily temperatures. Droughts are common with frost a frequent occurrence during winter. Rainfall is highly seasonal, peaking in summer with a mean annual precipitation (MAP) ranging from 100 mm in the west to about 500 mm in the east, decreasing from east to west and from north to south (Palmer and Hoffmann, 1997; Desmet and Cowling, 1999; Mucina et al., 2006a; Walker et al., 2018).

The Nama Karoo is mostly a complex of extensive, flat to undulating gravel plains dominated by grassy, dwarf shrubland vegetation of which its relative abundances are dictated mainly by rainfall and soil type (Cowling and Roux, 1987; Palmer and Hoffmann, 1997; Mucina et al., 2006a). Towards the Great Escarpment in the south and west, a much dissected landscape exists characteristic of isolated hills, koppies, butts, mesas, low mountain ridges and dolerite dykes supporting sparse dwarf Karoo scrub and small trees (Dean and Milton, 1999; Mucina et al., 2006a; Jacobs and Jangle, 2008).

Nama Karoo vegetation is not particularly species-rich and the biome does not contain any centres of endemism (Van Wyk and Smith, 2001). There are also very few rare or endangered indigenous plant species occurring in the biome. The level of endemism in the biome is very low with the majority of endemic species occurring in the Upper Karoo Hardeveld vegetation type. Plant families dominating the Nama Karoo veld are Asteraceae (daisies), Fabaceae (legumes) and Poaceae (grasses). Where the Nama Karoo interfaces with the Fynbos and Succulent Karoo biomes to the south and west, taxa in the Aizoaceae (vygies) and Asteraceae families are prominent, while elements of summer rainfall floras typical of the Grassland and Savanna biomes become prevalent in the north and east (Mucina and Rutherford, 2006). The presence of succulent taxa representative of the plant families Aizoaceae, Crassulaceae and Euphorbiaceae adds to the species richness of Nama Karoo vegetation.Dwarf shrubs (generally <1 m tall) and grasses dominate the current vegetation that is intermixed with succulents, geophytes and annual forbs. As a result, the amount and nature of the fuel load is insufficient to carry fires and fires are rare within the biome. Grasses tend to be more common in depressions and on sandy soils, whereas small trees occur mainly along drainage lines and on rocky outcrops (Palmer and Hoffmann, 1997; Mucina et al., 2006a). Some of the more abundant shrubs include species of *Drosanthemum, Eriocephalus, Galenia, Lycium, Pentzia, Pteronia*, *Rhigozum*, and *Ruschia*, while the principal perennial grasses are *Aristida, Digitaria, Enneapogon*, and *Stipagrostis* species. Trees and taller woody shrubs are mostly restricted to watercourses such as rivers and wetlands, and include *Boscia albitrunca, B. foetida, Diospyros lycioides, Grewia robusta, Searsia lancea, Senegalia mellifera, Tamarix usneoides* and *Vachellia karroo* (Palmer and Hoffmann, 1997; Mucina et al., 2006a).

The Nama Karoo biome, considered the third largest biome in South Africa after the Grassland and Savanna biomes, comprises an area of approximately 248 278 $km^2$, of which only approximately 1.6% is formally protected in statutory reserves such as the Augrabies and Karoo National Parks (Hoffmann et al., 2018). About 5% of the Nama Karoo has been transformed by human impact relative to other biomes in South Africa, leaving the majority of the land still in a state classified as Natural (Mucina et al., 2006a; Hoffmann et al., 2018). However, according to Hoffmann and Ashwell (2001) approximately 60% of the Nama Karoo landscape is characterised by moderately to severely degraded soils and vegetation cover (Mucina et al., 2006a). Despite the increasing impact of mainly soil erosion and overgrazing (Atkinson, 2007), the ecosystem threat status of all 14 Nama Karoo vegetation types are considered least threatened (South African Government Gazette, 2011).

The large historical herds of Springbok (*Antidorcas marsupialis*) and other game native to the Nama Karoo no longer exist as most of the Nama Karoo has been converted to fenced rangeland for livestock grazing during the past century, in particular sheep and mohair goats (Hoffmann et al., 1999). Although the habitat is mostly intact, heavy grazing has left certain parts of the Nama Karoo seriously degraded (Lloyd, 1999; Milton, 2009; Ndhlovu et al., 2011; Ndhlovu et al., 2015). Vegetation recovery following drought can be delayed due to increased stocking rates that in turn exacerbate the effects of subsequent drought periods. Under conditions of overgrazing many indigenous shrubs may proliferate, while several grasses and other palatable species may be lost (Mucina et al., 2006a), contributing to the gradual increase of land degradation in the Nama Karoo (Milton and Dean, 2012; Walker et al., 2018).

In addition to pastoralism, alien plant infestation, anthropogenic climate change, agricultural expansion, construction of linear structures, urban sprawl, the collection of rare succulents and reptiles for illegal trade, as well as the construction and failure of dams also threaten the Nama Karoo's biodiversity (Lovegrove, 1993; Lloyd, 1999; Rutherford et al., 1999; Mucina et al., 2006a; Milton, 2009; Dean et al., 2018). The introduction of a number of alien, drought-hardy ornamental and forage plants have the potential to seriously alter the biome's ecology and hydrology (Milton et al. 1999). Alien invasive plants currently common in the Nama Karoo region include *Argemone ochroleuca*, *Arundo donax*, *Atriplex* spp., *Limonium sinuatum*, *Opuntia* spp., *Phragmites australis, Prosopis* spp., *Salsola kali and Schkuhria pinnata,* as well as various members of the Cactaceae family such as *Echinopsis* spp. and *Tephrocactus articulates* (Van Wilgen et al., 2008; Walker et al., 2018).

The Nama Karoo is also threatened by increased mining activities such as open-cast zinc mining at Black Mountain and the Gamsberg near Aggeneys, as well as the potential threat of uranium mining around Beaufort West and the greater Lower Karoo region. The possibility of large scale shale gas fracking presents a further threat to the Nama Karoo biodiversity (Khavhagali, 2010; Milton and Dean, 2012; Cramer, 2016). An increased need for renewable energy has already seen the impact of several wind farms being developed in the Karoo region and along its margins, as well as planning and construction of a number of solar power projects (Walker et al., 2018).

Furthermore, the increased clearing of natural vegetation for cultivation along the lower Orange River destroys the natural habitat of many Nama Karoo fauna and flora. Pesticides used to control Brown Locust (*Locustana pardalina*) and Karoo Caterpillar (*Loxostege frustalis*) outbreaks also impact wildlife habitat severely, with the highest concentration of pesticides particularly within the avifauna, specifically raptors (Lovegrove, 1993; Khavhagali, 2010; Walker et al., 2018).

The overall improvement of ecosystem health and to ensure ecological sustainability of the Nama Karoo biome will require a dedicated effort and strategic collaboration from a wide range of stakeholders to achieve the preservation, conservation and management of its biodiversity.

Box 6: Terrestrial fauna of the Nama Karoo Biome.

The Nama Karoo never had the variety of wildlife that can be found for example in the Savanna biome; however, before pastoralism brought along fenced rangelands, vast herds of Springbok used to migrate through the region in search of water and grazing. Today, these free roaming herds are mostly replaced with livestock and game ranching. The majority of mammals in the Nama Karoo are species with a widespread distribution that originate in the Savanna and Grassland biomes (Dean et al*.,* 2018). The Nama Karoo boasts a mammal diversity of approximately 177 species of which more than 10 threatened species are known to occur in this biome. Common animals include the Bat-Eared Fox, Black-Backed Jackal, Spring Hare, Springbok, Gemsbok, Kudu, Eland and Hartebeest. Most noteworthy is the Critically Endangered Riverine Rabbit (*Bunolagus monticularis*) which is an endemic species of the central Nama Karoo (Holness et al., 2016; UCT, 2018a).

Other mammal species of conservation concern include the Endangered Southern Tree Hyrax (*Dendrohyrax arboreus*), as well as the Vulnerable Hartmann's Zebra (*Equus zebra hartmannae*), Cheetah (*Acinonyx jubatus*), Leopard (*Panthera pardus*), Black-footed Cat (*Felis nigripes*) and White-tailed Mouse (*Mystromys albicaudatus*). The Grey Rhebok *(Pelea capreolus*), Mountain Reedbuck (*Redunca fulvorufula* subsp. *fulvorufula*), Brown Hyena (*Hyaena brunnea*) and the Southern African Hedgehog (*Atelerix frontalis*) are all listed as Near-Threatened (UCT, 2018a).

Reptile diversity of the Nama Karoo is moderately high with nearly 221 species that can be found in this arid to semi-arid environment (UCT, 2018b). Important tortoise species include the Vulnerable Speckled Padloper (*Chersobius signatus*) and the Near-Threatened Karoo Padloper (*Chersobius boulengeri*). The Plain Mountain Adder (*Bitis inornata*), which is restricted to the Nuweveldberge, is the only snake species that is endemic to the Nama Karoo and it is categorised as Endangered. Also, the Elandsberg Dwarf Chameleon (*Bradypodion taeniabronchum*) is currently listed as endangered and the Braack's Pygmy Gecko (*Goggia braacki*) is considered Near-Threatened. Three other lizard species, the Dwarf Karoo Girdled Lizard (*Cordylus aridus*), the Karoo Flat Gecko (*Afroedura karroica*) and Thin-skinned Gecko (*Pachydactylus kladaroderma*) have much of their distribution in the Karoo.

The Nama Karoo boasts a fairly moderate diversity of Amphibia with about 50 frog species that could be found in this biome. Noteworthy species include the endemic Karoo Caco (*Cacosternum karooicum*) and the Near-Threatened Giant Bull Frog (*Pyxicephalus adspersus*) (Minter, 2004).

Terrestrial invertebrate diversity in the Nama Karoo is considerably high with up to 575 species of Lepidoptera (moths and butterflies), 84 species of dragonflies, 115 species of lacewings and more than 80 different species of dung beetle. Five butterfly species are wholly endemic to the Central Karoo (*Aloeides pringlei, Lepidochrysops victori, Thestor compassbergae, T. camdeboo* and *Cassionympha camdeboo*). The butterfly species, *Lepidochrysops victori* is categorised as Vulnerable (Mecenero et al. 2013; Holness et al*.,* 2016). Nearly 40 species of scorpions could occur in the Nama Karoo region (Holness et al*.,* 2016).

The Nama Karoo provides natural resources for a wide array of business activities; however, social wellbeing and economic viability of these enterprises greatly rely on the availability and spatial distribution of water. The main industry sectors underpinning economic growth in the Nama Karoo are agriculture (including game and livestock ranching, and crop cultivation), mining (including diamonds, granite, heavy metals and marble, as well as the potential for shale gas and uranium) and tourism (including ecotourism). All three of these sectors have potential to contribute to socio-economic growth of the region but are heavily dependent on sustainable water resources to exist (Hoffmann et al., 1999; Mucina et al., 2006a; Milton, 2009; Walker et al., 2018).

Other economic opportunities characteristic of the Nama Karoo relates to the development and commercial exploitation of medicinal plants (such as *Hoodia gordonii*), horticulture, manufacturing, biodiversity conservation (e.g. National Parks, nature reserves, game farms) and the significance of cultural heritage (Milton, 2009; Todd et al., 2016a; Dean et al., 2018; Walker et al., 2018). A recent increase in renewable energy installations (solar and wind) in the Nama Karoo has shown a total land cover of about 3.6% to date (Hoffmann et al., 2018).

### 6.1.4 Fynbos

The Fynbos Biome is globally recognised for its high diversity of plant species with about 7 500 species, 69% of which are endemic (Bergh et al., 2014; Rebelo et al., 2006) and 1 889 are listed as threatened (Turner, 2017). The biome is centred in the south-western part of the Western Cape with areas extending north-westwards for about 650 km, almost to the Orange River, and eastwards for 720 km to the Kap River mountains east of Grahamstown.

The western part of the biome receives its rainfall primarily in the winter months (June to August) and the eastern part has peaks in the spring and summer with some rain every month (Bradshaw and Cowling, 2014; Rebelo et al., 2006). The temperatures are hot in summer and cold in winter, especially when there is snow. The summers are also characterised by strong, desiccating, south-easterly winds and the winters by the passage of cold fronts with north-westerly and sour-westerly winds. Warm to hot berg winds occur when warm drains from the interior prior to the passage of cold fronts and can lead to fires (Geldenhuys, 1994; Heelemann et al., 2008). Lightning strikes are infrequent, around 1 per km$^2$ per year but were, historically the main cause of fires; most fires are now caused by people (Van Wilgen et al., 2010).

The Fynbos Biome in the proposed expanded Eastern EGI corridor comprises four vegetation types: Namaqualand Granite Renosterveld, Kamiesberg Granite Fynbos, Namaqualand Sand Fynbos, Stinkfonteinberge Quartzite Fynbos and Bokkeveld Sandstone Fynbos (Rebelo et al., 2006). Fynbos is found in two main settings on the shallow, rocky soils of the TMG sandstones of the mountains and foothills (montane Fynbos) and on the deep, leached sands of the lowlands and wetter inland valleys (sand plain Fynbos). Renosterveld is found on the shale-derived soils of the lowlands, the dry lower slopes and valleys, including the Roggeveld mountains. Strandveld generally occurs near the coast on more calcium-rich deep sands and on limestone soils.

The ecology of these major types differs as well. Fires in western Fynbos and Renosterveld occur primarily in the dry summer months but fires can occur at any time, including winter in the southern and eastern parts of the biome (Kraaij et al., 2013d; Kraaij and Wilgen, 2014). In the western and southern Fynbos, fire season has a marked impact on the regeneration of non-sprouters such as the Proteaceae, being most successful after fires in summer and autumn and least successful after fires in late-winter or spring (Bond et al., 1990; Kraaij et al., 2013b; Kraaij and Wilgen, 2014; Le Maitre et al., 2014). In the eastern Fynbos fire season has relatively little impact. Fire return intervals need to be long-enough for slow-maturing, non-sprouting species like many Proteaceae to produce sufficient seeds to maintain their populations; this typically requires fire return intervals of at least 10-12 years, preferably longer (Kraaij and Wilgen, 2014; Van Wilgen et al., 2010). Strandveld rarely burns but can do so under extreme fire conditions and regeneration apparently is not fire-dependent. Fynbos is subject to invasion by introduced alien tree species which must be removed in terms of the NEM:BA. Invasive trees known to be present in fynbos in the corridor include *Acacia cyclops* and *Prosopis* species. Invading alien grasses are an issue of increasing concern in the drier parts of South Africa and there is concern that they can alter and transform ecosystems, including making them fire-prone (Rahlao et al., 2009; Todd, 2008; Visser et al., 2017). In the corridor area the current and potential invaders include *Bromus* species and potentially *Pennisetum setaceum* which are invaders in the Succulent Karoo but are spreading into Fynbos. Both are dispersed by wind and along roads by the movement of vehicles and special care will have to be taken to avoid dispersing them in the construction and operational phases of the powerlines and to control them if they become established. Grass invasion may be facilitated by soil enrichment by the nitrogen-fixing Acacia species (Heelemann et al., 2010; Krupek et al., 2016; Le Maitre et al., 2011; Musil et al., 2005; Visser et al., 2017) and may severely affect heuweltjie[1] communities (D.C. Le Maitre personal observation).

[1] Heuweltjies are circular features with distinctive plant communities and enhanced levels of faunal diversity and activity associated with their characteristically relative fertile soils.

Arid Fynbos, especially on the deep sands of the Sandveld, would be expected to require fire, but fires are very infrequent in these Fynbos types. Only single occurrences of fires have been detected in the past 16 years and these affected <1% of the Fynbos in the area, with the largest fire being in the Kamiesberg (unpublished data, Advanced Fire Information System, Meraka Institute, CSIR). There have not been any studies of the effects of fire on these Fynbos vegetation types to assess the modes of regeneration (e.g. sprouting and non-sprouting, fire stimulated seed germination or flowering, seedling establishment) or of the time required for species to reach reproductive maturity. The low frequency of fires suggests that fire may not play a significant role in maintaining these communities so they may not require fire to maintain themselves.

There is a growing body of research on the restoration of Fynbos, but it is still a developing science (Gaertner et al., 2012a, 2012b, Heelemann et al., 2013, 2012; Holmes, 2008). There are some guides for restoration in books on the management of the Fynbos and Karoo but mainly developed for higher rainfall areas or the Nama Karoo (Esler et al., 2014, 2010; Esler and Milton, 2006; Krug, 2004). It is clear that removing the upper few centimetres of the topsoil and returning with minimal storage, and the use of treatments to simulate seed-germination can facilitate recovery, but this it still the subject of active research (Hall et al., 2017). Most of this work and experience has been gained in the higher rainfall parts of the biome and there is little experience in the arid areas (such as within the expanded Western EGI Corridor) to guide rehabilitation. These areas at the limits of the climatic tolerance of Fynbos species, so there is a high likelihood of failure at the establishment stage, and recovery after disturbance could be slow. Active restoration will be required but, even then, there is a high risk of failure. There has been research on restoration in Namaqualand but the studies have been located in the Strandveld or Succulent Karoo and not in the Fynbos (Carrick et al., 2015; Carrick and Krüger, 2007; James and Carrick, 2016; Todd, 2008). The uncertainties about the role of fire and the poor understanding of the potential for restoring Fynbos in these areas, compared with the adjacent Succulent Karoo vegetation, are strong rationales for making every effort to avoid Fynbos in arid areas when selecting the final power line routes and placement. Disturbance also facilitates invasion, so regular monitoring and control operations will be required as part of the Environmental Management Programmes (EMPrs) for the construction and operational phases.

Box 7: Terrestrial fauna of the Fynbos Biome.

The diversity and endemism of the terrestrial fauna in Fynbos is not particularly high except for certain groups such as amphibians (60 species in the Western Cape, 36 endemic and 15 threatened), reptiles (146 species, 18 threatened), fossorial mammals (moles) and invertebrates (particularly butterflies, dragon flies, long-tongued flies, beetles) (Anderson et al., 2014; Colville et al., 2014; Turner, 2017). Some of the taller Fynbos shrub species may exceed height requirements for the powerline although this is unlikely in the case of the arid fynbos occurring in this area. Should this be the case then the powerline servitude would have to be kept clear of these plants. The loss of these plant species will change the habitat suitability for fauna that live or feed on, shelter under, or otherwise use or depend on them, so that areas without them may become a barrier to the movement of some terrestrial fauna, notably reptile and invertebrate species.

Biotic interactions are essential for the pollination of many species and many species depend on ants for seed dispersal (myrmecochory) (Anderson et al., 2014; Rebelo et al., 2006). Ant seed dispersal is disrupted by the Argentinian ant which is able to invade disturbed areas and care will be needed to ensure that invasions by this ant species are not facilitated by, for example, ensuring that construction material does not contain colonies of this species (Anderson et al., 2014; Bond and Slingsby, 1990; Wilson et al., 2014).

Although much has been said about the uniqueness of Fynbos and its high plant biodiversity, Fynbos has many other values which generally are not adequately appreciated by the public. These include the benefits derived from the sustained flows of high quality water from Fynbos catchment that support cities and towns and their economies and are used for the production of irrigated crops. Other benefits include species with commercial value in the form of flowers or herbal teas and medicinal products, fibre and thatch, crop pollination, and landscapes that attract tourists (Turpie et al., 2017, 2003). The impacts of unwise developments on the commercial benefits provided by these ecosystems also need to be taken into account.

### 6.1.5 Birds

The following Red Data species, that are sensitive to power lines, are associated with the biomes and vegetation types found in the proposed Western Expansion EGI corridor (Table 11).

Table 11: Red Data bird species that occur in the proposed Western Expansion EGI corridor which are sensitive to power lines.

| Species | Status | Fynbos | Succulent Karoo | Nama Karoo | Desert | Azonal |
|---|---|---|---|---|---|---|
| African Marsh-Harrier | EN | x | | | | x |
| Black Harrier | EN | x | x | x | x | |
| Black Stork | VU | x | x | x | x | x |
| Blue Crane | NT | x | x | | | x |
| Caspian Tern | VU | | | | | x |
| Greater Flamingo | NT | x | x | x | x | x |
| Karoo Korhaan | NT | x | x | x | x | |
| Lanner Falcon | VU | x | x | x | x | x |
| Lesser Flamingo | NT | x | x | x | x | x |
| Ludwig's Bustard | EN | x | x | x | x | |
| Maccoa Duck | NT | | | | | x |
| Martial Eagle | EN | x | x | x | x | |
| Secretarybird | NT | x | x | x | | |
| Southern Black Korhaan | VU | x | x | | | |
| Verreaux's Eagle | VU | x | x | x | x | |
| Great White Pelican | VU | | | | | x |
| Kori Bustard | NT | | x | | | |
| *EN = Endangered; VU = Vulnerable; NT = Near Threatened* | | | | | | |

### 6.1.6 Bats

The following bats of conservation importance are found in the proposed Western Expansion EGI corridor (Table 12).

Table 12: Red Data bat species that occur in the proposed Western Expansion EGI corridor which are sensitive to power lines.

| Species Name | Common Name | Conservation Status (Child et al., 2016) |
|---|---|---|
| *Cistugo seabrae* | Angolan Hairy Bat | NT (Jacobs et al., 2016a) |
| *Laephotis namibensis* | Namib Long-eared Bat | VU (Jacobs et al., 2016b) |
| *VU = Vulnerable; NT = Near Threatened* | | |

#### 6.1.7 Freshwater ecosystems

Rivers are predominantly non-perennial/ephemeral in character. A small proportion (~10%) of the rivers are classified as perennial/permanently - flowing rivers, largely the Orange River and other smaller rivers (e.g. Doring, Olifants and Sout Rivers). Non-perennial systems that dominate the corridor include the Holgat, Kamma, Buffels Swartlintjies, Groen and Goergap. Most of the river habitats fall within the Namaqua Highland Ecoregion (48%), followed by the Western Coastal Belt (26%), and the Orange River Gorge (16%). Only 4% of the river habitat is considered to be Threatened (i.e. Endangered and Vulnerable). The Doring River and the lower Olifants River are the only flagship/free-flowing rivers in the corridor. The Present Ecological State (PES) of rivers is generally good, with less than 25% of the rivers assessed to be in either a fair, poor or very poor state.

Wetland habitats occupy a low proportion of the corridor (~1%) owing to the xeric climatic conditions of the Succulent Karoo. Nevertheless, the area supports up to 57 wetland types dominated by floodplain wetland habitat along the lower Gariep River and channelled-valley bottom wetlands within the Namaqualand Hardeveld region, as well as a number of endorheic pans that are more unique to the region. One Ramsar wetland occurs within the corridor, and is located at the mouth of the Gariep River. A small proportion of the wetlands in the corridor are characterised as NFEPA wetlands, which predominantly include floodplain wetlands along the Gariep River and seeps within the Namaqualand Hardeveld region.

Approximately 95% of the Western Corridor comprises land that is largely natural, thus only a small proportion is transformed through urbanisation, agricultural and mining developments. Impacts on freshwater ecosystems from associated land use activities of the transformed landscape are relatively localised within the corridor context. More widespread impacts to freshwater systems tend to be linked to livestock farming practices and infestation of IAPs. The combined effect of anthropogenic pressures results in both localised and widespread impacts that affect functioning and integrity of freshwater ecosystems. Key impacts include:

- Pollution from application of fertilizers, herbicides and pesticides, as well as point-source discharges from urban centres (e.g. Bitterfontein, Springbok and Vioolsdrif);
- Grazing by livestock, particularly high/concentrated levels of along watercourses, causing overgrazing and trampling within and adjacent to river and wetland systems, which in turn leads to increased erosion and changes in vegetation structure (notably, the loss of riparian habitat);
- Increases in woody vegetation along rivers, in particular by *Acacia karoo*, as well as infestations of invasive alien species (e.g. *Tamarix* spp. and *Prosopis glandulosa*). These deep-rooted species are able to readily consume groundwater. Heavily infested areas have a significant impact on the hydrology of catchments, as well as outcompeting indigenous species;
- More localised, yet severe impacts, linked to sand mining and other mining activities (e.g. alluvial diamond mining at the mouth of the Gariep River and along the west coast);
- Groundwater utilisation both for domestic and agricultural uses;
- Construction of weirs and dams along river systems, which alters the natural hydrological flows, which is most notable for the Gariep River as a consequence of numerous, large dams/impoundments in the catchment; and
- Road crossings, which cause concentration of surface runoff and localised sheet and gulley erosion in proximity to rivers and wetlands.

**Box 8: Red Data aquatic biota likely to be encountered in the proposed Expanded Western EGI corridor.**

One Endangered fish, *Pseudobarbus phlegethon* occurs in the Olifants River, which flows through the extreme south-western corner of the Western EGI Corridor. There are also two Near Threatened fish (i.e. *Labeobarbus seeberi* and *Pseudobarbus serra*) that occur in the corridor. Two notable amphibians occur in the north western parts of the corridor, namely *Breviceps macrops* (Near Threatened), which inhabits sandy habitats along Namaqualand coast, and *Breviceps branchi* (Data Deficient), which is only known from a single specimen collected near the Holgat River. One Critically Endangered reptile, *Pachydactylus rangei*, inhabits dry river beds and surrounding dunes/sanding environments in the north western corner of the corridor. The Spotted-necked Otter *Hydrictis maculicollis* (Vulnerable) has been recorded near the mouth of the Gariep River. Two Vulnerable plants, *Isoetes eludens* and *Oxalis dines*, and four Near Threatened plants occur as a few isolated populations in the corridor.

### 6.1.8 Estuarine ecosystems

In total seven estuaries fall within the Expanded Western EGI corridor. These have a combined estuarine habitat area of 5 300 ha. They include the Orange, Spoeg, Groen, Sout, Buffels, Swartlintjies and Olifants Estuaries. The Spoeg, Groen, Buffels and Swartlintjies are all small systems that extend less than 5 km into the proposed EGI corridor (Fielding, 2017). The remaining systems are longer and extend significant distances into the proposed EGI corridor (Olifants <20 km, Orange <10 km and Sout <10 km).

Three estuaries in this corridor (Swartlintjies, Spoeg and Groen) are in excellent or good condition (i.e. Categories A to B according to health status on the DWS scale, whereby “A” is near natural and “F” being extremely degraded) (Van Niekerk et al., 2018). These systems have a high sensitivity to change as they will degrade from their near pristine state relatively easily (Fielding et al., 2017).

Of the seven estuaries in this corridor, the Orange and Olifants estuaries are of Very High biodiversity importance, ranking in the top estuaries in South Africa (Turpie et al., 2002; Turpie and Clark, 2009). Four estuaries in the corridor are identified as national conservation priorities by the National Estuaries Biodiversity Plan (Turpie et al., 2012). These are the Orange, Spoeg, Groen and Olifants estuaries.

In addition, two estuaries, the Olifants and Orange, are important fish nurseries that play a critical role in the maintenance and recovery of South Africa’s recreational and commercial fish stock (Lamberth and Turpie, 2003; Van Niekerk et al., 2017). From a habitat diversity and abundance perspective the Orange, Spoeg, Groen, Sout and Olifants estuaries are also considered important as they support sensitive estuarine habitats such as intertidal and supratidal saltmarsh. The Buffels, Swartlintjies Groen, Spoeg and Sout are relatively small but recent studies on the ecological water requirements have highlighted their regional importance as a very limited wetland type habitat for estuarine and coastal birds along arid west coast (DWS, 2017).

Box 9: Estuarine Species of Conservation Concern.

**Plants**

Some macrophyte species (mangroves and eelgrass) have only recently been reassessed in the Red Data List and freshwater mangrove *Barringtonia racemosa* was only added in 2016 (IUCN, 2012). If categorised as a species of special concern the data provided for each assessment was tabulated. Further research on these species was also captured. If categorised as 'Least Concern' details pertaining to the state of the population was not captured unless noted in a particular study. While the spatial location of all species of special concern is not known for South Africa's estuaries, what is still clear is all estuaries support estuarine habitat of concern and should be deemed as highly sensitive.

Interference (harvesting, clearing, removal) of mangrove and swamp forest is regulated under the National Forests Act 84 of 1998 and destruction or harvesting of indigenous trees requires a licence. All mangrove trees and swamp forests are protected under this act. The taxonomy of some salt marsh species is under currently under review; which makes it difficult to determine their population sizes, report on their threat status or set targets for protection. However according to the National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008, as amended), all coastal wetlands, which include salt marshes and mangroves, form part of the coastal protection zone. The purpose of establishing this zone is to restrict and regulate activities in order to achieve the aims as set out in the Act. Other laws pertaining to species in these areas: National Environmental Management Act 1998, Marine and Living Resources Act 1998, The National Environmental Management: Biodiversity Act 2004, and National Forestry Act 1998.

**Fish**

The IUCN Red List of Threatened Species includes many fish that occur in estuaries in South Africa (ICUN, 2018). By far the majority of these fish are categorised as species of Least Concern. The IUCN Red List categories and criteria (IUCN, 2012) are designed to be applied to the entire (global) range of a species and fish listed in the Least Concern category here range from those which are actually quite common and (still) abundant in South African systems (e.g. *Rhabdosargus sarba*) to species which are uncommon, rare and in a national sense could be considered as endangered (e.g. *Microphis brachyurus*). A species of special concern, in the process of being IUCN red listed, is *Argyrosomus japonicus* (Dusky Kob), a species with South African populations at critically low levels (Griffiths, 1997, Mirimin et al., 2016). Predominant threats faced by the listed species include development (urban, commercial, recreational and industrial), agriculture, mining, resource use (fishing and harvesting of aquatic resources), modification of natural systems (flow modification and other), pollution, and climate change (ICUN, 2018). **All estuaries in the corridors function as nurseries for Critically Endangered or Endangered fish species of high recreational or conservation importance.**

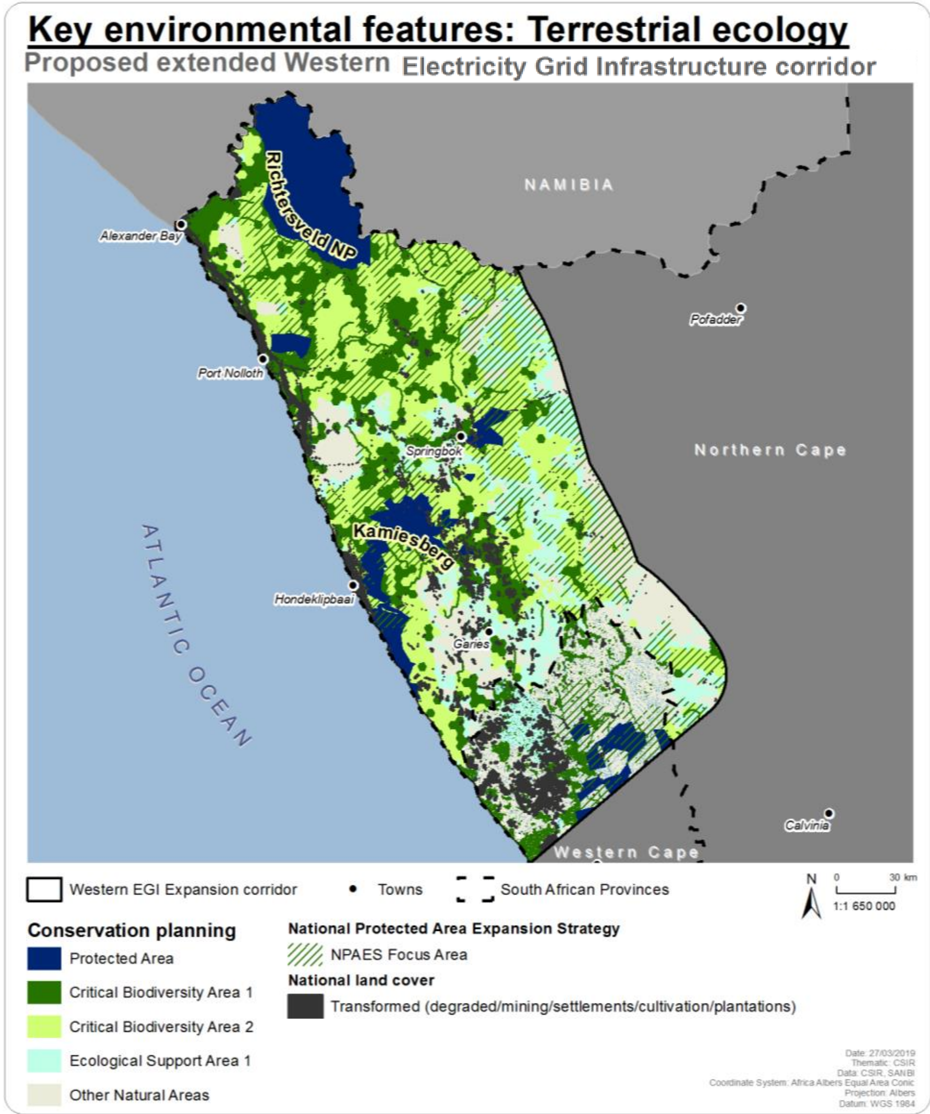



Figure 5: Key environmental features of the proposed Western EGI Expansion corridor.

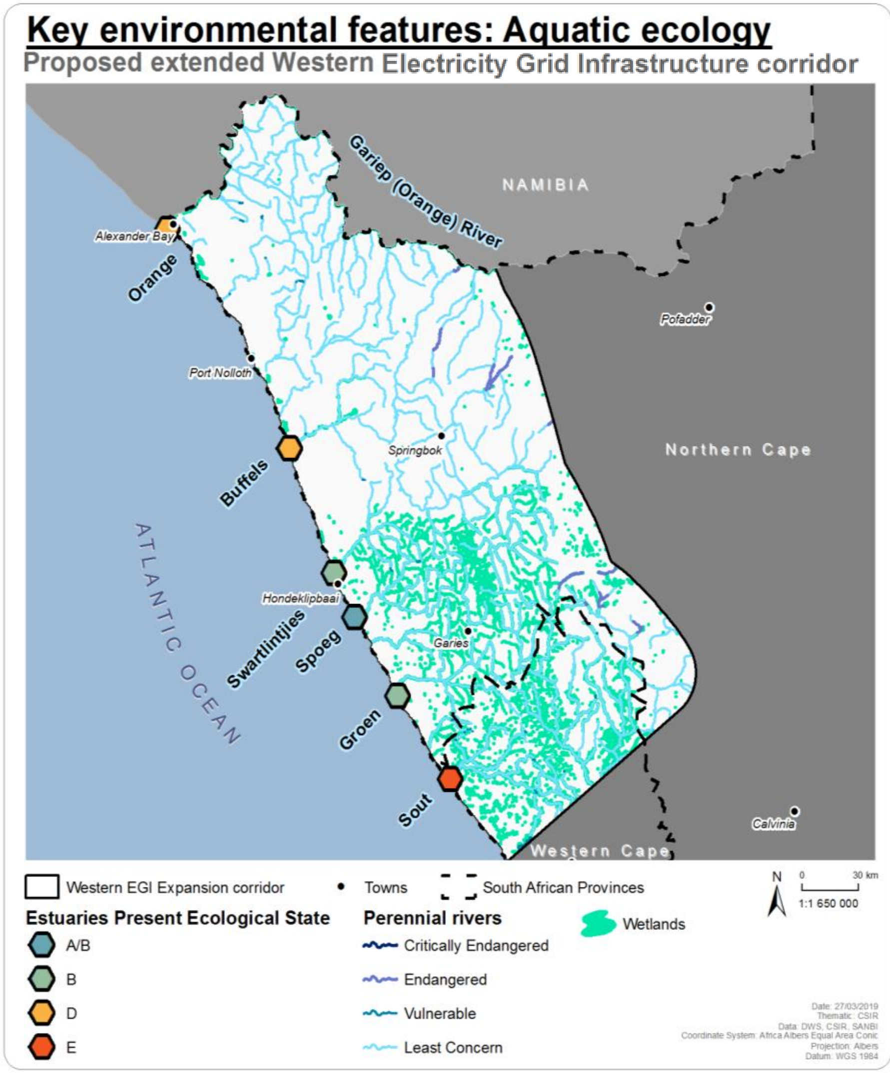



Figure 6: Key aquatic ecosystem features of the proposed Western EGI Expansion corridor.

*Note: Finer scale features may not be visible at the current map extent.*

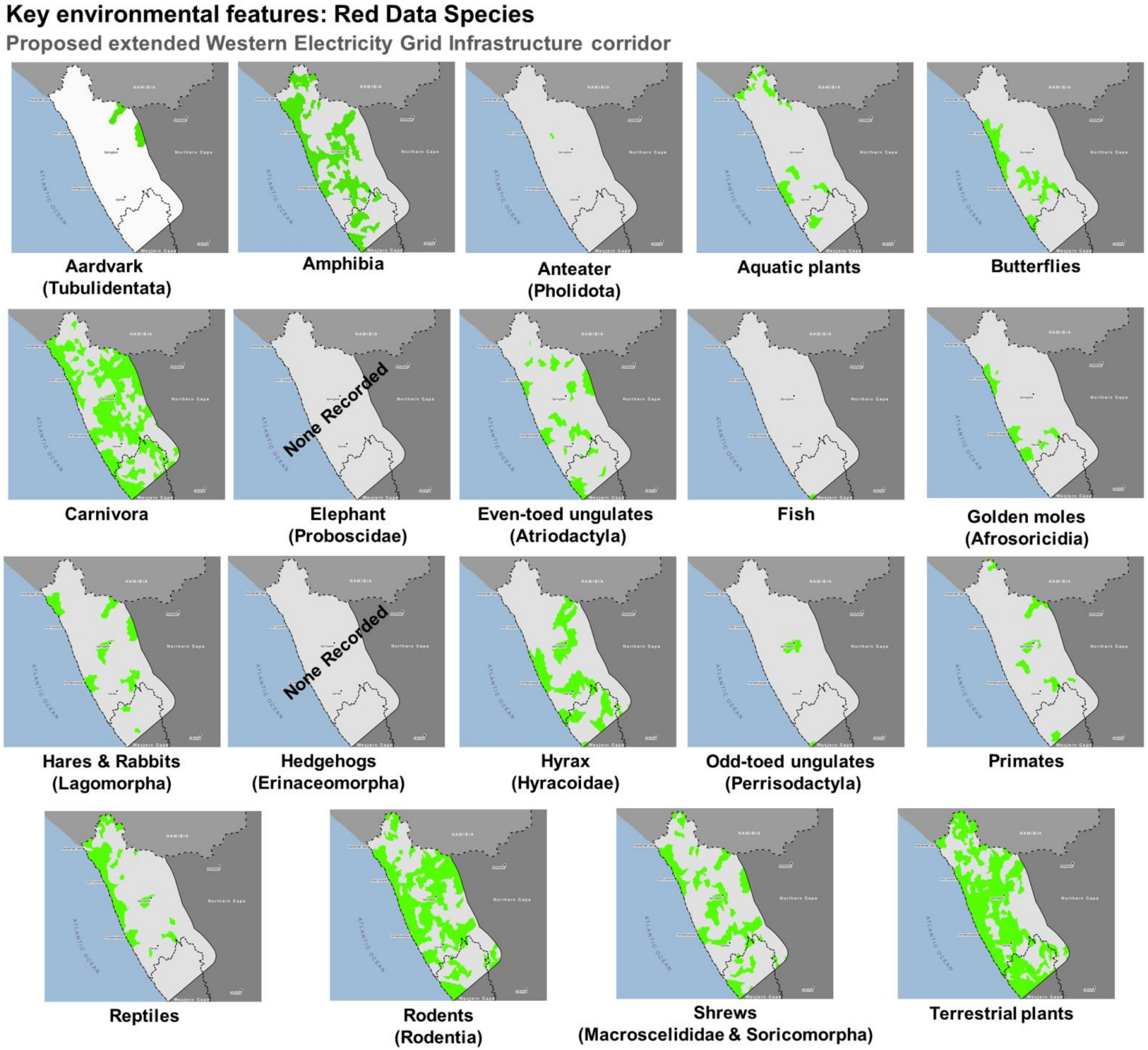



Figure 7: Distribution of recorded Red Data species in the proposed expanded Western EGI corridor (at quinary catchment scale).

## 6.2 Eastern Expansion Corridor

### 6.2.1 Indian Ocean Coastal Belt

The climate of the east coast of southern Africa is controlled by the presence of a high pressure system lying to the east of the sub-continent and intermittently, the area is influenced by low pressure systems arising from the Southern Ocean, particularly during winter. In the late summer, cyclonic systems moving across the Indian Ocean often lead to catastrophic storm events along the coastline (Tinley, 1985). This meteorological regime plays a significant role in determining the form of habitats that are found within the Indian Ocean Coastal Belt (IOCB) (Mucina and Rutherford, 2006) and gives rise, in part, to fundamentally differing habitat types within the biome. For example, within the northern areas, grasslands and forest habitats that are proximal to the coastline, are subject to intensive storm activity associated with cyclonic activities, which play a key role in forest gap dynamics (Yamamoto, 1996) while the high level precipitation associated with these events is an important driver in grassland and woodland communities in the north of KZN. Rainfall in the southern extent of the IOCB is comparatively less than that encountered in the north, although less seasonal with a more bimodal rainfall regime. It is perhaps due to these drivers that these vegetation types are primarily grassland and open woodland-mosaic environments which form an association of habitats within any given range.

Additionally, edaphic form and function within the IOCB can also be considered a primary driver of many of these habitats, tempering growth in woody species through the availability of freshwater and nutrients. The influence of anthropogenic factors, mainly fire but often the grazing of livestock, must also be considered one of the major drivers of the habitat forms within the IOCB, particularly over the last 500 years (McCracken, 2008).

The main vegetation types comprising the IOCB are:

- Maputaland Coastal Belt (CB1): Flat coastal plain. Densely forested in places. Range of non-forest vegetation communities – dry grasslands/palmveld, hygrophilous grasslands and thicket.
- Maputaland Wooded Grassland (CB2): Flat coastal plain. Sandy grasslands rich in geophytic suffrutices, dwarf shrubs, small trees and rich herbaceous flora.
- Kwazulu-Natal Coastal Belt (CB3) - Highly dissected undulating coastal plains. Subtropical coastal forest presumed to have been dominant. Themeda triandra dominated primary grassland.
- Pondoland-Ugu Sandstone Coastal Sourveld (CB4): Coastal peneplains and undulating hills with flat table lands and very steep slopes of river gorges. Species rich grassland punctuated with scattered low shrubs or small trees.
- Transkei Coastal Belt (CB5): Highly dissected, hilly coastal country. Alternating steep slopes of low reach river valleys and coastal ridges. Grasslands on higher elevations alternative with bush clumps and small forests.

Parts of the IOCB are threatened by heavy metal dune mining - prospecting and extraction; IAP invasion; tourism development; exploitation for commercial and small scale woodlot plantation; urban settlement and other agriculture (Mucina & Rutherford, 2006).

The expanded Eastern EGI corridor extends from Durban to the Mozambique border. The IOCB within this corridor comprises of Maputaland Coastal Belt (CB 1), Maputaland Wooded Grassland (CB 2) and KwaZulu-Natal Coastal Belt. Subtropical Freshwater Wetlands, Swamp Forest and Lowveld Riverine Forest are three significant azonal vegetation types found within this section of the IOCB. A prominent protected area and land use feature is the Isimangaliso Wetland Park, a Ramsar Site of significance and World Heritage Site. Isimangaliso Wetland Park extends from Maphelane, just north of Richards Bay to Kosi Bay and extends inland to the Mkuze Nature Reserve. iSimangaliso includes significant areas of swamp forest and riverine habitat as well as CB1 and CB2.

To the south, the IOCB, between Durban and Richards Bay the IOCB is largely transformed, with the exception of a few outliers of undisturbed and protected habitat, such as the Amatikulu Nature Reserve (Dokodweni/Nyoni area) and the Ongoye Forest, near Mtunzini. Apart from the abovementioned outliers of natural habitat, urban sprawl, the N2 freeway, extensive sugar cane farming and silviculture, as well as dune mining near Mtunzini are major disturbance factors within this section of the IOCB.

**Box 10: Terrestrial fauna of the Indian Ocean Coastal Belt Biome.**

The IOCB occupies a climatic niche identified using the Koppen – Geiger classification system as Cfa (*warm temperate; fully humid; hot summer*) (Kottek et al., 2006). This climatic regime, as explained above, as well as a topographically diverse environment and a relatively recent history of human settlement has given rise to some diverse ranges of habitat and a concomitantly diverse faunal assemblage. It follows that both **habitat form and structure** and **faunal presence** as well as the interface between these two elements forms the guiding pre-requisites for evaluation of suitable routes for EGI within the IOCB.

However, the rapid expansion of human settlement in the region, particularly following the nagana of the 1860s has seen the confinement of much of the larger fauna to protected areas and private game farms, while smaller species, including invertebrates are confined to niche environments, such as scarp forest, that are not affected by human activities. Notably, some species have benefitted from human settlement and agricultural activities, at the expense of others.

The subtropical climate experienced by the IOCB, as well as the availability of water, offer suitable habitat for a wide range of fauna. The network of protected areas, particularly in the northern portion of the IOCB are critical for the maintenance of faunal biodiversity, in the wake of the extensive disturbance which has been associated with urbanisation, peri-urban settlement and agriculture in surrounding area with the IOCB.

The Futululu and Dukuduku Forest areas as well as the Umfolozi floodplain between St Lucia and Mtubatuba indicate a concentration of reptile records, indicating a potential “hot spot” that should be avoided. In this instance the majority of records were *Bitis gabonica* (Gaboon adder). This species is found within the intact moist grasslands and forest margins that are present in this area. Another potential “hot spot” is Ongoye Forest inland of Mtunzini. This scarp forest and reserve is shown to support butterfly, amphibian and reptile species.

### 6.2.2 Grassland

Grasslands, as the name implies, are dominated by a grass layer. However, from a biodiversity perspective it is the huge diversity of non-grass species, often referred to as forbs, that give the Grasslands biome their high diversity (O’Connor and Bredenkamp, 1996; Mucina and Rutherford, 2006). It is also these forbs that are typically the rare and endangered species within the Grassland biome. Identifying and conserving these non-grass species will be of particular importance during the construction phase. In many cases these plants can be dug up and replanted once construction is completed.

Grasslands are arguably one of the most threatened biomes in the country, with many Grassland types very poorly conserved. In addition, Grasslands have some of the most transformed vegetation types, with a large proportion of the national cereal crop agriculture taking place in the Grasslands (Reyers, 2001; Fairbanks et al., 2000). Most of the plantation forestry, a large proportion of mining as well as some of the biggest metropolitan areas are also located within the Grasslands. Large amounts of the grassland in the Expanded Eastern EGI corridor has been transformed into subsistence agriculture, forestry plantations and sugarcane fields (Fairbanks et al 2000). This places a high conservation importance on all remaining Grassland.

### 6.2.3 Savanna

The unique feature of Savanna that separates it from Grassland is the occurrence of a tree layer in addition to an herbaceous layer. Savanna, although having a high *alpha* diversity (i.e. species diversity at the plot level), the species turnover, *beta* diversity, and landscape (*gamma*) diversity is relatively low (Scholes, 1997). This attribute of Savanna makes them relatively resistant to small-scale disturbances as a small disturbance is unlikely to have catastrophic loss to any particular species. However, there are specific locations with threatened and endangered species where these species would need protection. In addition, a number of the individual tree species within Savannas are protected, such as Stinkwood, require a permit in terms of the NFA to be cut.

Savanna as a biome, is well conserved; however, many of the specific Savanna vegetation types found within the corridor, are very poorly conserved, this is especially true for the Zululand area (Mucina and Rutherford, 2006).

Box 11: Terrestrial fauna of the Grassland and Savanna Biomes.

Savanna and Grassland are the home to a large number of mammals, and these animals move over considerable distances to locate grazing. During the EGI construction phase it is feasible that the movement of animals might be hindered if not managed appropriately, but this is not likely to be a factor in the post-construction phase assuming adequate rehabilitation is conducted. Small mammals, rodents, reptiles, invertebrates and ground birds, including disturbances to nesting sites, may also be hindered during construction. If the post-construction habitat does not have the same functional attributes (e.g. vegetation type and density) as the original habitat then some of these species may have difficulty crossing or utilizing the new habitat. Many of the large and charismatic threatened mammal species such as both black and white rhinoceroses (*Diceros bicornis* & *Ceratotherium simum*), cheetah (*Acinonyx jubatus*) and cape hunting dogs (*Lycaon pictus)* are found in the Savanna and Grassland within the corridor. These species are almost exclusively limited to protected areas and private reserves and as such their distribution is easily identified. Despite preventative measures being in place, during construction there is a potential threat of these species falling into the construction trench, although post construction impacts will be minimal. A few large endangered mammals such as leopard (*Panthera pardus)*, mountain reedbuck (*Redunca fulvorufula)* and Oribi (*Ourebia ourebi)* may occur in suitable habitats outside of conservation areas and will need specialists to identify potential locations where these species may be encountered (Child et al. 2016).

The distribution of small mammals, reptiles and insects are far harder to ascertain, although a large number of Critically Endangered, Endangered and Vulnerable species occur within the Expanded EGI corridors. In many cases these species have small ranges and often use burrows for shelter and breeding. As such the construction phase could potentially have high significance impacts.

The proposed expanded Eastern EGI corridor covers the Zululand area stretching from the Mozambique border to just north of Durban. It includes much of what is referred to as the Maputoland Centre of Plant Endemism. Excluding the northern edge of this corridor which is grassland, and the coastal edge which is IOCB vegetation, the balance is Savanna. Much of this Savanna vegetation is from threatened Savanna vegetation types. This region also has a large number of important conservation areas that are critical components of the conservation strategy for the region. In addition many of these reserves are key eco-tourism destinations. Though outside of the Savanna and grasslands, the iSimangaliso Wetland Park complex is a Ramsar site and important wetland area. Much of this area is under communal land management forming part of the previous Zululand homeland. As such it tends to have a high human settlement density. Plantation forestry and sugarcane fields are two of the most important agricultural activities, and both of these have fragmented the natural biodiversity.

### 6.2.4 Birds

The following Red Data species, that are sensitivity to power lines, are associated with the biomes and vegetation types found in the proposed Eastern Expansion EGI corridor (Table 13).

Table 13: Red Data bird species that occur in the proposed Eastern Expansion EGI corridor which are sensitive to power lines (Taylor et al., 2015).

| Species | Status | Savanna | Grassland | Forest | Indian Ocean Coastal Belt | Azonal |
|---|---|---|---|---|---|---|
| African Marsh-Harrier | EN | x | x | | x | x |
| Abdim's Stork | NT | | x | | | x |
| Black Harrier | EN | | x | | | |
| Black Stork | VU | x | x | | x | x |
| Cape Parrot | EN | | | x | | |
| Caspian Tern | VU | | | | | x |
| Greater Flamingo | NT | | | | x | x |
| Lanner Falcon | VU | x | x | x | x | x |
| Lesser Flamingo | NT | | | | x | x |
| Maccoa Duck | NT | | | | | x |
| Martial Eagle | EN | x | x | | x | |
| Secretarybird | NT | x | x | | | |
| Lappet-faced Vulture | EN | x | | | | |
| Verreaux's Eagle | VU | x | x | | | |
| Marabou Stork | NT | x | | | x | x |
| Denham's Bustard | VU | | x | | x | |
| Pink-backed Pelican | VU | | | | | x |
| Saddle-billed Stork | EN | | | | | x |
| Southern Bald Ibis | VU | | x | | | |
| Burchell's Courser | VU | | x | | | |
| Cape Vulture | EN | x | | | | |
| Southern Ground-Hornbill | EN | x | | | x | |
| Tawny Eagle | EN | x | | | | |
| Wattled Crane | CR | | x | | | x |
| African Grass-Owl | VU | | x | | | x |
| Grey Crowned Crane | EN | | x | | x | x |
| White-bellied Korhaan | VU | x | x | | x | |
| White-backed Vulture | CR | x | | | | |
| Yellow-billed Stork | EN | | | | | x |
| African Crowned Eagle | VU | | | x | | |
| African Finfoot | VU | | | | | x |
| African Pygmy-Goose | VU | | | | | x |
| Bateleur | EN | x | | | | |
| Great White Pelican | VU | | | | | x |
| Hooded Vulture | CR | x | | | | |
| Pel's Fishing-Owl | EN | | | | | x |
| Southern Banded Snake-Eagle | CR | | | | x | |
| White-headed Vulture | CR | x | | | | |
| White-backed Night-Heron | VU | | | | | x |
| Black-rumped Buttonquail | EN | | x | | | |
| Orange Ground-thrush | NT | | | | | |
| Spotted Ground-thrush | EN | | | x | | |
| *CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened* | | | | | | |

### 6.2.5 Bats

The following bats of conservation importance are found in the proposed Eastern Expansion EGI corridor (Table 14).

Table 14: Red Data bat species that occur in the proposed Eastern Expansion EGI corridor which are sensitive to power lines (Child et al., 2016).

| Species Name | Common Name | Conservation Status (Child et al., 2016) |
|---|---|---|
| *Cloeotis percivali* | Short-eared Trident Bat | EN (Balona et al., 2016) |
| *Epomophorus wahlbergi* | Wahlberg's Epauletted Fruit Bat | LC (Schoeman et al., 2016) |
| *Kerivoula argentata* | Damara Woolly Bat | NT (Monadjem et al., 2016a) |
| *Miniopterus inflatus* | Greater long-fingered bat | NT (Richards et al. 2016a) |
| *Neoromicia rendalli* | Rendall's serotine | LC (Monadjem et al., 2016b) Rare in SA |
| *Otomops martiensseni* | Large-eared free-tailed Bat | NT (Richards et al., 2016b) |
| *Rhinolophus blasii* | Peak-saddle Horseshoe Bat | NT (Jacobs et al., 2016c) |
| *Rhinolophus swinnyi* | Swinny's Horseshoe Bat | VU (Jacobs et al., 2016d) |
| *Rousettus aegyptiacus* | Egyptian Rousette Bat | LC (Markotter et al., 2016) |
| *Scotoecus albofuscus* | Thomas' House Bat | NT (Richards et al., 2016c) |
| *Scotophilus nigrita* | Giant Yellow House Bat | NT (Fernsby et al., 2016) |
| *Taphozous perforatus* | Egyptian Tomb Bat | NT (Richards et al., 2016d) |
| *EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern* | | |

### 6.2.6 Freshwater ecosystems

Rivers within the Eastern EGI Corridor are predominantly perennial/permanently-flowing (87%), majority of which occur in the North Eastern Uplands, Lowveld and North Eastern Coastal Belt ecoregions. Major river systems include the Mkuze, Phongolo, Mfolozi, Thukela, Mhlatuze and Mvoti Rivers that drain across the width of the corridor into the Indian Ocean. Up to 16% of the river habitat is considered to be Threatened (i.e. Critically Endangered, Endangered and Vulnerable). This corridor contains the following remaining flagship/free-flowing rivers in the country, namely: the Mfolozi and Thukela River systems, and the Mkuze River and one of its tributaries, the Msunduzi. The PES of rivers is fairly good, with 50% of the rivers assessed to be in a natural/good condition, while 35% are in a fair condition and 15% are in a poor/very poor condition.

Wetland habitats within the Eastern EGI Corridor occupy a notable proportion of the corridor (~10%) comprising up to 83 different wetland types dominated by channelled-valley bottom wetlands and floodplain wetlands, particularly within the IOCB region. The corridor boasts four Ramsar wetlands covering up to 185 000 ha, namely Ndumo Game Reserve, Kosi Bay, Lake Sibaya, and the St. Lucia System. A large proportion (~65%) of the wetlands in the corridor are characterised as NFEPA wetlands, a third of which is made up of channelled-valley bottoms, floodplains, seeps and valley-head seeps within the IOCB region.

Approximately 65% of the Eastern Corridor comprises land that is largely natural, with a significant proportion of the area protected by existing conservation areas (e.g. Isimangaliso Wetland Park, Hluhluwe-Imfolozi Game Reserve, Tembe Elephant Park, Ndumo Game Reserve, Ithala Game Reserve). The remaining area has been transformed largely by cultivation, plantations, urbanisation and rural settlements. Impacts on freshwater ecosystems caused by land use activities associated within these transformed areas vary across the landscape, however, combined effect has had a significant effect on freshwater ecosystem functioning and integrity. Key impacts include:

- Extensive urbanisation causing transformation and degradation of freshwater ecosystems, notably in the greater Durban region, which continues to expand up along the coast, as well as Richards Bay;

- Water quality impacts and pollution associated with urban areas (e.g. domestic and industrial effluents, failing water treatment infrastructure, etc.) and agriculture (e.g. pesticides, herbicides and fertiliser applications) all of which are contaminating receiving aquatic environments;
- Flow alteration caused by large impoundments (e.g. Inanda, Hazelmere and Goedertrouw and Pongolapoort Dams), inter-basin transfers, WWTW return flows, and stormwater runoff from hardened surfaces and sewer reticulation, all of which affect downstream aquatic systems (e.g. channel characteristics, riparian vegetation, and instream and floodplain habitats) as well as river continuity;
- Cultivation of wetlands and floodplains (notably sugarcane), especially along the coastal region;
- Illegal sand mining, as well as other mining activities, particularly in the Richards Bay region;
- Transformation and alteration of watercourses through canals, diversion structures, weirs, road crossings, flood control berms;
- Abstraction of water for irrigation and extensive forestry, which has a significant impact on groundwater and linked wetlands in the Maputaland region;
- Erosion and degradation, especially linked to overgrazing, which is notable in the more rural areas; and
- Excessive infestation of numerous IAPs, particularly along rivers and around wetlands, as well as instream (e.g. Water Hyacinth).

**Box 12: Red Data aquatic biota likely to be encountered in the proposed Expanded Eastern EGI corridor.**

The only Critically Endangered Odonata for South Africa occurs along the Phongolo River in the north-western corner of the Eastern EGI Corridor, namely *Chlorocypha consueta*. The Endangered *Diplacodes pumila* also occurs in the corridor along with seven species listed as Vulnerable and four species listed as Near Threatened. Two Endangered fish, *Marcusenius caudisquamatus* and *Silhouettea sibayi*, occur predominantly within coastal rivers within the corridor, as well as two species listed as Vulnerable, including the widespread *Oreochromis mossambicus*. The corridor also supports three Near Threatened and two Data Deficient fish species. Two Endangered amphibians, *Hyperolius pickersgilli* and *Natalobatrachus bonebergi*, also occur along the coastal areas, while the Endangered *Leptopelis xenodactylus* occurs more inland at isolated localities. Threatened reptiles include *Bradypodion melanocephalum*, which often occurs in vegetation along rivers and adjacent to wetlands, and *Pelusios rhodesianus*, which is known from a few water bodies along the coastal region – both are listed as Vulnerable. Up to eight Red Listed mammals occur within the Eastern Corridor, including five rodents/shrews, as well as Spotted-necked Otter *Hydrictis maculicollis* and Cape Otter *Aonyx capensis*. One Critically Endangered plant, *Kniphofia leucocephala*, occurs in isolation in the Richards Bay area. There are also five Endangered, 16 Vulnerable, 12 Near Threatened freshwater plants occurring within the corridor.

### 6.2.7 Estuarine ecosystems

In total, 21 estuaries fall within the Expanded Eastern EGI Corridor, with a combined estuarine habitat area of 55 700 ha. Most of the estuaries in the region are not particularly long and extend less than 10 km into the corridor, with the exception of the St Lucia (<30 km), Thukela (<25 km), Mhlathuze (<15 km), Mfolozi (<15 km) and Kosi (<10 km).

Only five estuaries in this corridor are in an excellent or good condition (Categories A to B). These are Mdlotane, Matigulu/Nyoni, Mlalazi, Mgobezeleni and Kosi estuaries. These systems have a high sensitivity to change as they will degrade from their near pristine state relatively easily.

Durban Bay, Mlalazi, Mhlathuze, Mfolozi, St Lucia and Kosi estuaries are of Very High biodiversity importance, ranking amongst the top estuaries in South Africa (Turpie et al., 2002; Turpie and Clark, 2009). In addition, Mgeni, Mhlanga, Mdloti, Tongati, Mhlali, Mdlotane, Zinkwasi, Thukela, Matigulu/Nyoni, Richards Bay and Nhlabane estuaries are rated as Important from a biodiversity perspective.

Seventeen estuaries in the corridor are identified as conservation priorities in the National Estuaries Biodiversity Plan (Turpie et al., 2012) and the KwaZulu-Natal Conservation Plan. These include Durban Bay, Mgeni, Mhlanga, Mhlali, Mvoti, Mdlotane, Zinkwasi, Thukela, Matigulu/Nyoni, Siyaya, Mlalazi, Mhlathuze, Richards Bay, Mfolozi, St Lucia, Mgobezeleni and Kosi estuaries.

Twelve estuaries are important fish nurseries that play a critical role in the maintenance and recovery of South Africa's recreational and commercial fish stock (Lamberth and Turpie, 2003; Van Niekerk et al., 2017). These include Durban Bay, Mgeni, Zinkwasi, Thukela, Matigulu/Nyoni, Mlalazi, Mhlathuze, Richards Bay, Nhlabane, Mfolozi, St Lucia and Kosi.

From a habitat diversity and abundance perspective, all the estuaries, with the exception of Mvoti, are considered important as they support sensitive estuarine habitats such as mangroves, swamp forest and saltmarsh (intertidal and/or supratidal).

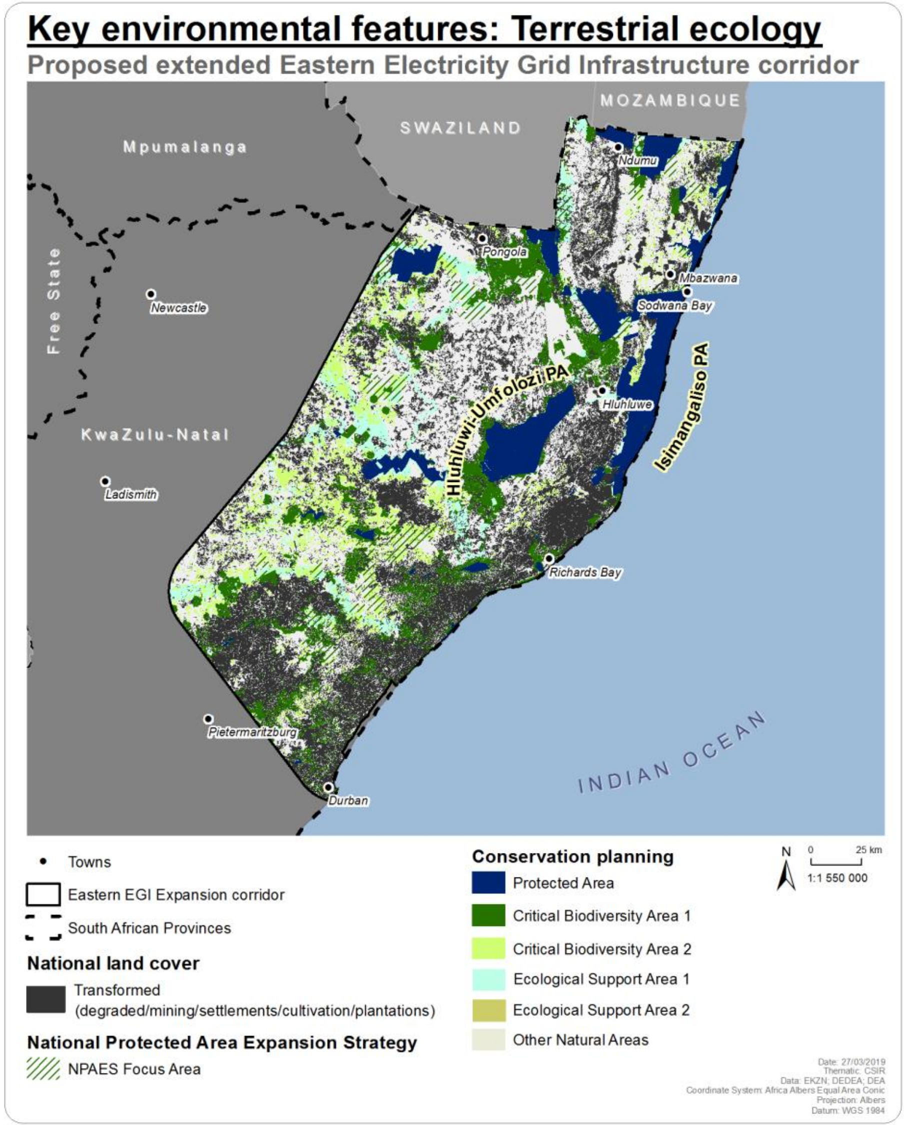



Figure 8: Key environmental features of the proposed Eastern EGI Expansion corridor.

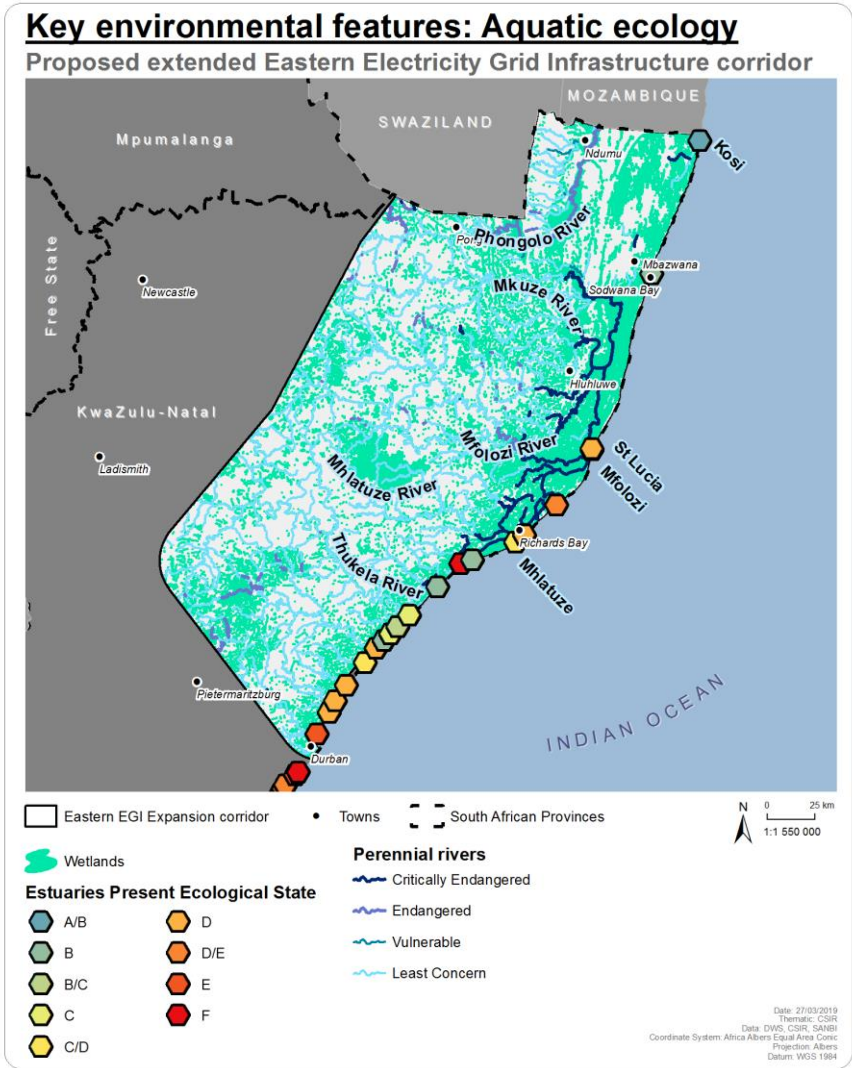
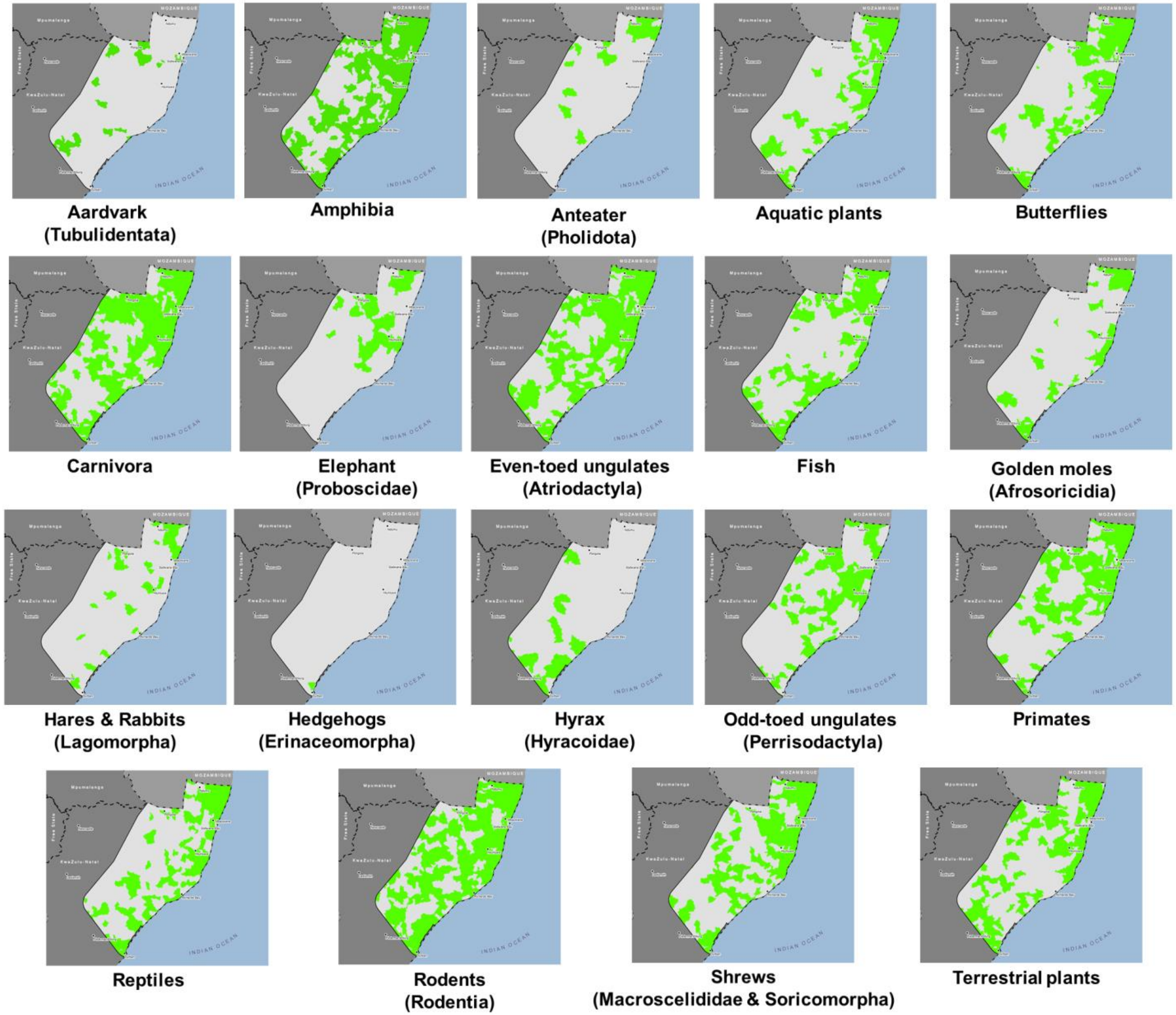



Figure 9: Key aquatic ecosystem features and associated Red Data species of the proposed expanded Eastern EGI corridor.

*Note: Finer scale features may not be visible at the current map extent.*

## Key environmental features: Red Data Species

### Proposed extended Eastern Electricity Grid Infrastructure corridor




*Note: Finer scale features may not be visible at the current map extent.*

Figure 10: Distribution of recorded Red Data species in the proposed expanded Eastern EGI corridor (at quinary catchment scale).

# 7 ENVIRONMENTAL SENSITIVITY

## 7.1 Identification of feature sensitivity criteria

The data presented in Table 1 - Table 6 (Section 4.2) were used as the point of the departure for the sensitivity analysis. Sensitivities were assigned to various important environmental features and identified buffers (where relevant). The sensitivities of the different biomes may vary, as they are known to have various degrees of resilience and recoverability. For example: rehabilitation may be more easily and successfully achieved in the Savanna and Grassland vegetation types than in Fynbos and Karoo vegetation types.

### 7.1.1 Desert, Succulent Karoo and Nama Karoo

The biodiversity sensitivity values are adapted from CBA classifications from provincial systematic conservation plans for the Northern, Western and Eastern Cape provinces, as well as relevant specialist experience and previous SEAs conducted in these biomes (Table 15).

Table 15: Sensitivity ratings assigned to important environmental features of the Desert, Succulent Karoo and Nama Karoo biomes in the proposed Expanded Western EGI corridor.

| Feature Class | Sensitivity Rating |
|---|---|
| **Conservation planning** | |
| CBA 1 | Very High |
| CBA 2 | High |
| ESA | Low |
| **Protected areas** | |
| PA | Very High |
| NPAES Focus Area | Medium |
| Old agricultural fields | Low |
| Old agricultural fields + CBA | Medium |
| Field crop boundaries | Low |
| **Specific Vegetation types** | |
| Azonal wetland related vegetation types | Very High |
| Azonal non-wetland related vegetation types | High |
| Vegetation types which have a high abundance of SCC | High |
| Vegetation types which are considered vulnerable to disturbance (dunes) | High |
| **Threatened ecosystems** | |
| CR | Very High |
| EN | High |
| VU | Medium |
| **Species of Conservation Concern** | |
| Quinary catchments where fauna and flora SCC are present | High |
| SCC Plant Habitats | Very High |
| **Other areas of biodiversity significance** | |
| Specialist identified sensitive areas in Karoo and Desert ecosystems (Todd, personal observations) | High |
| PA = Protected Area; CBA = Critical Biodiversity Area; NPAES = National Protected Area Expansion Strategy; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; ESA = Ecological Support Area; SCC = Species of Conservation Concern | |

### 7.1.2 Fynbos

The Fynbos sensitivity analysis relied primarily on the most recent conservation plans for the areas concerned as they already include all the relevant layers of information such as threatened vegetation, threatened vertebrates, protected area expansion strategies and climate adaptation corridors in their CBAs and ESAs and the latest information on the protected areas (Table 16).

Table 16: Sensitivity ratings assigned to important environmental features of the Fynbos biome in the proposed Expanded Western EGI corridor.

| Feature Class | Sensitivity Rating |
|---|---|
| **Protected Areas Western Cape** | |
| - NPs, Nature Reserves, World Heritage Sites | Very High<br>10 km Buffer[a]: High |
| - Private Conservation Areas (all types) | Medium<br>5 km Buffer: Medium |
| - Protected Environment | 5 km Buffer: Medium |
| - NPAES | 5 km Buffer: Medium |
| - Nature Reserve Buffer | 5 km Buffer: Medium |
| **Protected Areas Northern Cape (all types)** | Very High |
| - PA | 5 km Buffer[b]: High |
| - NPs | 10 km Buffer[b]: High |
| - World Heritage Sites | Very High |
| - NPAES | Medium |
| **Conservation planning** | |
| - CBA1 | Very High |
| - CBA2 | High |
| - ESA, ESA1, ESA2 | Medium |
| - Land Cover : Natural Area | Medium |
| - Land Cover: Transformed | Low |
| - Other Natural Areas | Medium |
| **Species of Conservation Concern** | |
| Quinary catchments where fauna and flora SCC are present | High |

[a] *EIA Regulations, No. R. 982, 4 December 2014 as updated in Government Notices 324 to 327 in Government Gazette 40772 of 7 April 2017.*

[b] *In the Northern Cape CBA plan all PAs were buffered by 5 km and National Parks by 10 km as minimum.*

*NP = National Park; WHS = World Heritage Site; NPAES = National Protected Area Expansion Strategy; PA = Protected Area; CBA = Critical Biodiversity Area; ESA = Ecological Support Area; SCC = Species of Conservation Consern*

### 7.1.3 Indian Ocean Coastal Belt

For the IOCB areas of high conservation value and existing conservation plans were selected as basis for the sensitivity analysis (Table 17).

Table 17: Sensitivity ratings assigned to important environmental features of the Indian Ocean Coastal Belt biome in the proposed Expanded Eastern EGI corridor.

| Feature Class | Sensitivity Rating |
|---|---|
| - Coastline | 1 km buffer: Very High |
| - PA | 5 km buffer: Very High |
| - WHS | Very High |
| - Ramsar Sites | High |
| - Forest Nature Reserve | Very High |
| - NPAES | Medium |
| - National Forests | Very High |

| Feature Class | | Sensitivity Rating |
|---|---|---|
| - Conservation categories from KZN CBA Plan | CBA Irreplaceable | High |
| | CBA Optimal | Medium |
| | ESA | Low |
| - Ezemvelo KZN Wildlife Stewardship areas | | Very High |
| - Landcover | Modified | Low |
| | Field Crop Boundaries | Low |
| - Vegetation | LT | Low |
| | VU | Medium |
| | EN | High |
| | CR | Very High |
| - Ecoregion | | Medium |
| - Private Nature Reserves and Game farms | Game Farms Title Deeds | 5 km buffer: Medium |
| | Nature Reserves/Protected Areas | Very High |
| *PA = Protected Area; WHS = World Heritage Site; CA = Conservation Area; CBA = Critical Biodiversity Area; ESA = Ecological Support Area; KZN = KwaZulu-Natal; LT = Least Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered.* | | |

### 7.1.4 Grassland & Savanna

The sensitivity of biodiversity and ecological features was based largely on sensitivities as used in Provincial biodiversity conservation plans.

Table 18: Sensitivity ratings assigned to important environmental features of the Grassland and Savanna biomes in the proposed Expanded Eastern EGI corridor.

| Feature Class | | Sensitivity Rating |
|---|---|---|
| PAs: national and provincial parks, forest wilderness, special nature reserves and forest nature reserves | | Very High |
| Coastlines | | Very High |
| All indigenous forests | | Very High |
| CBA 1 | | Very High |
| CBA 2 | | High |
| Threatened ecosystems | CR | Very High |
| | EN | High |
| | VU | Medium |
| Land Cover: Natural Area<br>Land Cover: Modified areas | | Low |
| Game Farms | | Medium |
| SANParks Buffer | | High |
| Protected Environments | | High |
| NPAES focus areas | | Medium |
| Mountain Catchment Areas | | High |
| Biospheres | | Medium |
| Botanical Gardens | | Medium |
| ESA | | Medium |
| **Species of Conservation Concern** | | |
| Quinary catchments where fauna and flora SCC are present | | High |
| *PA = Protected Area; CBA = Critical Biodiversity Area; NPAES = National Protected Area Expansion Strategy; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; ESA = Ecological Support Area* | | |

### 7.1.5 Birds

An aggregated bird habitat sensitivity score for each habitat class within each biome, within each corridor was calculated by summing the species-specific probability scores for that particular habitat class (Table 19 and Table 20).

Table 19: Sensitivity ratings for avifauna habitat and species in the Expanded Western EGI corridor.

| Biome | Feature Class | Sensitivity rating |
|---|---|---|
| Azonal Vegetation | Bare | Medium |
| | Cliffs | 1 km buffer: Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated vines | Medium |
| | Drainage lines | Medium |
| | Grassland | Medium |
| | Industrial | Low |
| | Low shrubland | Medium |
| | Plantations | Medium |
| | Shrubland fynbos | Medium |
| | Thicket /Dense bush | Medium |
| | Urban | 500 m buffer: Low |
| | Wetlands and waterbodies | 500 m buffer: Medium |
| | Woodland/Open bush | Medium |
| Desert | Bare | Medium |
| | Cliffs | 1 km buffer: Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated commercial pivots | Medium |
| | Cultivated orchards | Medium |
| | Cultivated vines | Medium |
| | Drainage lines | Medium |
| | Grassland | High |
| | Industrial | Low |
| | Low shrubland | High |
| | Shrubland fynbos | High |
| | Thicket /Dense bush | Medium |
| | Urban | 500 m buffer: Low |
| | Wetlands and waterbodies | 500 m buffer: Medium |
| | Woodland/Open bush | Medium |
| Fynbos | Bare | Medium |
| | Cliffs | 1 km buffer: Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated subsistence | Medium |
| | Drainage lines | Medium |
| | Grassland | Medium |
| | Industrial | Low |
| | Low shrubland | Medium |
| | Shrubland fynbos | Medium |
| | Thicket /Dense bush | Medium |
| | Urban | 500 m buffer: Low |
| | Wetlands and waterbodies | 500 m buffer: Medium |

| Biome | Feature Class | Sensitivity rating |
|---|---|---|
| | Woodland/Open bush | Medium |
| Nama Karoo | Bare | Medium |
| | Cliffs | 1 km buffer: Medium |
| | Drainage lines | Medium |
| | Grassland | High |
| | Industrial | Low |
| | Low shrubland | High |
| | Shrubland fynbos | High |
| | Thicket /Dense bush | Medium |
| | Wetlands and waterbodies | 500 m buffer: Medium |
| | Woodland/Open bush | Medium |
| Succulent Karoo | Bare | Medium |
| | Cliffs | 1 km buffer: Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated commercial pivots | Medium |
| | Cultivated subsistence | Medium |
| | Cultivated vines | Medium |
| | Drainage lines | Medium |
| | Grassland | High |
| | Industrial | Low |
| | Low shrubland | High |
| | Plantations | Medium |
| | Shrubland fynbos | High |
| | Thicket /Dense bush | Medium |
| | Urban | 500 m buffer: Low |
| | Wetlands and waterbodies | 500 m buffer: Medium |
| | Woodland/Open bush | Medium |
| Key avifauna features | Nest sites of Red Data species | 2.5 km buffer: Very high |
| | Cape Vulture colonies and vulture restaurants | 5 km buffer: Very high |

Table 20: Sensitivity rating for avifauna in the Expanded Eastern EGI corridor

| Biome | Feature Class | Sensitivity rating |
|---|---|---|
| Azonal Vegetation | Bare | Medium |
| | Cliffs | 1km buffer: Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated commercial pivots | Medium |
| | Cultivated orchards | Medium |
| | Cultivated subsistence | Medium |
| | Cultivated sugar cane | Medium |
| | Drainage lines | High |
| | Grassland | Medium |
| | Indigenous Forest | Medium |
| | Industrial | Low |
| | Low shrubland | Medium |
| | Plantations | Medium |
| | Thicket /Dense bush | Medium |
| | Urban | 500 m buffer: Low |

| Biome | Feature Class | Sensitivity rating |
|---|---|---|
| | Wetlands and waterbodies | 500 m buffer: Very high |
| | Woodland/Open bush | High |
| Forests | Bare | Medium |
| | Cliffs | 1 km buffer: Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated orchards | Medium |
| | Cultivated subsistence | Medium |
| | Cultivated sugar cane | Medium |
| | Drainage lines | Medium |
| | Grassland | Medium |
| | Indigenous Forest | Medium |
| | Industrial | Low |
| | Low shrubland | Medium |
| | Plantations | Medium |
| | Thicket /Dense bush | Medium |
| | Urban | 500 m buffer: Low |
| | Wetlands and waterbodies | 500 m buffer: Medium |
| | Woodland/Open bush | Medium |
| Grassland | Bare | Medium |
| | Cliffs | 1 km buffer: Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated commercial pivots | Medium |
| | Cultivated orchards | Medium |
| | Cultivated subsistence | Medium |
| | Cultivated sugar cane | Medium |
| | Drainage lines | Medium |
| | Grassland | High |
| | Indigenous Forest | Medium |
| | Industrial | Low |
| | Low shrubland | Medium |
| | Plantations | Medium |
| | Thicket /Dense bush | Medium |
| | Urban | 500 m buffer: Low |
| | Wetlands and waterbodies | 500 m buffer: High |
| | Woodland/Open bush | High |
| Indian Ocean Coastal Belt | Bare | Medium |
| | Cliffs | Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated orchards | Medium |
| | Cultivated subsistence | Medium |
| | Cultivated sugar cane | Medium |
| | Drainage lines | Medium |
| | Grassland | Medium |
| | Indigenous Forest | Medium |
| | Industrial | Low |
| | Low shrubland | Medium |
| | Plantations | Medium |
| | Thicket /Dense bush | Medium |
| | Urban | 500m buffer: Low |

| Biome | Feature Class | Sensitivity rating |
|---|---|---|
| | Wetlands and waterbodies | 500 m buffer: High |
| | Woodland/Open bush | High |
| Savanna | Bare | Medium |
| | Cliffs | 1 km buffer: Medium |
| | Cultivated commercial fields rainfed | Medium |
| | Cultivated commercial pivots | Medium |
| | Cultivated orchards | Medium |
| | Cultivated subsistence | Medium |
| | Cultivated sugar cane | Medium |
| | Drainage lines | High |
| | Grassland | High |
| | Indigenous Forest | Medium |
| | Industrial | Low |
| | Low shrubland | Medium |
| | Plantations | Medium |
| | Thicket /Dense bush | Medium |
| | Urban | 500 m buffer: Low |
| | Wetlands and waterbodies | 500 m buffer: High |
| | Woodland/Open bush | Very high |
| Key avifauna features | Nest sites of Red Data species | 2.5 km buffer: Very high |
| | Cape Vulture colonies and vulture restaurants | 5 km buffer: Very high |

### 7.1.6 Bats

Habitat features and types were assigned varying sensitivities according to their bat importance. Where appropriate, buffers with a specific sensitivity have been assigned. The exact bat roost points have remained confidential in order to protect the roosts.

Table 21: Sensitivity rating for bats in the proposed Expanded Eastern and Western EGI corridors.

| Feature Class | | Sensitivity rating |
|---|---|---|
| Ecoregions | KwaZulu-Cape Coastal Forest Mosaic | High |
| | Maputuland Coastal Forest Mosaic | High |
| | Maputuland-Pondoland Bushlands and Thickets | High |
| | Nama Karoo | Low |
| | Drakensberg Montane Grasslands, Woodlands and Forest | Medium |
| | Southern African Mangroves | Low |
| | Zambesian and Mopane Woodlands | Medium |
| | Montane Fynbos and Renosterveld | Low |
| | Succulent Karoo | Low |
| Geology | Limestone | 200 m buffer: Very High |
| | Dolomite | 200 m buffer: Very High |
| | Arenite | 200 m buffer: Medium |
| | Sedimentary and Extrusive Rock | 200 m buffer: Medium |
| Bat Roosts | Bat Roost Points | 500 m buffer: Very High |

| Feature Class | | | Sensitivity rating |
|---|---|---|---|
| Landcover | Plantations / Woodlands: Young and Mature | | 200 m buffer: Medium |
| | Thicket/ Dense Bush | | 200 m buffer: Medium |
| | Indigenous Forest: Very High | | 200 m buffer: Very High |
| | Urban Areas | | Medium |
| | Disturbed and eroded land | | Low |
| | Irrigated fields | | Medium |
| Wetlands | All Wetlands | | 200 m buffer: Very High |
| Rivers | Major Perennial Rivers | | 200 m buffer: Very High |
| Dams | Farm Dams and Natural Dams | | 200 m buffer: Very High |
| EOO | *Cistugo seabrae* | Expanded Western EGI corridor | Medium |
| | *Laephotis namibensis* | | |
| | *Cloeotis percivali* | Expanded Eastern EGI corridor | |
| | *Epomophorus wahlbergi* | | |
| | *Kerivoula argentata* | | |
| | *Miniopterus inflatus* | | |
| | *Neoromicia rendalli* | | |
| | *Otomops martiensseni* | | |
| | *Rhinolophus blasii* | | |
| | *Rhinolophus swinnyi* | | |
| | *Rousettus aegyptiacus* | | |
| | *Scotoecus albofuscus* | | |
| | *Scotophilus nigrita* | | |
| | *Taphozous perforates* | | |
| *EoO = Extent of Occurrence* | | | |

### 7.1.7 Freshwater ecosystems

The sensitivity rating for freshwater ecosystems is a combined rating for rivers, wetlands and freshwater biota (Table 22). The total score for each SQ4 catchment were collapsed into the four sensitivity classes using a quantile data split. This coverage provides an integration of all data pertaining to freshwater biodiversity and ecosystems, and is particularly useful for identifying preferred alignments for EGI in order to reduce impacts on freshwater ecosystems and associated biodiversity.

Table 22: Sensitivity ratings assigned to important freshwater features in the proposed Expanded Eastern and Western EGI corridors.

| Feature Class | Sensitivity Rating |
|---|---|
| Wetlands: Critically Endangered wetlands and Irreplaceable CBAs (aquatic) | 200 m buffer: Very High |
| Wetlands: Ramsar wetlands, KZN priority wetlands, Endangered or Vulnerable wetlands, Optimal CBA (aquatic) | 100 m buffer: High |
| Wetlands: NFEPA wetlands, Near Threatened wetlands and ESA (aquatic) | 50 m buffer: Medium |
| Wetlands: probable wetland, non-NFEPA wetlands, least threatened wetlands, ONA (aquatic), formally protected aquatic features | 32 m buffer: Low |
| River ecosystems (including instream and riparian habitats) | 200 m buffer Very High |
| | 100 m buffer: High |
| | 50 m buffer: Medium |

| Feature Class | | Sensitivity Rating |
|---|---|---|
| | | 32 m buffer:<br>Low |
| Freshwater fauna and flora per quinary catchment | CR<br>Data Deficient | Very High |
| | EN<br>VU | High |
| | NT<br>Rare | Medium |
| | LT | Low |
| *CBA = Critical Biodiversity Area; NFEPA = National Freshwater Ecosystem Priority Areas; KZN = KwaZulu-Natal;; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LT = Least Threatened; ESA = Ecological Support Area; ONA = Other Natural Area* | | |

### 7.1.8 Estuarine ecosystems

Sensitivity was assigned to a suite of environmental indicators for estuaries (Table 23).

Table 23: Sensitivity ratings assigned to important estuarine features in the proposed Expanded Eastern and Western EGI corridors.

| Sensitivity Indicator | Sensitivity Class |
|---|---|
| Estuaries in Formally /desired PAs | Very High |
| Estuaries of high biodiversity importance | Very High |
| Important nurseries | Very High |
| Important estuarine habitats | Very High |
| Natural or near natural condition estuaries | Very High |
| Estuaries that support species of conservation importance | Very High |
| Coastal rivers, wetlands and seeps above or adjacent to estuaries | 5 km around EFZ:<br>High |
| Coastal rivers, wetlands and seeps | 5 - 15 km buffer around EFZ:<br>Medium |
| Terrestrial environment | 15 km or more from EFZ:<br>Low |
| *PA = Protected Area; EFZ = Estuary Functional Zone* | |

## 7.2 Four-Tier Sensitivity Mapping

### 7.2.1 Expanded Western Corridor

#### *7.2.1.1 Terrestrial ecosystems*

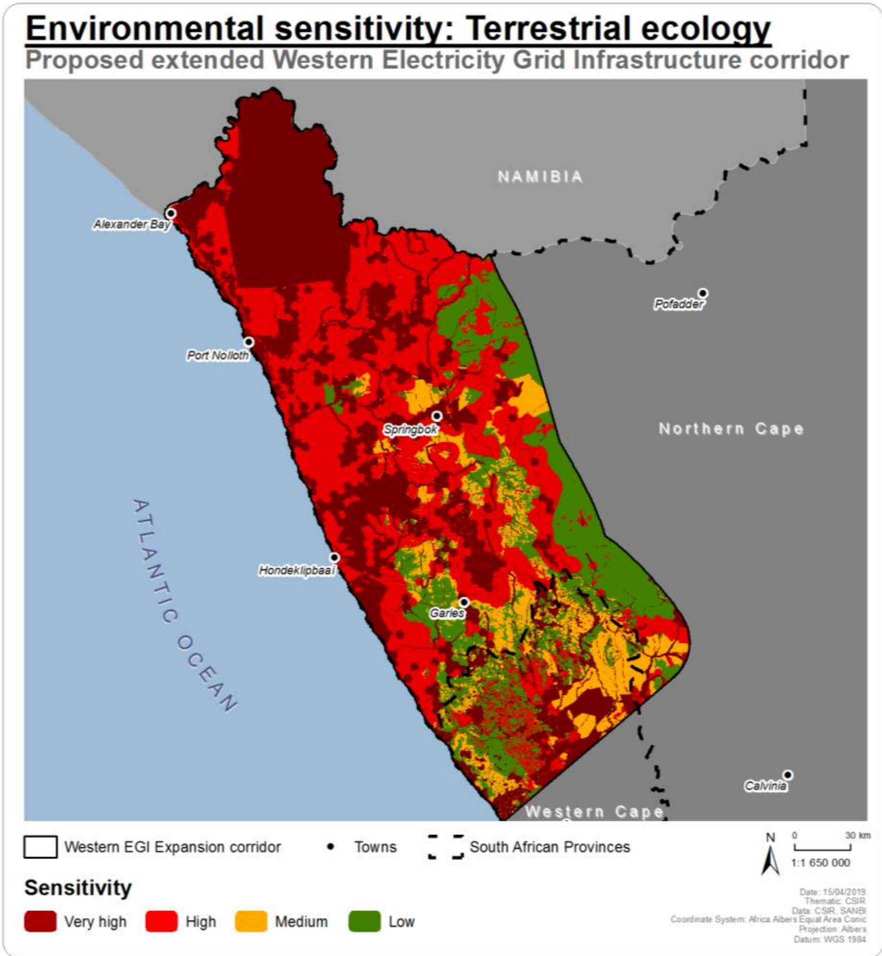



Figure 11: Environmental sensitivity of terrestrial ecosystems to proposed EGI development in the expanded Western EGI corridor.

#### *7.2.1.2 Birds*

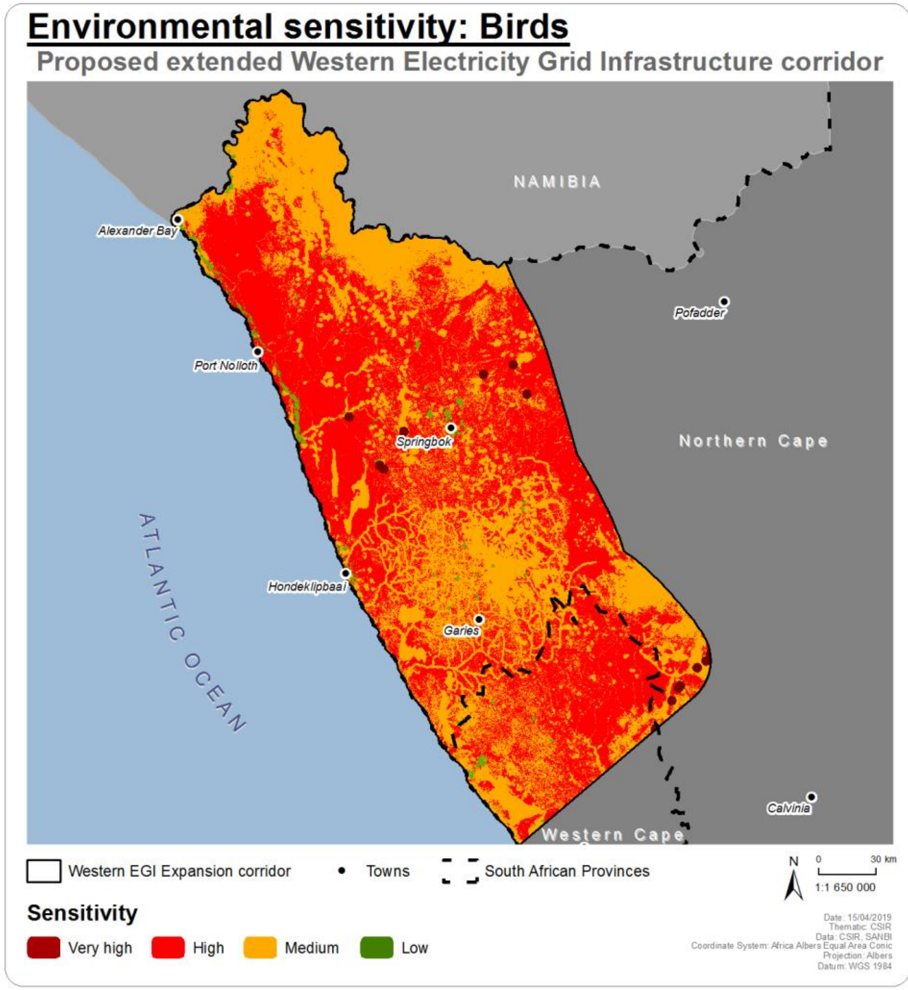



Figure 12: Sensitivity of birds to proposed EGI development in the expanded Western EGI corridor.

#### *7.2.1.3 Bats*

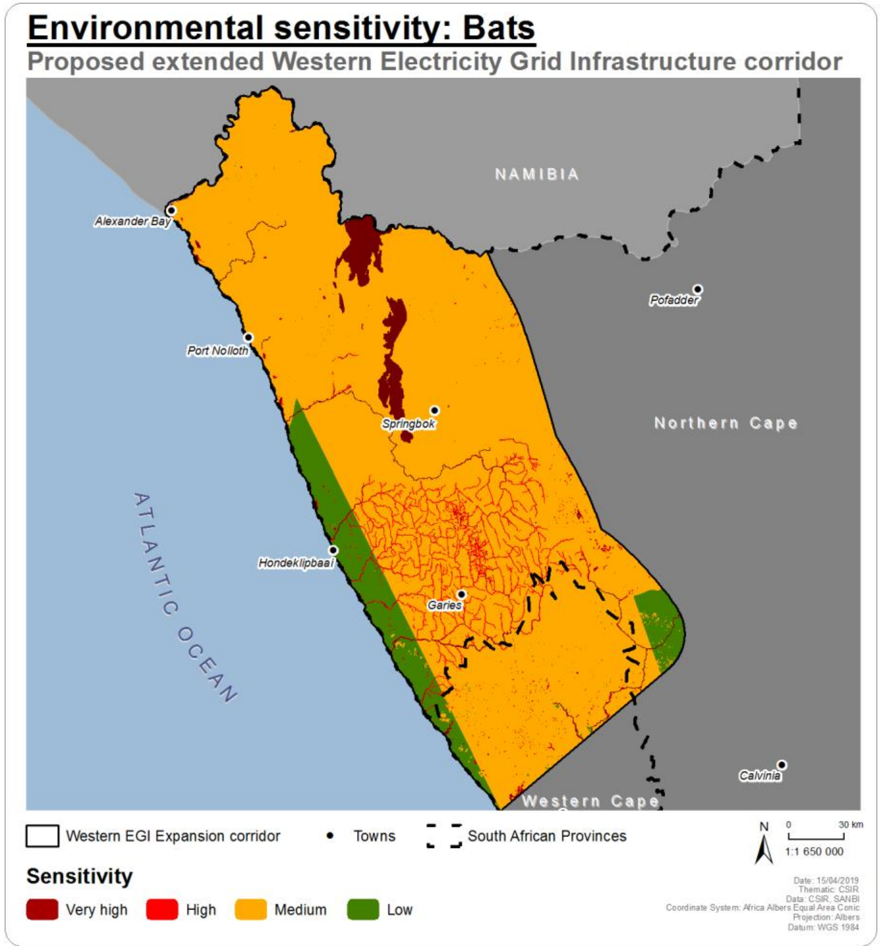



Figure 13: Sensitivity of bats to proposed EGI development in the expanded Western EGI corridor.

#### *7.2.1.4 Aquatic ecosystems*

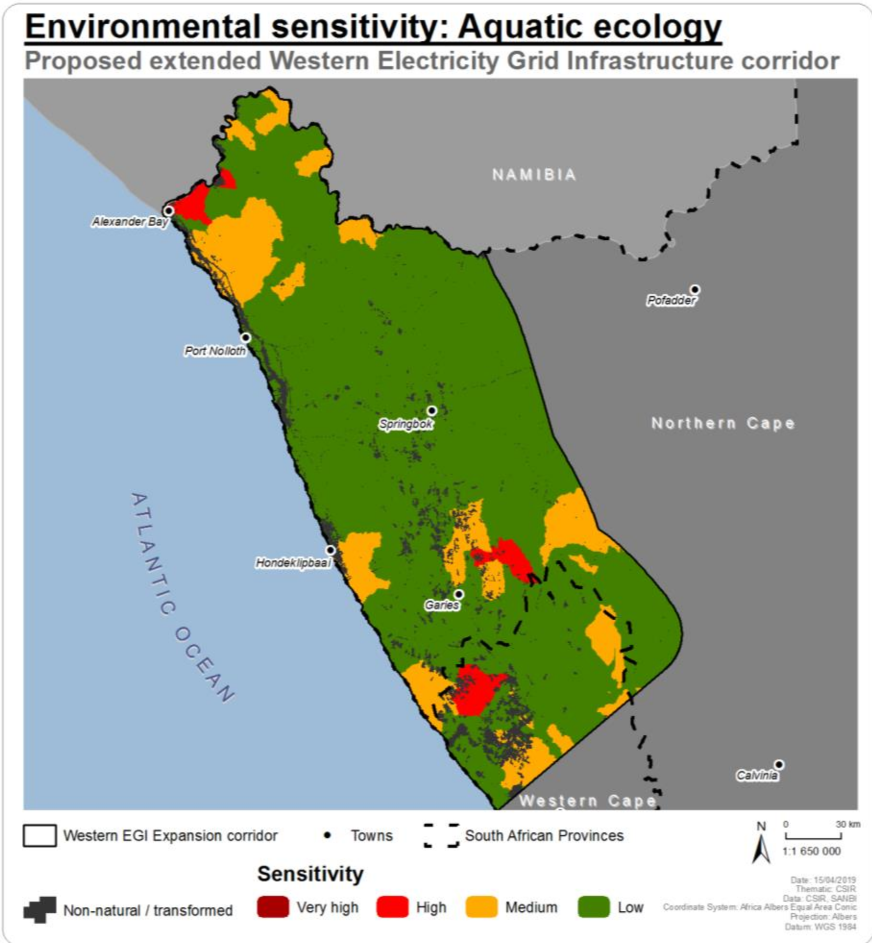



Figure 14: Environmental sensitivity per quinary catchment (overlaid with non-natural/transformed landcover) of aquatic ecosystems to proposed EGI development in the expanded Western EGI corridor.

#### *7.2.1.5 Estuarine ecosystems*

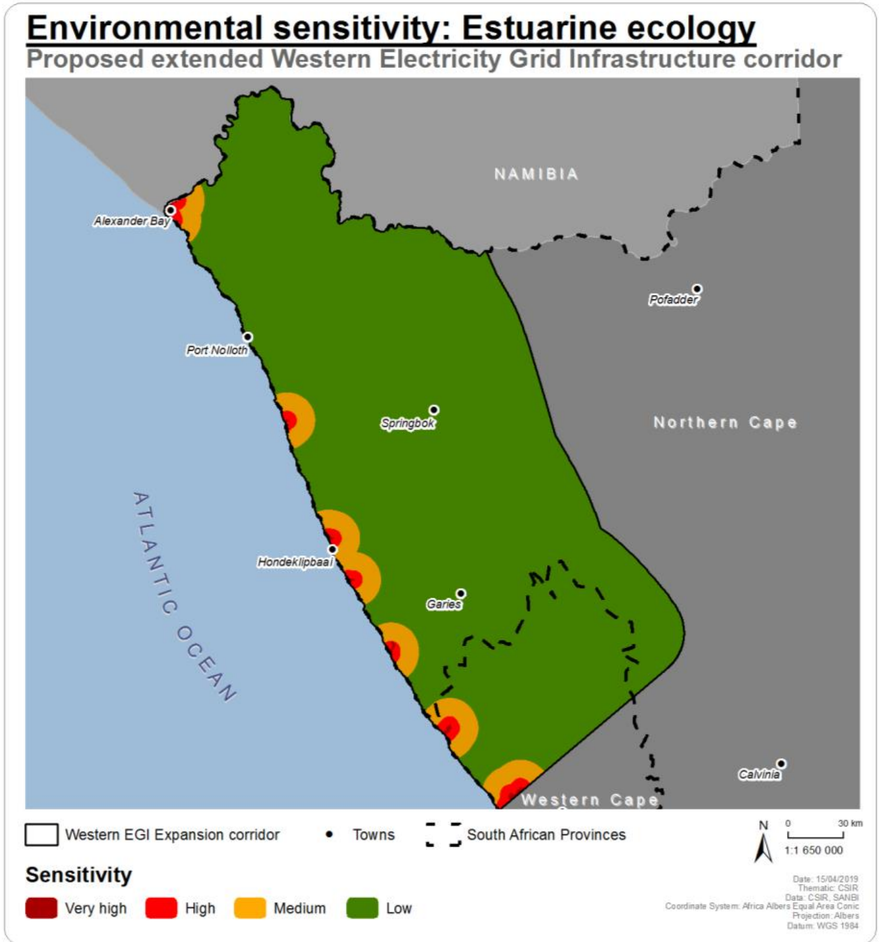



Figure 15: Environmental sensitivity of estuarine ecosystems to proposed EGI development in the expanded Western EGI corridor.

### 7.2.2 Expanded Eastern Corridor

#### *7.2.2.1 Terrestrial ecosystems*

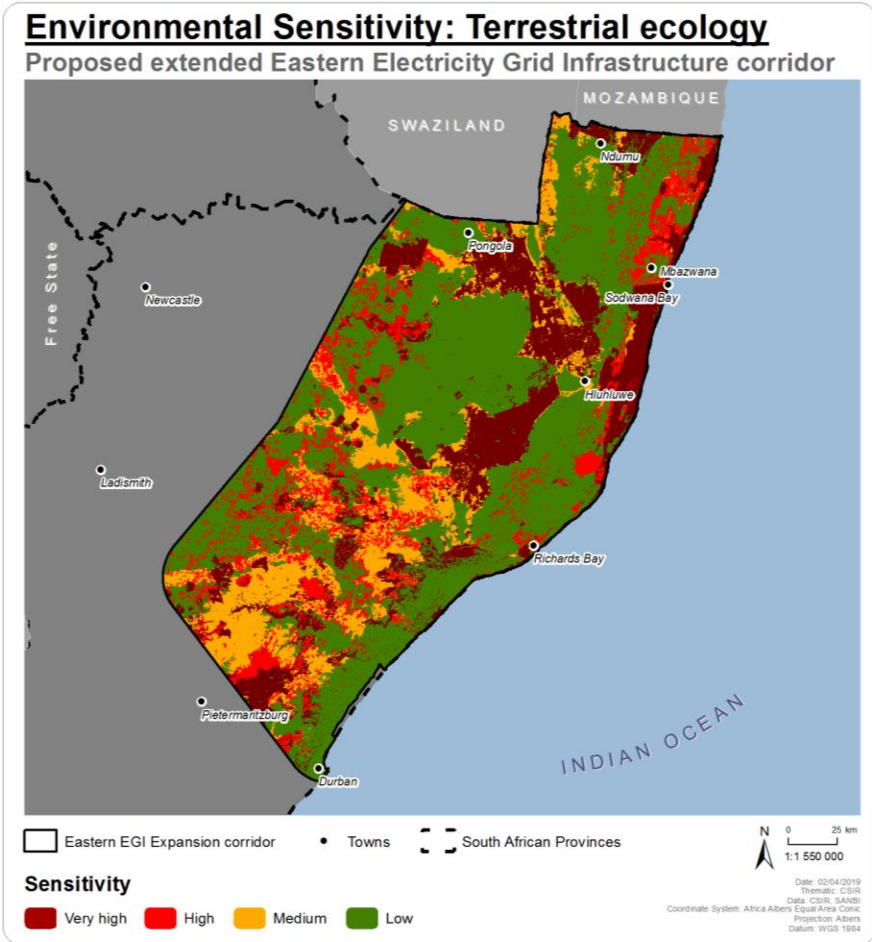



Figure 16: Environmental sensitivity of terrestrial ecosystems to proposed EGI development in the expanded Eastern EGI corridor.

#### *7.2.2.2 Birds*

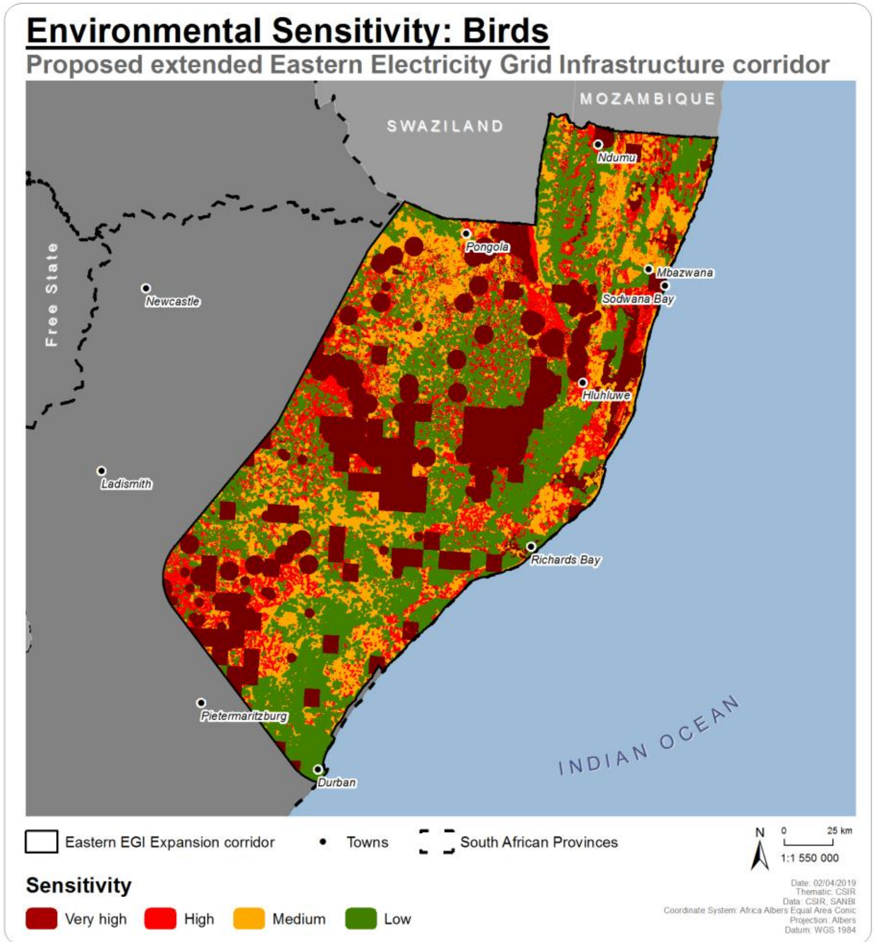



Figure 17: Sensitivity of birds to proposed EGI development in the expanded Eastern EGI corridor.

#### *7.2.2.3 Bats*

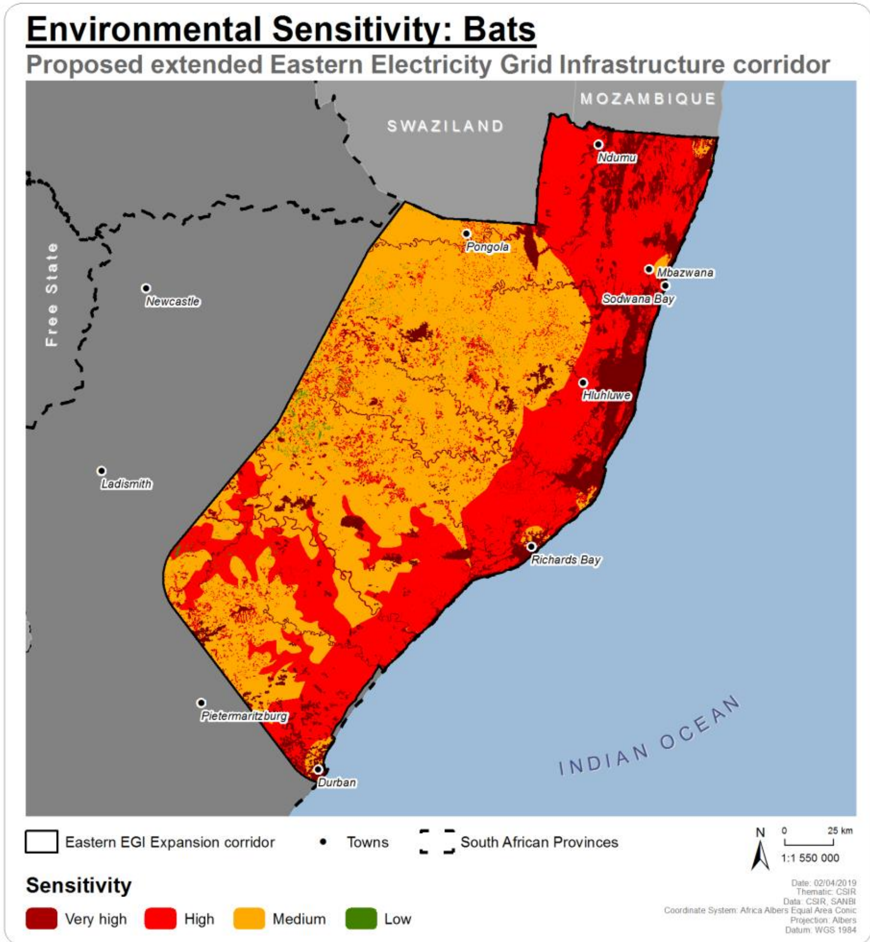



Figure 18: Sensitivity of bats to proposed EGI development in the expanded Eastern EGI corridor.

#### *7.2.2.4 Aquatic ecosystems*

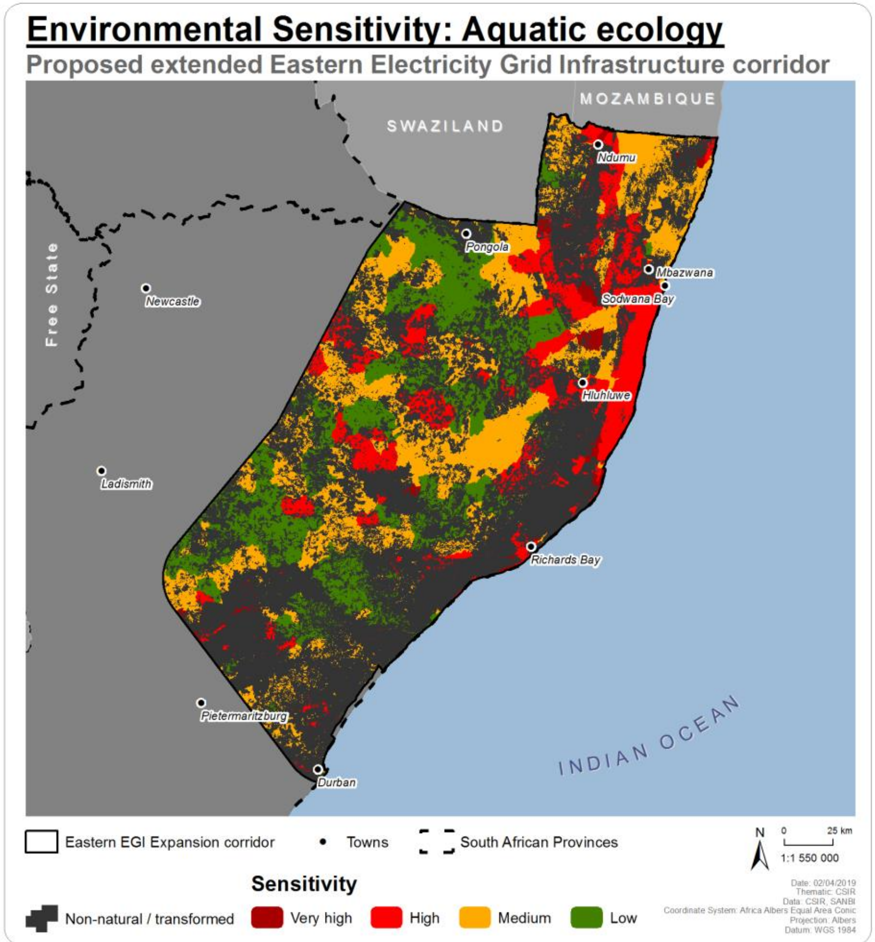



Figure 19: Environmental sensitivity per quinary catchment (overlaid with non-natural/transformed landcover) of aquatic ecosystems to proposed EGI development in the expanded Eastern EGI corridor.

#### *7.2.2.5 Estuarine ecosystems*

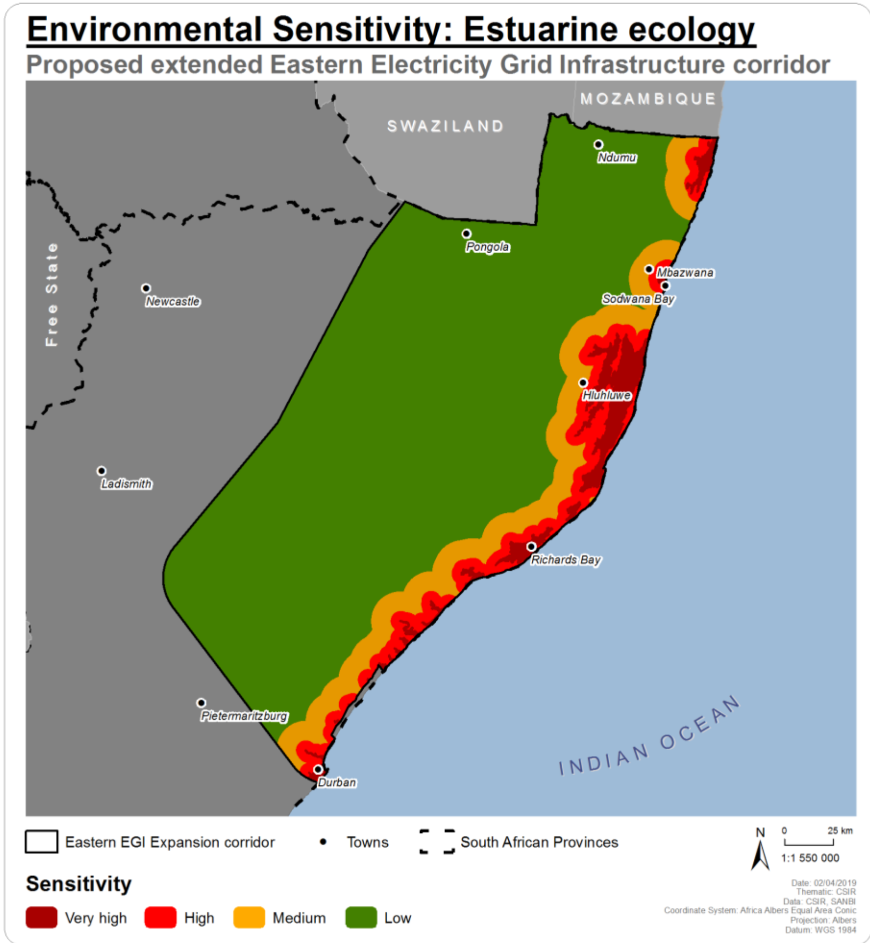



Figure 20: Environmental sensitivity of estuarine ecosystems to proposed EGI development in the expanded Eastern EGI corridor.

# 8 KEY POTENTIAL IMPACTS AND MITIGATION

The NEMA calls for the widely recognised mitigation hierarchy (avoid, mitigate/manage, rehabilitate, offset) (Figure 21) to be implemented to minimise or negate negative impacts, and maximise positive impacts of infrastructure development. Section 8 presents recommended mitigation measures for potential environmental impacts from EGI development.

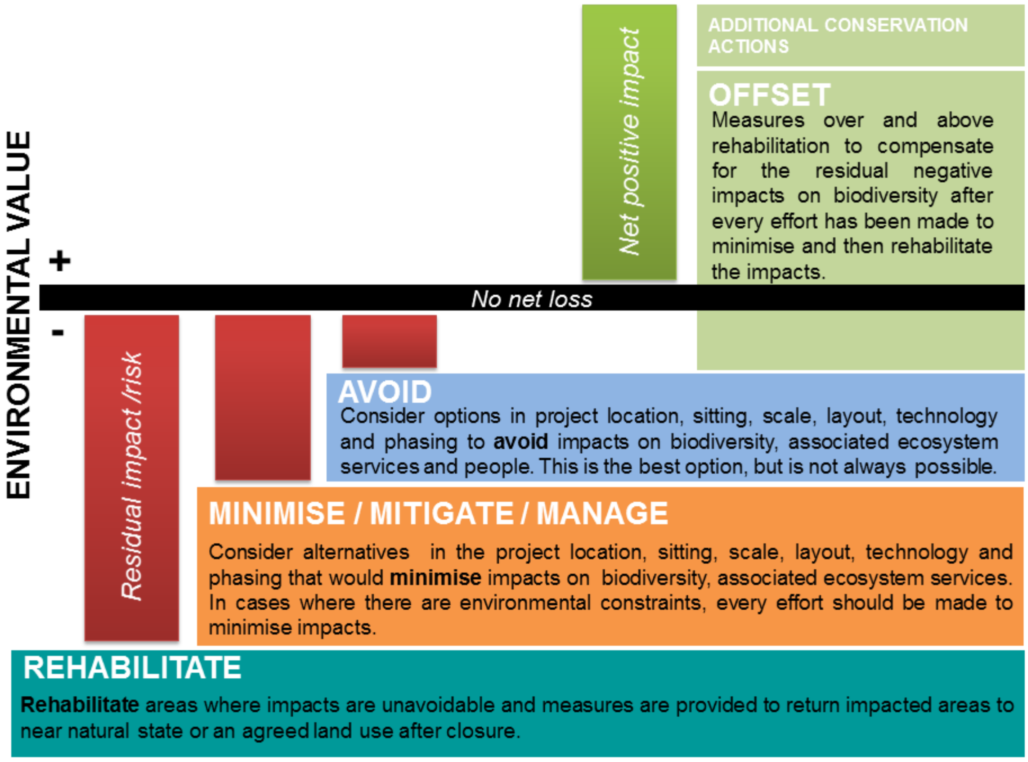



Figure 21: Implementation of the mitigation hierarchy is encouraged to ensure more sustainable and responsible development (after Rio Tinto, 2013).

## 8.1 Physical disturbance to soils, fauna and flora (Terrestrial Ecology and Species)

| Planning and pre-construction |
|---|

*AVOID*

- Use of **environmental sensitivity maps** and **least cost path analysis findings** in routing design;
- **Avoid**, as far as possible, **High and Very High sensitive areas (including areas of natural forest), which may also contain valuable species,** during the route planning;
- Areas with a high abundance of threatened ecosystems and species (High to Very High Sensitivity) should be avoided if possible.
- **Avoid**, as far as possible, **crossing key migration or movement corridors for fauna** during the route planning;
- **Avoid** any construction on **steep slopes** (>25 degrees);
- **Avoid areas of high erosion vulnerability** as far as possible; and
- **Route roads so they do not run directly up steep slopes, provide good drainage and erosion control, and re-vegetate bare soil.**

*MINIMISE / MITIGATE / MANAGE*

- Design to **use common/shared infrastructure** as far as possible with development in nodes, rather than sprawling development;
- All **access tracks must be built and maintained to appropriate environmental standards**;
- If areas with high abundance of threatened ecosystems cannot be avoided, then relocation of threatened species or some form of offset may provide some mitigation;
- **Design and install mammal and snake barriers or deterrents on pylons** in areas with high mammal and/or snake activity or High sensitivity; and
- **Undertake specialist assessments:**
    - Where avoidance is not possible, in areas of Medium to Very High sensitivity undertake specialist faunal and plant species assessments to propose site-specific mitigation or recommend alternatives prior to finalising the route; and
    - Undertake specialist surveys or inspections to establish/confirm whether threatened or endemic species are present in areas of lower sensitivity. If populations of threatened or endemic species are encountered and unavoidable then specialist inputs should be obtained.

| Construction |
| --- |

*AVOID*

- **Avoid the roosts nests, burrows, and movement corridors of sensitive faunal species** (e.g. porcupines, aardvarks) and **establish sensitivity buffers** where they are in the vicinity;
- **Avoid** construction activities in the **breeding and/or migration seasons** of threatened and important taxa;
- **Avoid unnecessary vegetation clearing**;
- **Prohibit collection of 'fuel wood'** on site;
- **Prohibit poaching of animals, or illegal collection of rare species**. All instances of illegal collection should be reported to the applicable provincial Nature Conservation Authorities; and
- **No dogs or other pets** should be allowed on site.

*MINIMISE / MITIGATE / MANAGE*

- **Undertake construction activities in short phased stretches** and continuously rehabilitate as sections are complete;
- **Minimise the development footprint and physical extent**;
- **Clearly demarcate the construction footprint;**
- **Keep the duration of the activities on-site to a minimum** - complete them in as short a time as possible;
- **Construction activities should take place outside of peak rain seasons** as much as possible;
- **Develop community environmental education programs** to ensure that all staff understand that no plants and animals may be intentionally harmed, killed, poached, or collected. Also **monitor staff behaviour** and **sanction transgressions**;
- **Plant rescue of small tree specimens may be undertaken** (with necessary approvals in place as required) and transferred to outside of the servitude;
- **Specialist inspection (walk through) of proposed micro-sited route and pylon foundation to be conducted prior to clearing of vegetation and breaking of ground** to **ensure no animal burrows, nests, and roosts are harmed**. Rescue and release less mobile species such as snakes, frogs, reptiles, invertebrates and certain burrowing mammals that are found prior to construction. No animals should be intentionally harmed or killed for any purpose;
- **Flushing or active capture and removal of key faunal species** from the working area;
- If roads or structures are fenced, **use fencing that allows safe animal movement** through fences;
- **Electrical fences**, if installed, should be erected **at least 30 cm from the ground** or according to relevant the norms and standards of the Nature Conservation Authorities;
- **Equip deep open trenches at pylon foundation sites with suitable ramps, ladders or steps** so that trapped animals can escape;

- **In areas where there is high animal activity, fine-mesh fences should be laid out around the open section** and secured to minimise the likelihood that animals will fall in;
- Do **daily patrols to rescue trapped animals**;
- **Ensure that rare and endangered species are not buried** under the temporary soil dumps**;**
- **Use plant rescue to remove and relocate rare plants** in construction footprint;
- **Control dust** to minimise impacts by regulating vehicle speeds and using geotextiles, particularly on soil dumps;
- **Control soil erosion and sediments in runoff leading to rivers and wetlands** through appropriate drainage and erosion control structures to minimise impacts on rivers and wetlands (e.g. barriers, geotextiles, active rehabilitation);
- **Where the EGI cuts through unstable soils** (e.g. sodic soils) ensure that adequate interventions are taken to prevent erosion and piping;
- **Take care where the EGI crosses dynamic swelling and contracting soils** (e.g. vertic soils) ensure that soil movement does not cause damage to the EGI resulting in further secondary environmental damage;
- **Limit vehicle speeds** to minimise potential collisions with animals and dust creation;
- **Limit night driving**;
- **Use existing roads** as far as possible for access;
- Provide new **roads with run-off structures**; and
- **Prevent fuel or oil leaks and make provision to contain them** (e.g. in drip trays) to reduce risk of contamination of surrounding soil and water.

| Operations and maintenance |
|---|

*MINIMISE / MITIGATE / MANAGE*

- **Limit vehicle speeds** to minimise potential collisions with animals and dust creation; and
- **Surveillance and monitoring of potential poaching and illegal species collection** (e.g. snares, debarking, hunting);

| Post-construction and rehabilitation |
|---|

*REHABILITATE*

- **Return the area to as near natural a state as possible**, with natural processes such as fire being retained;
- **Maintain top soil for later rehabilitation;**
- **Replace soil in the sequence it was extracted** – this should be carried **out within a month of excavation.** This not only limits changes in the soil, but ensures that the exposed area of trenches dug for infrastructure foundations, a potential trap for animals, is minimised;
- **Retain rootstock of existing vegetation** where possible[2];
- **Rehabilitate using locally indigenous plant species.** Where feasible translocate savage plants. Where not feasible use a seed mix that includes both annuals and perennials;
- **Stabilise all slopes and embankments**;
- **Re-establish ecological connectivity** where fragmentation of key habitats has occurred using landscape design methods (e.g. over and under pass wildlife bridges); and
- **Develop an Open Space Management Plan**, which makes provision for favourable management of the infrastructure and the surrounding area for fauna.

[2] Savanna trees, particularly, have an incredible ability to sprout from felled trees and hence can re-colonise the area much faster than new seedlings.

## 8.2 Establishment and spread of Invasive Alien Plants

| Planning and pre-construction |
|---|

*AVOID*

- **Incorporate, and budget for, control of invasive species** in environmental management plans for the construction, operation and decommissioning phases of the EGI;
- **Identify and map IAPs** along and within the planned route prior to construction;
- **Prepare systematic and properly costed plans for invasive species control** for sections of the proposed route; and
- **Carry out initial control measures prior to the construction.**

| Construction |
|---|

*AVOID*

- **Avoid unnecessary disturbance** of plant cover and topsoil;
- **Do not use soil sources contaminated with IAP seeds** for construction work.

*MINISMISE / MITIGATE / MANAGE*

- **Environmental education programmes on IAPs** for staff to assist in the identification of existing and potential invasive species that may affect the servitude;
- **Use existing roads** as far as possible for access;
- **Ensure that machinery is properly cleaned** before being brought onto site and also before moving it onto the pylon site both when initially brought into the area and when moved between vegetation types, as well as before moving it from a section of the route where invading species were controlled to a section that is free of invading species. Keep vehicle and machinery movement to a single route to reduce the extent of the impact;
- **Any materials that may include alien species propagules must be obtained from sources known to be free of listed alien species** (e.g. only source sand from a quarry certified to be alien species free);
- **Minimise imports of materials that could contain propagules of invasive species**, particularly plants and/or screening such materials to ensure they are propagule free;
- **Remove IAPs before they set seed** on or in vicinity of construction site**;**
- **Dispose of all the cut plant material from site** immediately using carefully considered and suitable methods that are in compliance with relevant legislation and based on consultation with experts, as required.

| Operations and maintenance |
|---|

*MINIMISE / MITIGATE / MANAGE*

- **Develop and implement an Alien Invasive Species Management Plan**, which makes provision for regular inspections (particularly at the pylon sites and access roads), alien clearing and monitoring.
- **Carry out regular surveys to identify invading species**; where they are found, carry out the necessary control operations;
- **Regular** (at least bi-annual) **IAP control** using the most appropriate and specific measures to control exotic species that have established (e.g. herbicides, fire, manual removal);
- **Ensure that appropriate follow-up operations are continued until the invading species are effectively under control;**
- **If and when the EGI is replaced then follow the same procedures as for the construction**;
- **Avoid off road driving;** and
- **Keep all livestock out of rehabilitated areas**;

**Post-construction and rehabilitation**

*REHABILITATE*

- **Ensure that appropriate follow-up operations are continued until the invading species are effectively under control;**
- **Avoid off road driving.**

### 8.3 Ecosystem alteration and loss

**Planning and pre-construction**

*AVOID*

- **Avoid CBAs** as far as possible;
- **Avoid impact to restricted and specialised habitats** such as cliffs, large rocky outcrops, quartz, pebble patches and rock sheets;
- **Use environmental sensitivity maps and least cost analyses in routing design**;
- Design and layout of infrastructure to **avoid**, as far as possible **highly sensitivity areas**;
- **Conduct ground assessments** and verification before construction;
- **Design to use as much common/shared infrastructure** as possible with development in nodes, rather than spread out; and
- **Avoid**, as far as possible, construction on **steep slopes** (> 25 degrees).

**Construction**

*MINIMISE / MITIGATE / MANAGE*

- **Minimise construction in ESAs** as far as possible;
- **Locate temporary-use areas such as construction camps and lay-down areas in previously disturbed areas** as far as possible;
- **Ensure proper design and planning for demolition activities**, with an emphasis on using delayed explosion methods, if and where blasting is required;
- **Minimise blasting operations to mid-day**, if and where blasting is required;
- **Obtain expert inputs on appropriate rehabilitation techniques and species choices** to ensure that ecosystem structure and function recover;
- **Rapidly rehabilitate** the area to pre-construction conditions where possible;
- **Replace top soil (seed bearing soil) as soon as possible**;
- **Control dust** to minimise impacts by regulating vehicle speeds and using geotextiles, particularly on soil dumps; and
- **Ensure proper runoff management and erosion control**, especially on steeper slopes.

**Operations and maintenance**

- **Control dust** to minimise impacts by regulating vehicle speeds and using geotextiles, particularly on soil dumps.

**Post-construction and rehabilitation**

- **Obtain expert inputs on appropriate rehabilitation techniques and species choices** to ensure that ecosystem structure and function recover;
- **Rapidly rehabilitate** the area to pre-construction conditions where possible
- **Replace top soil (seed bearing soil) as soon as possible**;
- **Planting of plant stock and reseeding should be timed to maximise the likelihood of successful recruitment** (e.g. do not revegetate after the end of spring);

- **All plant stock and seed must be from local populations,** whenever possible avoid introduction of non-local genetic material;
- **Use material from that section of the route in its rehabilitation** or, where this is not feasible, **from a source community matched as closely as possible**, excluding Very High sensitivity areas; and
- Wherever there is an evident change in the vegetation or community (i.e. between two neighbouring vegetation communities / types), **keep the rehabilitation material for each community's section separate to minimise introduction of non-local genetic stock.**

Box 13: Environmental Offsets

"Environmental / Biodiversity Offsets" are often promoted as a means of redressing the apparent disturbance or "loss" of natural habitat or systems. The benefit and success of offsets has yet to be proven (Bull et al., 2013) and is a debatable topic.

Offsets should not be considered as a first management/mitigation option, and should be avoided unless absolutely necessary.

Calculating, identifying and successfully establishing a suitable offset can be a complex and costly undertaking with no guarantee of success. Other forms of Offsets are also considered by various authorities, including financial contributions and stewardship programmes or partnerships with conservation authorities. Given the strategic importance of the proposed EGI, the latter option may be the most practical offset strategy, if the offset approach is adopted.

## 8.4 Impacts to birds

The key potential impacts to avifauna are: 1) Mortality of power line sensitive Red Data species through collisions; 2) Mortality of power line sensitive Red Data species through electrocutions; and 3) Displacement of Red Data species due to habitat destruction and disturbance. These impacts pose specific risks to various sensitivity Red Data avifauna species, the effects of which can manifest as multiple casualties that destabilise populations and result in negative population growth (Shaw, 2013). The species-specific risks and recommended mitigation actions are presented in Table 24 (proposed Expanded Western EGI corridor) and Table 25 (proposed Expanded Eastern EGI corridor).

Table 24: Mortality and displacement of specific Red Data bird species in the proposed Expanded Western EGI corridor, and recommended mitigation measures.

| Species-specific Risk | Mitigation |
|---|---|
| **Greater Flamingo** collisions at waterbodies. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with nocturnal light emitting diode (LED) mitigation devices. |
| **Kori Bustard** collisions in the Nama and Succulent Karoo. | Mark power lines with Bird Flight Diverters (BFDs). |
| **Black Stork** collisions and displacement at waterbodies, drainage lines and cliffs. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies and across drainage lines with BFDs. Search suitable cliffs for nest sites and buffer nests by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the Environmental Control Officer (ECO). An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain, if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Blue Crane** collisions at cultivated commercial fields and waterbodies. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with nocturnal LED mitigation devices. Buffer all nests by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Great White Pelican** collisions at waterbodies and along the coast | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with BFD. |
| **Lesser Flamingo** collisions at waterbodies and along the coast. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with nocturnal LED mitigation devices. |

| Species-specific Risk | Mitigation |
|---|---|
| **Ludwig's Bustard** collisions in the Nama and Succulent Karoo. | Mark power lines with BFDs. |
| **Martial Eagl**e electrocutions and displacement of breeding birds on transmission lines in the Nama and Succulent Karoo. | Use only bird-friendly power line designs. Investigate all suitable transmission and sub-transmission lines (≤66kV) for nests and buffer by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Secretary Bird** collisions in the Nama and Succulent Karoo. | Mark power lines with BFDs |
| **Verreaux's Eagle** electrocutions, collisions and displacement of breeding birds at cliff sites throughout the corridor. | Use only bird-friendly power line designs. Investigate all suitable cliff sites for nests and buffer by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Caspian Tern** collision at large waterbodies throughout the corridor. | Mark power lines with BFDs. |

Table 25: Mortality and displacement of specific Red Data bird species in the proposed Expanded Eastern EGI corridor, and recommended mitigation measures.

| Species-specific Risks | Mitigation |
| --- | --- |
| **African Marsh-harrier** collisions throughout the corridor. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines with Bird Flight Diverters (BFDs). |
| **Southern Ground Hornbill** collisions, electrocutions and displacement throughout the corridor. | Use only bird-friendly power line designs. Buffer all nests by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Black Stork** collisions and displacement at waterbodies, cliffs and drainage lines throughout the corridor. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies and across drainage lines with BFDs. Search cliff areas for nest sites and buffer these by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Blue Crane** collisions and disturbance of breeding birds in grassland and wetland areas in Grassland. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with nocturnal LED mitigation devices. Buffer nest sites by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Cape Vulture** electrocutions, disturbance at breeding colonies and roosts throughout the corridor. Collisions and electrocutions at vulture restaurants. | Use only bird-friendly designs. Buffer breeding colonies and vulture restaurants by 5 km. Should the full extent of the buffering at vulture restaurants and breeding colonies not be practically possible, the areas must be thoroughly investigated by an avifaunal specialist and those power lines that could pose a collision threat to vultures must be identified and marked with BFDs. In addition, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |

| Species-specific Risks | Mitigation |
|---|---|
| **Denham's Bustard** collisions in grassland areas throughout the corridor. | Mark power lines with BFDs |
| **Great White Pelican** and **Pink-backed Pelican** collisions and displacement at waterbodies in Indian Ocean Coastal Belt. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies BFDs. |
| **Greater and Lesser Flamingo** collisions at waterbodies throughout the corridor. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with nocturnal LED mitigation devices. |
| **Grey Crowned Crane** collisions at wetlands and cultivated commercial fields in Grassland and Indian Ocean Coastal Belt. Displacement of breeding birds in wetlands in Grassland and Indian Ocean Coastal Belt. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with nocturnal LED mitigation devices. Buffer all nests by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Secretary Bird** collisions throughout the corridor except Indian Ocean Coastal Belt. | Mark power lines with BFDs |
| **Verreaux's Eagle** electrocutions, collisions and displacement of breeding birds at cliff sites. | Use only bird-friendly power line designs. Investigate all suitable cliff sites for nests and buffer by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Wattled Crane** collisions and displacement at wetlands in Grassland. | Avoid routing power lines within 500 m of the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with nocturnal LED mitigation devices. Buffer all nests by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Southern Bald Ibis** collision and displacement at cliffs in Grassland. | Investigate all suitable cliff sites for nests and buffer all nests by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule |

| Species-specific Risks | Mitigation |
|---|---|
| | which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Blue Swallow** displacement due to habitat destruction in the KwaZulu – Natal mistbelt in the Grassland biome. | Buffer all known Blue Swallow breeding habitat by 2.5 km. Should the full extent of the buffering not be practically possible, a thorough investigation must be conducted by a suitably experienced avifaunal specialist with experience of Blue Swallows to identify any potential nesting holes, which must then be appropriately buffered, in consultation with EKZN Wildlife and BLSA to prevent destruction of the nest holes. |
| Displacement due to disturbance and habitat destruction at nest localities of **Bateleur, Lappet-faced Vulture, Marabou Stork, Martial Eagle, Secretarybird, Tawny Eagle, Southern, White-backed Vulture, Hooded Vulture** and **White-headed Vulture** in Savannah, **African Crowned Eagle** and **Banded Snake-Eagle** in Forest, and **Pel's Fishing Owl** at rivers and waterbodies in the northern part of the corridor. | Buffer all nests by 2.5 km. Should the full extent of the buffering not be practically possible it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the ECO. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain if, when and where breeding birds could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle. |
| **Saddle-billed Stork** and **Yellow-billed Stork** collisions at waterbodies in Savanna. | Avoid routing power lines within 500 m from the edge of waterbodies found to be suitable for the species, and if unavoidable, mark power lines at waterbodies with BFDs |

1

## 8.5 Potential impacts to bats

Table 26 presents mitigation measures for potential impacts from EGI development to bats.

Table 26: Potential impacts from EGI development to bats, and recommended mitigation actions.

| Key Impact | Mitigation |
|---|---|
| Displacement and disturbance | Avoidance of verified high and very high bat sensitivity areas where possible. Particular attention in the bat impact assessments and specialist opinions should be given to species of conservation importance as per Sections 6.1.6 and 6.2.5. If development does take place in areas of High or Very High sensitivity, a bat specialist must be appointed to undertake site visits to recommend micro-siting measures, and advise on the least harmful time in terms of the breeding season of the relevant bats in the area. |
| Electrocution | Avoidance of verified high and very high bat sensitivity areas where possible. Particular attention in the bat impact assessments and specialist opinions should be given to fruit bats and large insectivorous bats. |
| Electromagnetic interference | Avoidance of verified high and very high bat sensitivity areas where possible. The bat impact assessments and specialist opinions should conduct a desktop review on any possible new developments in this area of research. |

## 8.6 Degradation, fragmentation and loss of aquatic ecosystems and species

| Planning and pre-construction |
|---|

***AVOID***

- Power line routing and siting of other EGI to **avoid catchments with a very high sensitivity** as far as possible, and try to avoid catchments with a medium to high sensitivity.
- **Avoid clearing of sensitive indigenous vegetation** including **estuarine vegetation and associated coastal freshwater riparian vegetation,** as far as possible.
- **Avoid EFZs** (very high sensitivity), and, if possible, other areas of high sensitivity.
- **Avoid road crossings and servitude clearance through wetlands, rivers and estuaries by using existing road networks and crossings,** and avoid and/or minimise these activities in associated coastal wetlands and rivers within 5 km of EFZ.
- **Excavations and construction of borrow pits for road construction should be located outside of the recommended buffer areas around wetlands and watercourses** and should be rehabilitated following construction. Pits or excavations should be checked regularly by the on-site ECO and plans put in place for species rescue and relocation.
- **As far as possible heavy machinery should not be operated in wetlands / water course and their associated buffers.** If this is unavoidable then all operations should be managed by an on-site ECO, with further screening/groundtruthing assessments conducted on an ad-hoc basis. Relocation of sensitive flora and fauna may be required prior to operation.
- **Ensure that a Water Use License (WUL) is undertaken where developments will occur within 500 metres of a wetland or 100 metres from a river** to authorise certain activities as per Section 21 of the National Water Act (Act 36 of 1998).

**MINIMISE / MITIGATE / MANAGE**

- Where highly sensitivity catchments area unavoidable, placement of pylons and EGI within these catchments (as well as catchments with a low sensitivity) should as far as possible **avoid freshwater ecosystems,** or areas of these systems that are deemed to be sensitive or of concern **and associated buffers**, which should be determined during route screening, validation and walk-throughs.
- Minimise the number of watercourse crossings for access roads.
- **Where road crossings through wetlands, rivers, and rivers flowing into estuaries, cannot be avoided or minimised**:

- **Ensure that appropriate crossings are designed and constructed to minimise impacts**, as well as to ensure connectivity and avoid fragmentation of ecosystems, especially where systems are linked to a river channel.
- **Designs** to consider use of riprap, gabion mattresses, with pipe crossings or culverts. The concentration of flow (particularly during high flow conditions) should be minimised as far as possible.

- **Bank stabilisation measures** (gabions, eco logs, geofabric, sediment fences) are required when wetland or watercourse banks steeper than 1:5 are denuded during construction.
- **Minimise disturbance to surrounding vegetation** as possible when construction activities are undertaken, as intact vegetation adjacent to construction areas will assist in the control of sediment dispersal from exposed areas.
- **Implement dust suppression methods** (e.g. spraying surfaces with water) to minimise the transport of wind-blown dust.
- **A mitigation option for potential vegetation clearing/trimming impacts includes constructing taller pylons in certain areas** that are high enough to allow for the growth of relatively tall vegetation.

| Construction |
| --- |

*AVOID*

- **All wetlands, watercourses and estuaries (as well as their associated inflowing coastal wetlands and rivers) should generally be** avoided (as far as possible) and appropriately demarcated as no-go areas.
  - No vehicles, machinery, personnel, construction materials, cement, fuel, oil or waste should be allowed into these demarcated areas without the express permission of and supervision by an on-site Environmental Control Officer (ECO);
- **Prohibit fishing or hunting** by personnel in the proximity of aquatic habitats.

*MINIMISE / MITIGATE / MANAGE*

- **Construction camps, ablution facilities, and temporary laydown areas should be located outside of the recommended buffer areas around wetlands and watercourses** and should be rehabilitated following construction;
- **Trenches/excavations should be backfilled and rehabilitated immediately after the necessary infrastructure have been installed**;
- **Open, deep trenches/excavations for infrastructure foundations should be inspected daily** by an ECO:
  - **Implement plans to rescue any vertebrate fauna that have become trapped within a trench/excavation.**
  - **Use low fences that will prevent fauna from entering areas where dug trenches are required**, especially in situations where trenches/excavations remain open for longer periods of time (i.e. a few weeks to several months).
- **All construction activities** (including establishment of construction camps, temporary lay-down areas, construction of haul roads and operation of heavy machinery), associated with wetlands and rivers should ideally **take place during the dry season** to reduce potential impacts to coastal freshwater ecosystems, downstream estuaries, and freshwater ecosystems that are linked to rainfall-runoff;
- **Workers should be made aware** of the importance of not destroying or damaging the vegetation along and in watercourses, wetlands and estuaries of not undertaking activities that could result in the pollution aquatic systems, and of not killing or harming any animals that they encounter. This awareness should be promoted throughout the construction phase and can be assisted through erecting appropriate signage; and
- **Fixed point photography to monitor vegetation changes and potential site impacts** occurring during construction phase

**Operations and maintenance**

*MINIMISE / MITIGATE / MANAGE*

- **Roads/crossings not needed after the construction process should be decommissioned and rehabilitated** in accordance with detailed rehabilitation plans.
- **Minimise the amount of lighting at substations and switching stations by installing low intensity lights** that are directed exclusively to the areas where night-time lighting is required.

**Post-construction and rehabilitation**

*REHABILITATE*

- **Plan appropriate rehabilitation procedures/measures**;
- **Fixed point photography could be used to monitor** long-term vegetation changes and potential site impacts;
- **Active removal of alien vegetation/spraying to be guided by an IAP control programme** with long term monitoring; and
- **Implement continuous erosion control.**

## 8.7 Altered hydrology

**Planning and pre-construction**

*AVOID*

- **Use existing road networks and river crossings**, as far as possible:
  - Where this is not possible, **avoid and/or minimise road crossings through wetlands and rivers as far as possible**;
- **Avoid EFZs** (very high sensitivity), and, if possible, other areas of high sensitivity;
- **Avoid road crossings and servitude clearance through estuaries** and avoid and/or minimise these activities in associated coastal wetlands and rivers within 5 km of EFZ; and
- **Avoid clearing of estuarine vegetation and riparian vegetation.**

*MINIMISE / MITIGATE / MANAGE*

- **Minimise the number of watercourse crossings** for access roads;
- **Ensure adequate watercourse crossings** (i.e. culverts of the correct specification) are designed where roads traverse these areas so that the concentration of flow (particularly during high flow conditions) is minimised as far as possible;
- **Employ river/wetland bank stabilisation measures** (gabions, eco logs, geofabric, sediment fences or similar adequate measures) are required when wetland or watercourse banks steeper than 1:5 are denuded during construction. Appropriate rehabilitation procedures/measures should be planned; and
- **Suppress dust** (e.g. spraying surfaces with water obtained from a suitable, licenced/approved source) to minimise the transport of wind-blown dust into aquatic systems.

Box 14: Rehabilitation of estuarine ecosystems.

While extent and duration of disturbances from the construction of the EGI may not be very substantial, the restoration of altered habitat and recovery of invertebrate, fish and bird population can be prolonged (and is not assured). This depends on the overall complexity and health of the systems (Yu et al., 2010). There are no examples in South Africa of successful estuarine restoration following largescale degradation as has occurred in systems such as Nhlabane, Mhlanga, and St Lucia in KwaZulu-Natal. In most cases it has only been possible to restore a degree of functionality as reflected by the overall low estuarine health score.

## 8.8 Water quality deterioration

| Planning and pre-construction |
| --- |

*AVOID*

- **Use existing road networks and river crossings**, as far as possible:
  - Where this is not possible, **avoid and/or minimise road crossings through wetlands and rivers as far as possible**; and
- **Avoid construction activities within estuaries** (i.e. EFZ).
- **Stockpiling and washing areas should be clearly demarcated and sign posted.** These areas should be **set back outside of the buffer zone of freshwater ecosystems** - 30 m of the edge of any wetlands or drainage lines/rivers.
- **No vehicles, machinery, personnel, construction material, cement, fuel, soap/detergents, oil or waste should be allowed outside of the demarcated stockpiling/washing areas.**

*MINIMISE / MITIGATE / MANGE*

- **Minimise the number of watercourse crossings** for access roads; and
- **Ensure adequate watercourse crossings** (i.e. culverts of the correct specification) are designed where roads traverse these areas so that the concentration of flow (particularly during high flow conditions) is minimised as far as possible.

| Construction |
| --- |

*AVOID*

- **No washing of vehicles and machinery within 30 metres** of the edge of any wetland or watercourse; and
- **No fuel storage, refuelling, vehicle maintenance or vehicle depots should be allowed within 30 metres** of the edge of any wetlands, rivers or drainage lines.
- **No effluents or polluted water should be discharged** directly into any watercourse, wetland, or estuary areas;
- **No spoil material, including stripped topsoil, should be temporarily stockpiled within 30 m of the edge of any wetland, watercourse, drainage line or estuary**:
  - Freshwater ecosystems located in close proximity to construction areas (i.e. within ~30 m) should be inspected on a regular basis by the ECO for signs of disturbance from construction activities, and for signs of sedimentation or pollution. If signs of disturbance, sedimentation or pollution are noted, immediate action should be taken to remedy the situation and, if necessary, a freshwater ecologist should be consulted for advice on the most suitable remediation measures.

*MINIMISE / MITIGATE / MANAGE*

- **Restrict construction activities** associated with the establishment of access roads through wetlands, watercourses and estuaries (if unavoidable) **to a working area of ten metres in width either side of the road**:
  - **Clearly demarcate these working areas**;
  - **No vehicles, machinery, personnel, construction material, cement, fuel, oil or waste should be allowed outside of the demarcated working areas.**
- **Refuelling and fuel storage areas, and areas used for the servicing or parking of vehicles and machinery, should be located on impervious bases** and should have bunds around them. Bunds should be sufficiently high to ensure that all the fuel kept in the area will be captured in the event of a major spillage; and
- **If construction areas are to be pumped of water (e.g. after rainfall), this water should be pumped into an appropriate settlement area**, and not allowed to flow straight into any watercourses or wetland areas.

| Operations and maintenance |
|---|

*AVOID*

- **Avoid the use of herbicides within 50 m** of wetlands, rivers or EFZs, and within 10 km of EFZ of inflowing coastal wetlands/ rivers.

# 9 BEST PRACTICE GUIDELINES AND MONITORING REQUIREMENTS

In addition to the mitigation and management actions recommended in Section 8, the following key best practice guidelines and monitoring requirement recommendations, again following the mitigation hierarchy (refer to Figure 21), need to be taken into account.

## 9.1 Terrestrial ecosystems

### 9.1.1 Planning and pre-construction

Avoidance of areas of very high sensitivity, and as far as possible avoiding areas of high sensitivity, has the potential to greatly reduce impacts on terrestrial and aquatic ecosystems and associated fauna and flora.

- The following areas should be avoided as far as possible:
  - Areas of critical biodiversity or conservation importance;
  - Steep slopes where erosion may be more prevalent and inhibit rehabilitation success;
  - Areas with protected tree species and other threatened species.
- Plan power line routes to follow, as far as possible, existing disturbance corridors.
- Develop robust pre-construction environmental baseline, including identified indicator species as reference for monitoring;
- Planning stage avoidance of high-threat status ecosystems, as well as fauna and flora species populations of conservation concern is required.
  - In many areas, the known EoO / distribution range of Species of Conservation Concern (SCC) are not well known and as such, the planning phase should make provision for flexibility in determining the final EGI alignment to avoid locally sensitive features and populations of SCC.
  - Should sections of the planned EGI route transect the known EoO / distribution of an SCC, a taxon-specific specialist should be appointed to confirm the sensitivity and assess the significance of potential impacts on that SCC.
  - The project level assessment process must prove to the relevant competent authority that the proposed development will not have an unacceptable negative impact on SCC populations, both locally and regionally.
  - Any identified impacts should be avoided or mitigated. All mitigation measures from the specialist study to be incorporated into the EMPr. A South African Council for Natural Scientific Professions (SACNASP) accredited botanist and zoologist must conduct the impact assessment in accordance with the NEMA regulations.
- The final power line routing and placement of substations and other ancillary infrastructure should be checked in the field by the appropriate accredited specialists and at the appropriate time of year. In the winter rainfall areas, all fieldwork for flora should take place from late July through to mid-September depending on the exact timing of rainfall. In the summer rainfall areas, fieldwork should take place following good rainfall and growth of the vegetation. In most areas this is usually late summer to early autumn (February to April).
- Plan the route to avoid threatened species occurrences and populations where these are found. Where this is not possible, obtain appropriate permits for special and threatened species where they will be disturbed or displaced. Plan for re-location where necessary.
- Little is known about the seasonality of animal movements but minimise disturbances in the spring which is likely to be the breeding season; movements are most likely in spring and autumn.

- Consider seasonal timing – winter will likely be best to avoid breeding seasons when appropriate. Spring and autumn are typically most likely for seasonal migrations and if migrations are an issue should be avoided.
- Convene an expert workshop to discuss and debate the best options and propose methods for rehabilitation, including experiments that should be carried out and monitored, and obtain their recommendations on monitoring and evaluating the effectiveness of the rehabilitation in terms of ecosystem biodiversity, structure and function for areas with different sensitivities. The outputs of this workshop should be incorporated into the EMPr.
- Plan access track (service road) routes and pylon locations to minimise risks of erosion through routing and effective drainage measures.
- Pre-construction walk-through and on-site assessment by a SACNASP accredited botanist and zoologist of the final EGI route is mandatory to identify any features that should be avoided or buffered from impact, and to identify and locate any plant and animal SCC that should be subject to search and rescue prior to construction.
- Where high sensitivity areas cannot be avoided and there is significant habitat loss in these areas, an offset study should be conducted to ascertain whether an offset is an appropriate mechanism to offset the impact on the high sensitivity area. This should include an identification of offset receiving areas as well as an estimate of the required extent of the offset and the degree to which the offset would be able to compensate for the assessed impacts.

### 9.1.2 Construction

- Limit disturbance footprint, and the associated duration of the disturbance.
- The construction operating corridor should be clearly delimited and demarcated with construction tape or similar markers to limit construction activity and disturbance to the EGI construction corridor.
- Helicopters should be used to string lines, especially where lines traverse high or very High sensitivity environments or rugged areas.
- When introducing material for rehabilitation, try to obtain it from local sources or at least from the same vegetation type.
- Carry out regular inspections to ensure that no alien species are becoming established, and eradicate those species populations that are detected.
- Temporary lay-down areas should be located within previously transformed areas or areas that have been identified as being of low sensitivity. These areas should be rehabilitated after use.
- Implement sound “housekeeping” of construction activities.
- Proper topsoil storage, for minimal timespans.
- Revegetate under pylons with species indigenous to the area. A mix of local grass species is best to rapidly establish ground cover and initiate ecological process.
- Minimise soil erosion and IAP establishment risk.
- Relocate threatened species based on expert advice.
- Construction activities should only occur in appropriate seasons (e.g. avoid breeding/migrating season of threatened fauna, avoid peak rain seasons).
- Limit the duration of open trenches.
- Regular checks of open trenches to rescue trapped animals.
- Ensure proper drainage so that roads do not initiate erosion.
- Environmental awareness of construction workers.
- Measures should be taken to prevent and limit poaching of fauna and harvesting of flora by construction crews or other people accessing the EGI route.
- All construction vehicles should adhere to a low speed limit (30km/h for trucks and 40km/h for light vehicles) to avoid collisions with susceptible species such as snakes and tortoises.
- All hazardous materials should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner as related to the nature of the spill.

- Appoint and involve an ECO to provide oversight and guidance to all construction activities, as well as ensure full consideration and implementation of the EMPr.
- Power line pylon footprints should be cordoned off during the construction phase and vegetation control and management around pylon footings should be undertaken during and immediately after the construction of pylons to prevent exotic weed invasion at these points.

### 9.1.3 Operations and maintenance

- Follow general vegetation- and access management measures.
- If the substations need to be lit at night for security purposes, this should be done with low-ultraviolet (UV) type lights (such as most Light Emitting Diodes (LEDs)), which do not attract insects.
- If any parts of power lines, substations, ancillary infrastructure, or any work area in the vicinity of EGI need to be fenced, then no electrified strands should be placed within 30 cm of the ground as some species such as tortoises are susceptible to electrocution from electric fences as they do not move away when electrocuted but rather adopt defensive behaviour and are killed by repeated shocks.
- All vehicles accessing the EGI should adhere to a low speed limit (30 km/h max) to avoid collisions with susceptible species such as snakes and tortoises.
- Oils, fuels and other hazardous materials required for machine and vehicle maintenance and repair are to be securely stored to prevent spill and contamination during operation and maintenance of EGI;
- Monitor vegetation recovery using photographic methods.
- The monitoring of “sensitive habitats” where power line pylons have been established either within or adjacent to such vegetation units, should be undertaken. Monitoring should include evaluation of change in adjacent habitat form and structure, as well as other more evident factors such as erosion and collapse related to the structures.
- Ongoing IAP and erosion management:
    - An annual check with follow-up rehabilitation and remediation should be sufficient in most areas. It is important to note that erosion can be severe in semi-arid environments due to the occasional occurrence of heavy showers and the lack of sufficient vegetation cover to protect the soil or slow runoff, with the result that occasional high-risk erosion events can cause large amounts of damage.
- Monitor the success of the rehabilitation measures and carry out remedial measures where necessary.
- The issue of maintaining fire regimes is problematic because fires appear to be very rare in these arid fynbos environments and little is known about the desired intervals between such fires. They are most likely to occur in summer. The best option is to ensure that records are kept of all fires and their causes so that information on the fire regimes in this arid fynbos can be accumulated, assessed and use to guide fire management decisions and actions.
- Ensure necessary precautions to prevent electric shock hazards by installing (i) barriers to prevent unauthorised climbing on transmission towers/pylons, and (ii) appropriate colour coding and warning signs on EGI facilities and structures.

### 9.1.4 Post-construction and rehabilitation

- Clear rehabilitation targets should be set for each area based on the background perennial vegetation cover.
- Follow best rehabilitation practices as recommended by the expert workshop and incorporated into the EMPr (this includes minimising the duration and extent of the disturbance).
- All species used in rehabilitation should be locally occurring, indigenous, perennial species. A mixture of different functional type species is recommended.
- No fertilizers or irrigation should be applied during rehabilitation as this is likely to lead to a green flush after rain and failure of perennial species to establish in competition with annuals and ephemerals.

- There should be annual monitoring and follow-up action on IAP occurrence and erosion.
- Undertake rehabilitation processes as soon as possible.

**Box 15: Environmental rehabilitation in arid areas.**

Arid areas, as found in the proposed Expanded Western EGI Corridor, are very difficult to rehabilitate with a variety of constraints limiting success. In most cases topsoil management is a key factor as the soils deeper down may have a very high pH, be salt- or metal-laden, be very nutrient poor or otherwise inhospitable to plant establishment. Furthermore, in most instances, the restoration of pre-construction levels of diversity is not a realistic goal and the rehabilitation should focus on the establishment of an ecologically functional cover of locally-occurring species to protect the soil and provide some cover for fauna.

A reasonable rehabilitation target for arid areas would be 60% of the vegetation cover of adjacent indigenous vegetation achieved after five years.

### 9.1.5 Monitoring requirements

- Populations of key fauna and flora SCC, of which the known EoO or distribution range was identified and confirmed by a SACNASP accredited botanist and zoologist during the planning (pre-construction) phase and which are being transected by planned power line routes, should be monitored throughout construction and operation to ensure that these SCC are not being poached or otherwise negatively impacted by the presence and operation of the EGI:
  - Monitoring frequency depends to some extent on the longevity of a specific species, but should also be informed by its threat status and the consequences of not identifying unacceptable negative impacts beforehand;
  - Any identified impacts should be avoided or mitigated. As such, the following basic monitoring schedule is proposed – Pre-construction, Post-construction and every 3-5 years during operation depending on the species.
- The successful establishment and persistence of plant species of high conservation concern translocated during the search and rescue should be monitored for at least five years after construction is completed. An appropriate frequency would be a year after translocation and every second year thereafter.
- Develop robust pre-construction environmental baseline, including identified indicator species as reference for monitoring;
- Biodiversity monitoring programme should consider:
  - Vegetation rehabilitation progress;
  - State of rare/endangered vegetation types within reasonable proximity to the infrastructure;
  - Overland flow patterns of water (runoff), sedimentation and erosion, especially on steep slopes and near watercourses.
- Conduct monitoring of terrestrial ecosystems in spring and autumn seasons.
- Monitoring of poaching/livestock theft/illegal plant collection along the line of the powerline, especially where it passes through private or public protected areas, especially during construction, but also during operation.
- Use of Geographic Information Systems, spatial data and aerial photography / satellite imagery is recommended as a key tool for long-term monitoring and management.

## 9.2 Birds

### 9.2.1 Planning and pre-construction

***Identification of technically feasible assessment corridor alternatives for assessment during the project specific assessment process.***

A suitably qualified avifaunal specialist should be appointed to conduct an avifaunal impact assessment study. The specialist should proceed as follows:

- The centre line of each assessment corridor must be determined.
- A 2 km buffer zone must be drawn around the centre line of each assessment corridor.
- The sum total area of each habitat sensitivity class in the assessment corridor must be calculated, based on the four-tier avifaunal sensitivity map.
- The procedure to follow for the avifaunal assessment of each assessment corridor alternative must be determined, based on the majority sensitivity class in the corridor.
- The specialist must make a recommendation on whether the power line may proceed or not, based on the anticipated impacts on Red Data avifauna, and must identify a preferred corridor which will have the least impact on Red Data avifauna, i.e. one which avoids Very High and High sensitive areas as much as possible.
- If the power line project may proceed, the specialist must describe suitable mitigation measures to be implemented, based on the type of impacts.

### 9.2.2 Construction

***Power line pylon pegging and servitude clearing***

If a feasible corridor alternative is identified and authorisation or similar is obtained to proceed with the project, the procedure is as follows:

- Once the pylon positions have been pegged, a walk-through should be conducted by a suitably qualified avifaunal specialist to identify all active Red Data nests in the servitude and immediately adjacent areas prior to the commencement of the servitude clearing. Due to the length of time between the authorisation (or similar) of the project and the commencement of construction activities, the nest surveys (if any) conducted during the planning phase will have to be repeated. This is usually only applicable in Very High and High sensitivity areas but depending on the circumstances of each project and the professional opinion of the specialist, this may have to be extended to Medium and Low sensitivity areas as well. The width of the corridor to be surveyed will be determined by the species which are likely to breed there.
- Should such a nest be discovered, the avifaunal specialist should be provided with a work schedule which will enable him/her to ascertain, if, when and where the breeding birds could be impacted by the clearing activities.
- During the walk-through, the specialist must also identify sections of line to be marked with Bird Flight Diverters (BFDs).

***Pylon foundation construction and power line stringing***

- If it has been established during the walk-through that a breeding pair of Red Data species could be displaced, appropriate management measures would need to be implemented, the nature of which will depend on the Red Data conservation status of the species and the location of the nest. Each case will have to be dealt with on an ad hoc basis but could include the following:
    - The eggs and/or chicks must be removed to a rehabilitation facility if the nest will be destroyed.
    - Construction activities must be timed to avoid the disturbance of the breeding birds during critical phases of the breeding cycle.
    - Activities must be restricted to the servitude width.
    - No access must be allowed to property/habitat beyond the servitude.
    - Maximum use must be made of existing access roads to prevent the unnecessary construction of new roads.
    - BFDs must be fitted to those sections of the line which were identified during the walk-through.

*Rehabilitation*

- Activities must be restricted to the servitude width.
- No access must be allowed to property/habitat beyond the servitude.
- Maximum use must be made of existing access roads to prevent the unnecessary construction of new roads.
- People and equipment must be restricted to a minimum to execute the on-site work.
- A suitably qualified rehabilitation expert must be appointed to manage the process in order to recreate the natural environment as best as possible.

### 9.2.3 Operations and maintenance

*Aerial/ground patrol of the power lines*

- If possible, patrols should be scheduled to occur outside of breeding window of Red Data species, especially large raptors breeding on transmission lines.
- Once-off pass through should be planned vs. "in and out' to limit potential disturbance to birds.

*Repairs and maintenance*

- If feasible, repairs should be scheduled outside the breeding window of Red Data species, especially large raptors breeding on the power line.
- Temporary removal of a nestlings and/or eggs by a qualified expert for the duration of the repair activities might be necessary.
- Problem nests to be relocated to a different location to prevent pollution of insulators and eliminate the risk of streamer faulting, through the use of nesting platforms.

### 9.2.4 Rehabilitation and post-closure

*Dismantling and recycling*

- A walk-through should be conducted by a suitably qualified avifaunal specialist to identify all active Red Data nests in the servitude, including those on the pylons, and immediately adjacent areas prior to the commencement of the dismantling operations.
- Should such a nest be discovered, the avifaunal specialist should be provided with a work schedule which will enable him/her to ascertain, if, when and where the breeding birds could be impacted by the dismantling operations.
- If it has been established during the walk-through that a breeding pair of Red Data species will be displaced, appropriate management measures would need to be implemented, the nature of which will depend on the Red Data conservation status of the species and the location of the nest. Each case will have to be dealt with on an ad hoc basis but could include the following:
    - The eggs and/or chicks must be removed to a rehabilitation facility if the nest will be destroyed.
    - Dismantling activities must be timed to avoid the disturbance of the breeding birds during critical phases of the breeding cycle.
- Activities must be restricted to the servitude width.
- No access must be allowed to property/habitat beyond the servitude.
- Maximum use must be made of existing access roads to prevent the unnecessary construction of new roads.

### 9.2.5 Monitoring requirements

Depending on the sensitivity of the power line, post-construction monitoring may be required for a specific period to assess the effectiveness of BFDs, and to identify additional sections of line to be fitted with BFDs.

## 9.3 Bats

### 9.3.1 Planning and pre-construction

- Ensure site specific Bat Impact Assessments/ Bat Specialist Opinions are conducted to inform planning and placement.

### 9.3.2 Construction, Operational, Rehabilitation and Post-Closure

- Site specific Bat Impact Assessments/ Bat Specialist Opinions to conduct impact assessments and provide mitigation and monitoring requirements for each phase of development. The principles of avoidance, minimization, mitigation and only if unavoidable offset/ compensation should apply.

### 9.3.3 Monitoring requirements

- The EMPr should be audited bi-annually to ensure that any mitigation measures listed were and continue to be adhered to.

## 9.4 Aquatic ecosystems

### 9.4.1 Planning and pre-construction

The planning phase for EGI development through firstly establishing preferred power line alignments, then determining sites for substations, placement of pylons, and needs for ancillary infrastructure (e.g. access roads, water abstraction points, etc.) has the potential to greatly reduce impacts on freshwater ecosystems and associated fauna and flora through simply avoiding areas of very high sensitivity, and as far as possible avoiding areas of high sensitivity. In order to significantly reduce potential impacts on freshwater biodiversity, sub-quaternary catchments classified with a very high or high sensitivity should be avoided. Where these areas cannot be avoided, a detailed desktop investigation should be followed to determine whether the EGI alignment and development footprint can avoid the actual freshwater ecosystems (i.e. wetland and river habitats) and associated buffers. This process should also be followed for all other quinary catchments (including medium and low sensitivities).

Where it is impossible to avoid freshwater ecosystems (i.e. wetland and river habitats) and associated buffers altogether, it will be necessary to undertake more detailed project level specialist studies, and if necessary investigate needs and opportunities for offsets. Preference should be given to position the EGI within already disturbed/degraded areas (e.g. freshwater ecosystems and buffers that are already invaded by IAPs). Mitigation specific to impact significance should be considered that is cognisant of the mitigation hierarchy, where very high significance impacts are avoided, while high and medium significance impacts are mitigated as far as possible. Offsets should only be considered once alternatives and mitigation measures have been exhausted, and in instances where it is provided that there are significant residual impacts due to the proposed development. Any freshwater ecosystems that will be affected by EGI development must be subject to project level assessments.

### 9.4.2 Construction

This phase may include the construction of pylons and substations, and stringing of transmission lines, and will thus include a number of impacts typical of construction activities, such as disturbance to wildlife through noise/light pollution, creation of dust, erosion and degradation/disturbance of habitats and vegetation (including areas for access via roads and servitudes and movement of heavy machinery), and bulldozing and vegetation/habitat clearing. Specific measures and actions required during the construction phase are presented in Sections 8.6 - 8.8, but key aspects to consider are:

- Timing of construction activities to occur in the dry season as much as possible;

- Appointment and involvement of an ECO to provide oversight and guidance to all construction activities, as well as ensure full consideration and implementation of the EMPr; and
- Environmental monitoring (or biomonitoring) required for pre-construction, during construction and post construction at strategically selected monitoring sites based on additional detail specified in Section 9.4.5.

### 9.4.3 Operations and maintenance

This phase will predominantly include activities typical of routine maintenance, such as clearing/trimming of natural wetland or riparian vegetation (to maintain required height clearance of transmission lines over vegetation), IAP control and application of herbicides, and operation of high-voltage transmission lines. Specific measures to be considered are provided in in Sections 8.6 - 8.8.

### 9.4.4 Rehabilitation and post-closure

Rehabilitation and post-closure measures would most likely be required for areas in and around pylons within or in proximity to freshwater ecosystems, as well as for areas degraded by access routes, operation of vehicles/heavy machinery, and infestation of servitudes by IAPs. In general, the following processes/procedures as recommended by James and King (2010):

- Initiation – to assemble the rehabilitation project team/specialists, identify problem/target areas, establish reference condition and desired states, and define rehabilitation targets and objectives;
- Planning - to account for constraints, budgeting and timeframes;
- Analysis – evaluation of alternatives and strategies to achieve the objectives, and to develop preliminary designs and inform feasibility;
- Implementation – a including detailed engineering designs, construction and inspections; and
- Monitoring – to establish need for maintenance and repair of interventions, as well as provide feedback regarding success and failure.

Additional points to be considered regarding rehabilitation of degraded areas within and adjacent to freshwater ecosystems include:

- IAP clearing and control – an IAP control programme should be developed and implemented based on site-specific details, including, but not limited to, types of IAPs, growth forms, densities and levels of infestation, potential dispersal mechanisms, knock-on impacts to freshwater ecosystems caused during implementation (e.g. herbicide drift and contamination), etc.;
- Erosion control and re-vegetation – the objective should be to establish indigenous vegetation cover as soon as possible, as well as to control and limit secondary impacts caused by rainfall-runoff. Where necessary geotextile fabrics, brush mattresses/bundles, geocells, and hydroseeding with a suitable grass seed mix should be considered, while more severe cases of erosion/bank collapse will require more advanced stabilisation methods (e.g. reshaping, planting, concrete blocks, riprap, gabions/reno mattresses, etc.).

### 9.4.5 Monitoring requirements

Sites/areas where freshwater ecosystems are likely to be affected by EGI development, according to the various phases of development (including rehabilitation), appropriate measures of monitoring should be considered, including:

- Upstream and downstream biomonitoring to include appropriate indicators/measures of assessing rivers (e.g. diatoms, water quality/clarity, macro-invertebrates using the SASS5 method, instream and riparian habitat using the Index of Habitat Integrity (IHI) method) and wetland habitats (e.g. WET-Health and WET-EcoServices) of a potential impact is recommended at suitable sites to be determined in-field by a specialist.
- Monitoring/sampling is to be conducted by suitably qualified specialists (e.g. DWS accredited SASS 5 practitioners) with sufficient experience in assessing aquatic ecology and water quality;

- A single sampling event is recommended prior to construction taking place to serve as a reference condition;
- Monthly monitoring is recommended for the duration of construction to evaluate trends;
- Biannual monitoring is recommended thereafter during the operation phase (biannual monitoring during the operational phase is not necessary for transmission lines or pylons);
- A single sample can be collected at closure, with additional sampling events 3 and 6 months post closure; and
- Fixed point photography to monitor changes and long term impacts.

## 9.5 Estuarine ecosystems

In addition to the best practice guidelines and monitoring requirements recommended for aquatic ecosystems (Section 9.4), the following requirements apply specifically to estuarine ecosystems.

### 9.5.1 Planning and pre-construction

The careful and informed planning of EGI development through firstly establishing preferred power line routes, determining suitable sites for substations, placement of pylons, and needs for ancillary infrastructure (e.g. access roads) has the potential to greatly reduce impacts on estuarine and associated freshwater aquatic ecosystems through simply avoiding areas of very high sensitivity, and as far as possible avoiding areas of high sensitivity. Where estuarine areas cannot be avoided, then a detailed investigation should be followed to determine whether the EGI alignment and development footprint can avoid the actual estuarine ecosystems (i.e. estuary) and associated aquatic and riparian buffers.

Where it is impossible to avoid estuaries and associated aquatic ecosystems and buffers altogether, then it will be necessary to undertake more detailed project level specialist studies, and if necessary investigate needs and opportunities for offsets. Preference should be given to position the EGI within already disturbed/degraded areas. Mitigation specific to impact significance should be considered that is cognisant of the mitigation hierarchy, where very high significance impacts are avoided, while high and medium significance impacts are mitigated as far as possible. Offsets should only be considered once alternatives and mitigation measures have been exhausted. Indeed, in the case of estuaries there is very little if any potential for offsets. Any estuarine ecosystem that will be affected by EGI development within the proposed Expanded EGI Corridors must be subject to an appropriate site-specific estuarine specialist investigation.

### 9.5.2 Construction

Given the high sensitivity and ecological importance of estuaries it is recommended that clearing of estuarine vegetation and disturbance of estuarine processes be avoided.

Some key mitigation measures specific to estuaries, and additional to those proposed for aquatic ecosystems in general (Section 9.4), include

- Detailed site-specific assessment required if construction is planned for within the EFZ.
- An onsite ECO is required to provide oversight and guidance to all construction activities.
- Environmental monitoring or biomonitoring is required pre-, during- and post-construction at pre-selected monitoring sites. This should include fixed point photography or remote sensing should be implemented to monitor changes and long term impacts.
- Construction activities to occur, if possible, while the estuary mouth is open to minimise impacts to biodiversity.
- Dust suppression is required to prevent smothering of estuarine vegetation.

### 9.5.3 Operations and maintenance

Assuming that EGI development does not occur in the EFZ as a result of very high sensitivity and ecological importance of estuaries, operations and maintenance predominantly include activities typical of routine maintenance, such as clearing/trimming of coastal riparian or wetland vegetation within 5 km of the estuaries, as well as IAP control and application of herbicides. In addition to the mitigation measures presented in Sections 8.6 - 8.8, specific measures for protecting estuarine processes are:

- Fixed point photography could be used to monitor long-term vegetation changes and potential site impacts.
- Avoid the use of herbicides in close proximity (closer than 50 m) to wetlands or rivers and do not disturb riparian/or wetland buffer areas.
- At all times care should be taken not to destabilise riparian areas and increase the sediment load down-stream to the estuary.

### 9.5.4 Monitoring requirements

Given the high sensitivity and ecological importance of estuaries it is recommended that EGI development should not occur within the EFZs. However, EGI development may involve construction and operation activity within or in proximity to coastal freshwater ecosystems such as rivers, wetlands and seeps that flow into estuaries. Where impacts to estuaries and/or coastal freshwater ecosystems within 5 km of estuaries cannot be avoided, monitoring measures should be implemented at a minimum; with additional supporting input from in-depth specialist studies where required.

For all construction activities within 5 km of an estuary, monitoring of a potential impact is recommended at sites to be determined in-field by qualified and experienced estuarine and/or freshwater ecosystems specialists. Sampling is required prior to construction taking place to allow for the establishment of the systems baseline condition (i.e. its state prior to development activities). Monthly monitoring is recommended for the duration of construction to evaluate trends, with summer and winter monitoring at three year intervals recommended thereafter during the operation phase.

Depending on the impact site, monitoring/sampling is to be conducted by estuarine/freshwater specialists with relevant qualifications and experience pertaining to estuarine sediment dynamics, physical processes, water quality and ecology (or freshwater aquatic ecology if in coastal freshwater ecosystem). Resource Quality Objectives (RQO) as set under the NWA provides the benchmark conditions to maintain in estuaries or rivers.

Monitoring effort should be appropriate to the nature and intensity of potential impacts, and information from monitoring should be used to inform and influence EGI development activities to prevent environmental damage, or ensure that remediation measures after the fact are successful in rehabilitating impacted habitats. This will require the development of case-specific monitoring plans, but some guidelines are presented here which are based on those developed for use in RQO studies. These requirements are specifically important in the event of construction within an estuary and its EFZ is impossible to avoid.

Direct impacts to the EFZ require monitoring of:

- Hydrodynamics;
- Sediment dynamics;
- Water Quality;
- Macrophytes;
- Microalgae;
- Invertebrates;
- Fish;
- Birds.

Indirect impacts to the EFZ require monitoring of:

- Water Quality;
- Microalgae;
- Invertebrates;
- Fish.

In cases where freshwater ecosystems within 5 km upstream of estuaries are likely to be affected by EGI development appropriate measures of monitoring should be considered as recommended in Section 9.4.5.

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