# CHAPTER 3

# Terrestrial and Aquatic Ecology

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# *Executive Summary*

This chapter on Aquatic and Terrestrial Ecology is an integration of the (i) Aquatic; (ii) Avifaunal; (iii) Bat; (iv) Mammal, Reptile and Amphibian; as well as (v) Vegetation and Flora components assessed and reported on in free-standing reports that are provided as Supplementary Material to this chapter.

## Aquatic ecology

The aquatic ecology report, based mainly on a desktop review of available literature and spatial mapping products, with limited time for ground-truthing/calibration of mapped wetland areas, highlights the importance and sensitivity of the inland and estuarine aquatic ecosystems on and in the vicinity of the proposed Boegoebaai Port and Special Economic Zone (SEZ).

- Overall, the assessment showed that the study area is not rich in inland aquatic ecosystems, however, those that do occur are likely to be of **Very High** importance for terrestrial fauna. The ephemeral pans are assumed to support rare aquatic invertebrate communities, including crustacean zooplankton fauna, with potentially high levels of regional endemism. The larger pans (Visagiespan, Rietfontein and Rietfonteinpan) afford substantial wetland and pan habitat, with links to primary and/or secondary aquifers, which form springs (e.g. Visagiespan), creating permanent standing water pools. These are utilised by wildlife, either directly as a brackish to saline water source or indirectly, for grazing of wetland plants. Other inland aquatic ecosystems of assumed **High** biodiversity and conservation importance include ephemeral pans (rock pools) in rocky outcrops, some of which are likely to support invertebrate communities adapted to ephemeral conditions and of high conservation importance.

- The National Wetland Map (V5) classified all mapped inland aquatic ecosystems on site as depressions. Larger pans belong to the Namaqualand Sandveld Bioregion with depressions rated as **Critically Endangered (CR).**

- There are no estuaries on site. However, two estuarine systems lie in close proximity and could potentially be affected by impacts associated with the proposed development.

    - (i) The Orange River Estuary flows into the sea between Alexander Bay and Oranjemund. This estuary comprises an almost permanently open river mouth; a 2–3 m deep tidal basin; a braided channel system; and a severely degraded saltmarsh. It is a rare and unusual wetland type on the arid coastline of southern Africa, deriving its flows from a large catchment that begins in the Lesotho Highlands. The estuary is both nationally and internationally important, having been accorded Ramsar Wetland status. The condition of this estuary falls short of its Recommended Ecological Category, requiring active interventions to improve estuarine condition. New developments e.g. the Boegoebaai Port and SEZ that, directly or indirectly, threaten its condition, would have direct negative implications for meeting the estuary's Resource Quality Objectives.

    - (ii) The Holgat River enters the sea just south of the study area. It is ephemeral and classified as a micro-outlet, with river flows rarely passing into the estuarine area. The outlet has been highly modified by mining operations.

The main report findings indicate that the proposed development would result in the potential loss of all inland aquatic ecosystems identified in the study area. Of these, natural pans and depression are rated as **CR** systems in the 2018 National Biodiversity Assessment. The report thus recommends that the development layout must **avoid** these systems. It furthermore recommends the inclusion of ecological corridors that link important terrestrial, coastal and inland aquatic areas across the site. The site sensitivity map (see section 6.1) indicates the natural depressions as having a **Very High** sensitivity and the artificial

wetlands as having a **High** sensitivity. Buffer zones around the depressions were allocated a Medium sensitivity.

Mitigation measures include addressing potential impacts such as concentrated stormwater flows, which could bypass dependent aquatic ecosystems or result in downstream erosion or blockages of flows in flood conditions. Other mitigation measures address indirect impacts due to expansion of urban areas, such as the need for upgrading solid waste management. The report further recommends that, if the development were approved, it would need to allow for increased human and financial resources at the Orange River Estuary to control and police fishing, grazing, hunting and vehicle access and movement within the estuary, including its saltmarshes. In addition, it would need to match any provision of fresh water from desalination plants to any communities/urban areas with an equal increase in infrastructure and human resource capacity to treat the additional wastewater to a level that would not impact negatively on any receiving watercourse, and the Orange River Estuary in particular.

The report highlighted some **information gaps** that would need to be addressed if the proposed project is considered further. These include (i) detailed studies to unpack surface/groundwater linkages driving the larger pan and associated wetland function and structure in the Visagiespan, Rietfontein and Rietfonteinpan systems; (ii) identification and refined mapping of key temporary pan habitat in rocky outcrops; (iii) wet-season assessment of ephemeral wetland invertebrate faunal communities; (iv) development of detailed stormwater management plans; and (v) details on measures to address impact avoidance, mitigation and management outlined in the report.

The aquatic report concluded that that there are no positive impacts to inland or estuarine aquatic ecosystems that would be associated with the proposed Boegoebaai Port and SEZ development, and substantial negative impacts could accrue, unless stringently addressed in development layout (avoidance), design and management.

## Terrestrial ecology

### ***Fauna: Avifauna***

To assess the avifaunal sensitivity of the broader area, various data sets were used to compile sensitivity layers for each Species of Conservation Concern (SCC). The layers were ranked according to endemicity, conservation status and fine-scale habitat suitability to develop a four-tier sensitivity map.

The Second Southern African Bird Atlas Project (SABAP2) has recorded 87 bird species in the broader area. Of the 87 bird species, 47 are considered priority species where priority species are defined as South African Red List species (SCC); South African endemics, near-endemics or range-restricted species; waterbirds; raptors; and species vulnerable to disturbance and/or habitat loss. Of the 87 bird species recorded in the broader area, 13 species were selected for further assessment. This selection includes SCC as well as endemics, near-endemics to South Africa or range-restricted species.

Although the region does not host a wide diversity of birds, it is home to the range-restricted regional subspecies of the dune lark (*Calendulauda erythrochlamys patae;* previously classified as the **NT** Barlow's lark *Calendulauda barlowi*). The sheltered bays and dune fields along the coast could provide suitable habitat for the **CR** Damara tern *(Sterna balaenarum),* while freshwater pans and estuarine habitats along the coast could support various species of conservation concern, including the **VU** curlew sandpiper *(Calidris ferruginea);* **VU** great white pelican (*Pelecanus onocrotalus);* **VU** Caspian tern *(Sterna caspia);* **NT** Eurasian curlew (*Numenius arquata);* and **NT** greater flamingo (*Phoenicopterus roseus).* Suitable habitat is also present on site for the **EN** black harrier (*Circus maurus);* **EN** Ludwig's bustard (*Neotis ludwigii);* endemic Cape long-billed lark (*Certhilauda curvirostris);* and near-endemic jackal buzzard (*Buteo rufofuscus).* The site could potentially also support the **EN** martial eagle *(Polemaetus bellicosus)* and **VU** Lanner falcon (*Falco biarmicus*).

Broad mitigation measures to be considered with all new developments include the avoidance of known large raptor nests and sensitive, core breeding habitats to reduce the impact on reproduction, feeding and roosting of avifauna. In addition, powerlines should be fitted with bird flight diverters to reduce the risk of collisions with this infrastructure.

From an avifaunal perspective the Boegoebaai Port and SEZ development site exhibits predominantly **Medium** and **High** sensitivity (see section 6.2). All proposed developments within the Port and SEZ should incorporate an avifaunal specialist study.

### *Fauna: Bats*

The bat report was based mainly on a desktop review of available literature with the sensitivity map based partially on satellite imagery and partially on ground-truthing during a brief site visit. The sensitivity map considers man-made structures, habitat alterations and natural terrain features that are likely to offer roosting and foraging opportunities for bat species. The predominantly desktop assessment on bats concluded that there are no fatal flaws from a bat sensitivity perspective which should prevent the proposed development from proceeding towards the Environmental Impact Assessment process.

Based on literature sources, ten (10) bat species have previously been recorded in the area or may occur in the region. One of these species has a regional **NT** status (2016) and three species had a **NT** status in the 2004 listing. The Angolan wing-gland bat (*Cistugo seabrae*) (regional **NT**) may roost in buildings, the Holgat ravine or the Boegoeberg Twins. The sensitivity map (see section 6.3) showed important foraging and roosting sites for bats as having a **Very High** sensitivity; temporal water sources as a **High** sensitivity; and areas where livestock aggregate as Medium sensitivity.

The most prominent impacts on bats were: (i) light pollution affecting light averse bat species and creating artificial foraging habitats; (ii) possible bat mortalities or injuries due to hot steam/water discharge at the water-cooling tower blowdown; and (iii) foraging and roosting habitat destruction. Of these impacts, light pollution is the most significant. However, if the water-cooling towers are equipped with exposed radiator designs, acute and high bat mortality impacts may occur. A bat specialist should be consulted on the intended design of the water-cooling towers. Mitigation measures proposed include (i) keeping artificial lighting on infrastructure to a minimum, while still adhering to safety and security requirements; (ii) closing up water-cooling radiators with a mesh/grid with a diameter of 10 mm or less, to prevent bats and other wildlife from taking refuge inside radiator spaces; and (iii) adhering to the bat sensitivity map should adequately mitigate against habitat and roosting habitat destruction.

### *Fauna: Mammals, reptiles and amphibians*

The desktop fauna assessment on mammals, reptiles and amphibians is based on secondary data sources, including GIS mapping, literature reviews and biodiversity databases, which inherently present spatial and temporal limitations.

The proposed Boegoebaai Port and SEZ site includes habitats of ecological importance, characterised by critical biodiversity features and a diversity of faunal SCC. The area encompasses **CR** ecosystems such as the Richtersveld Coastal Duneveld and Namib Seashore Vegetation. These habitats host unique fauna, some of which are highly specialised and endemic to the region. Species such as the **CR** De Winton's golden mole (*Cryptochloris wintoni*), **VU** Grant's golden mole (*Eremitalpa granti granti*) and the **VU** desert rain frog (*Breviceps macrops*) rely on specific sandy habitats for survival. Overall, the faunal community includes a diverse array of mammals, reptiles and amphibians, comprising 10 SCC consisting of four mammal, five reptile and one amphibian species. Among the mammal SCC, the brown hyaena (*Parahyaena brunnea*) has been confirmed on site, while De Winton's golden mole and Grant's golden mole (*Eremitalpa granti granti*) have a high likelihood of occurrence. Notable representatives among the reptiles are the Namaqua dwarf adder (*Bitis schneideri*) and Namib web-footed gecko (*Pachydactylus rangei*) that have both been confirmed on site. The only amphibian SCC, the desert rain frog, has also been

confirmed on site. These species underscore the ecological significance of the area and highlight the potential risks posed by habitat loss and disturbance.

The site sensitivity map (see section 6.4) applied a **Very High** sensitivity to the CR ecosystems (Richtersveld Coastal Duneveld and Namib Seashore Vegetation) and other unique features as well as areas providing suitable habitat for some SCC. Remaining habitat of the saline depressions; Western Gariep Plains Desert; corridors connecting coastal and inland habitats and areas included in the NPAES were rated as **Medium to High** sensitivity.

Habitat loss and alteration are noteworthy concerns, particularly for species relying on the specialised dune ecosystems that are vulnerable to disturbance by construction and operational activities. The ecosystems on site provide critical ecological services, including supporting rare and endemic species, stabilising sandy substrates and maintaining biodiversity corridors. Fragmentation of habitats due to infrastructure development, such as roads, pipelines and buildings, can restrict species movement, disrupt breeding patterns and isolate populations. These impacts are especially critical for fossorial species, such as moles and reptiles, that depend on undisturbed sandy habitats. Disturbance from increased human activities such as noise, light pollution and dust could have long-term implications for biodiversity.

During construction, impacts are expected to be most severe due to the direct transformation of natural ecosystems, specifically, activities that disturb nocturnal and crepuscular species. Additionally, roadkill by increased traffic presents a tangible threat to slow-moving species e.g. tortoises and frogs. The operational phase may see reduced activity, but residual impacts from wind erosion and alien plant invasions may persist unless mitigated effectively.

A suite of mitigation measures aimed at minimising ecological harm were identified. **Avoiding** development in areas of **Very High** sensitivity, such as the remnants of **CR** ecosystems which support fauna SCCs, is a primary recommendation. Strategic site selection can help protect key habitats while maintaining biodiversity corridors. During the construction phase, minimising vegetation clearance, implementing species-specific conservation actions and avoiding sensitive periods for breeding and foraging can reduce impacts. To reduce roadkill, speed limits and wildlife crossings should be established on access roads. Noise and light pollution can be mitigated by limiting construction hours and using directional lighting to minimise spillover into natural areas. Rehabilitation plans should focus on re-establishing native vegetation and stabilising disturbed soils to prevent erosion. Mitigation strategies should include training programs for staff to minimise inadvertent impacts on fauna and promoting community involvement in conservation initiatives.

**Information gaps** of the faunal assessment include the underrepresentation of cryptic or nocturnal species and the limited resolution of habitat maps for site-specific assessments. To address these limitations, targeted field surveys are recommended to validate findings and refine sensitivity maps. These surveys should focus on confirming the presence of SCC and updating ecological data to ensure accuracy and comprehensiveness. No invertebrates were assessed.

### *Vegetation and Flora*

The assessment of the vegetation and flora was based mainly on a desktop review of available literature and spatial mapping products followed by a reconnaissance site visit. The site hosts many features indicating priority habitat for biodiversity conservation, e.g. (i) two **CR** ecosystems, the Richtersveld Coastal Duneveld and the Namib Seashore Vegetation; (ii) habitat to **CR** plant species (*ca*. eight spp. some still being re-assessed); (iii) large areas classified as **irreplaceable CBA 1s** or **optimal CBA 2s**; (iv) portions included in the **National Protected Area Expansion Strategy** (NPAES); (v) inclusion into an internationally recognised **Key Biodiversity Area** (KBA); and (vi) the close proximity of the **CR** Namib Lichen Fields. From a vegetation and flora perspective the major source of impacts from the proposed development will result directly or indirectly from vegetation clearance with the associated habitat loss and transformation which will lead to the loss of the priority features mentioned above.

A large proportion of the site was previously mined and the vegetation in these mined areas has been transformed. Furthermore, mine-induced sand plumes cover large sections of land. These transformed habitats, west of the R382, could be used for the proposed development provided that areas of priority habitat are not negatively impacted by the development. The level of infestation by alien invasive plant species on site is currently low.

The Screening Tool rated the sensitivity of the Plant Theme[1] as Medium based on the presence of model-derived suitable habitat for threatened and/or rare species (see section 6.5). The current assessment recommends an upscaling of the Plant Theme to **Very High** due to the presence of 46 SCC on site and ca. 75% of the site having a **Very High** sensitivity (Figure S.1a). The current assessment supported the Screening Tool's **Very High** sensitivity of the Relative Terrestrial Biodiversity Theme (75%; Figure S.1b). During the planning phase, areas of **Very High** sensitivity should be **avoided**, and as far as possible also areas of **High** sensitivity. Habitat loss in areas of **Very High** sensitivity, i.e. irreplaceable biodiversity value, is unacceptable as this may compromise the ability to meet conservation targets and furthermore, residual impacts on irreplaceable biodiversity cannot be offset and compensation would not be feasible according to EWT (2023).

**Information gaps** relating to the vegetation and flora include the lack of comprehensive point data for SCC and a detailed baseline vegetation map of the proposed site. As a priority, it is strongly recommended that the current coarse-scale vegetation and sensitivity maps are refined to inform the planning and layout of the Boegoebaai Port and SEZ. Considering the large areas with a **Very High** sensitivity rating, it would be prudent to conduct an in-depth, fine-scale analysis of the vegetation as soon as possible (before the EIA phase) to produce a detailed vegetation map that could be used to plan the layout of the port and SEZ in order to avoid placing footprints in areas that could potentially not receive Environmental Authorization.

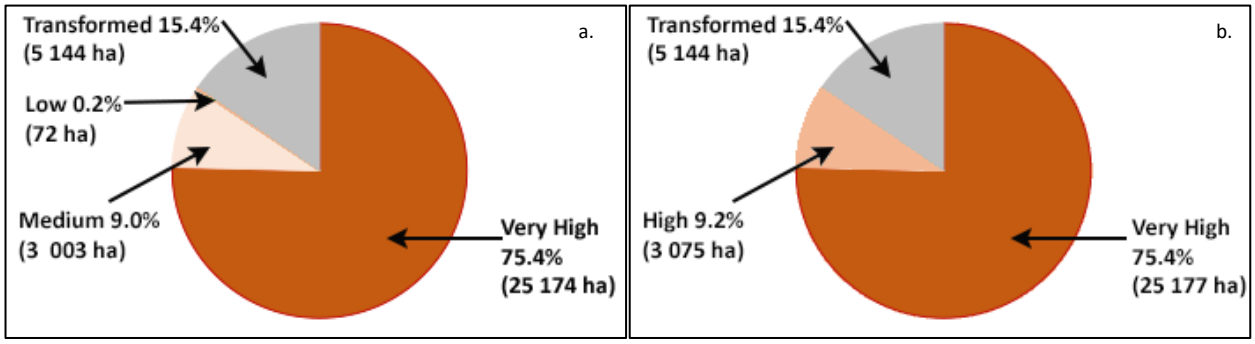


Figure S.1: Areas covered by the various sensitivity classes as assessed during the current evaluation of (a) the Plant Theme (High sensitivity is too small to indicate in the figure and covers 0.01% of the total area = 3 ha) and (b) the Relative Terrestrial Biodiversity Theme.

Overall, the integrated terrestrial and aquatic ecology report concludes that:

- The potential benefits of the Boegoebaai development must be evaluated against the irreversible loss of fauna and flora diversity and ecosystem services.
- The aquatic assessment contended that the proposed development has no positive impacts and substantial negative impacts could accrue, unless addressed in layout (avoidance), design and management.
- The high-level plant and animal theme assessments demonstrated large areas of **High to Very High** sensitivity.

[1] Theme refers to each of the environmental and planning spatial datasets contained in the Screening Tool. The Plant Theme considers the plant Species of Conservation Concern (SCC).

- The current high-level evaluation of the site demonstrated a **Very High** sensitivity for the Relative Terrestrial Biodiversity Theme. The findings of this assessment highlight the importance of adopting a precautionary approach, balancing economic objectives with the preservation of ecological integrity.

- In section 6.6 the site sensitivity maps of all the Aquatic and Terrestrial assessments were integrated using the maximum rule, i.e. the highest sensitivity overrides the lower sensitivities. According to the integrated sensitivity map most of the proposed development site has a **Very High** sensitivity.

- Transformed habitats, west of the R382, could be used for the proposed development provided that areas of priority habitat are not negatively impacted by the development.

- Monitoring will be essential to assess how effective mitigation measures are and to ensure long-term ecological sustainability. A full monitoring programme should be development during the EIA phase.

- While mitigation can reduce some risks, it cannot eliminate irreversible loss of critical habitats and species, where **avoidance** is the only option.

- Sand stabilisation will be crucial to avoid negative impacts on threatened ecosystems further north. The use of geotextiles or chemical approaches should be investigated.

- Hyper-arid areas are very difficult to revegetate/rehabilitate successfully. A rehabilitation specialist, with West Coast expertise, should be consulted for advice on techniques and species that could potentially be used.

- There is a risk that inadequate rehabilitation during decommissioning could leave behind a degraded and vulnerable ecosystem.

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# *Abbreviations and Acronyms*

| Acronym | Explanation |
|---|---|
| AIS | Alien Invasive Species |
| ADU | Animal Demography Unit |
| AOO | Area of Occupancy |
| CBA | Critical Biodiversity Area |
| CITES | Convention on International Trade in Endangered Species |
| CR | Critically Endangered |
| CSIR | Council for Scientific and Industrial Research |
| DD | Data deficient |
| DFFE | Department of Forestry, Fisheries and the Environment |
| DAERL | Department of Agriculture, Environmental Affairs, Rural Development and Land Reform |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| EN | Endangered |
| EOO | Extent of Occurrence |
| ESA | Ecological Support Area |
| EWT | Endangered Wildlife Trust |
| GIS | Geographic Information System |
| IFC | International Finance Corporation |
| IUCN | International Union for Conservation of Nature |
| KBA | Key Biodiversity Area |
| NBA | National Biodiversity Assessment |
| NEMA | National Environmental Management Act (107/1998) |
| NEM:BA | National Environmental Management: Biodiversity Act (10/2004) |
| NEM:PAA | National Environmental Management: Protected Areas Act (57/2003) |
| NFA | National Forest Act (84/1998) |
| NFEPA | National Freshwater Ecosystem Priority Areas |
| NHS | National Heritage Site |
| NPAES | National Protected Area Expansion Strategy |
| NT | Near Threatened |
| NWM | National Wetland Map |
| ONA | Other Natural Area |
| PA | Protected Area |
| PAOI | Project Area of Influence |
| SABAP2 | Second Southern African Bird Atlas Project |
| SACAD | South African Conservation Areas Database |
| SANBI | South African National Biodiversity Institute |
| SANParks | South African National Parks |
| SAPAD | South African Protected Areas Database |
| SCC | Species of Conservation Concern |
| SEA | Strategic Environmental Assessment |
| SKEP | Succulent Karoo Ecosystem Programme |
| TNPA | Transnet National Ports Authority |
| ToPS | Threatened or Protected Species Regulations (2013) |
| TOR | Terms of Reference |
| VU | Vulnerable |
| WHS | World Heritage Site |

# CHAPTER 3. TERRESTRIAL AND AQUATIC ECOLOGY

## 3.1 INTRODUCTION

### *3.1.1 Background*

Energy is one of the most carbon-intensive sectors in South Africa and to reduce global warming a radical change in energy production and consumption is needed. Hydrogen produced from renewable sources is termed "green hydrogen ($GH_2$)" and could potentially provide an opportunity to decarbonise the South African energy economy while also generating revenues, creating jobs and developing skills. As part of South Africa's drive to become a player in the globally emerging $GH_2$ market, an ambitious programme of greenfield infrastructure has been proposed in the Northern Cape.

The production of $GH_2$ at the scale envisaged could have multiple direct and indirect impacts, including on local economies, infrastructure, communities and natural ecosystems and resources. In order to consider these potential impacts, the Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent Strategic Environmental Assessment (SEA). The overarching purpose of the SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, Special Economic Zone (SEZ) and wider Namakwa region in a sustainable manner (Schreiner *et al.,* 2024).

The Boegoebaai Port and SEZ, i.e. the study site, covering 33 500 ha (Figure 3-1), in the Northern Cape has been proposed to advance South Africa's $GH_2$ strategy. The conceptual layout of the project site, which is to be assessed for Work Package 1 includes the Port precinct (Zones 1 & 2) at 3 357 ha and the SEZ at 30 143 ha (Zones 3 – 10). A phased approach has been proposed for constructing the infrastructure and facilities for the Boegoebaai Port and SEZ.

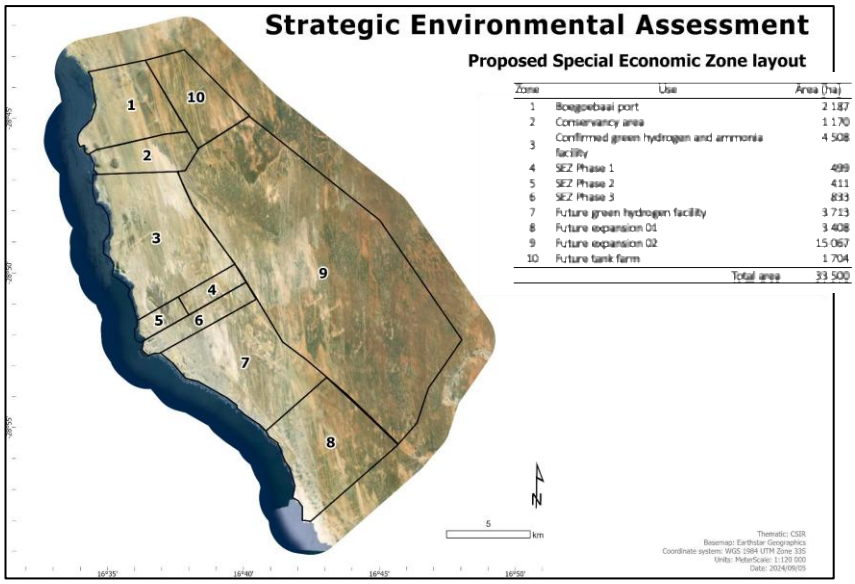


Figure 3-1**:** The layout of the Boegoebaai Port and Special Economic Zone (source: Schreiner *et al.,* 2024).

This chapter on Aquatic and Terrestrial Ecology is an integration of the (i) Aquatic; (ii) Avifaunal; (iii) Bat; (iv) Mammal, Reptile and Amphibian; as well as (v) Vegetation and Flora components assessed and reported on in free-standing reports that are provided as Supplementary Material to this chapter.

### *3.1.2 Assumptions, limitations and uncertainties*

The **aquatic report** is a broad-based, primarily desktop assessment, based on existing mapped data and available reports with no new biophysical data collected, other than once-off water quality data, of limited value.

- The assessment relied on existing watercourse and estuary maps, included in the NFEPA and NWM (V5) datasets. These data are useful to inform broad conservation planning, but have not been ground-truthed sufficiently for high-confidence information for detailed development planning. This is a noteworthy limitation since the mapped extent of watercourses in the above datasets is not necessarily accurate.

- Although the current extent of most watercourses is discernible from aerial imagery, floodplain extent for major storm events is unknown.

- This report was not informed by a project-specific geohydrological report, which would have increased the confidence with which surface/groundwater interactions could be reported. Geohydrological reports for the Alexkor Mining area (Mavurayi, 2014) did not comment in any detail on groundwater interactions with any of the wetlands and/or springs within the current study area.

The **avifaunal study** assumed that the sources of information used in the report are reliable and noted the following:

- The focus of the study is primarily on the potential impacts of the development on priority species which were defined as: South African Red List species (SCC); South African endemics, near-endemics or range-restricted species; waterbirds; raptors; and species vulnerable to disturbance and/or habitat loss.

- The assessment of impacts is based on the baseline environment as it currently exists at the development site and nearby surrounding environment.

- Conclusions are based on experience of these and similar species in different parts of South Africa. Bird behaviour can however, never be entirely reduced to formulas that will be valid under all circumstances.

- The broader area refers to the area covered by 20 SABAP2 pentads within which the proposed site is located.

The **bat report** mentioned that distribution maps of South African bat species still require further refinement, and thus if a species has a known distribution proximal to the site, it was assumed to occur in the area. The sensitivity map is based partially on satellite imagery and one site visit. There is always the possibility that what has been mapped may differ slightly to what is on the ground.

Using secondary data for the **mammals, reptile and amphibian** desktop assessment in a remote region, involves several limitations and assumptions that can impact the reliability and applicability of the findings.

- Available secondary data might not cover all habitats or especially lesser-studied or cryptic species.

- Historical data lack recent trends on population dynamics due to environmental changes.

- Full coverage of the 33 500 ha area is constrained in the databases, particularly in remote areas.

- The scale of secondary data may not align with the finer resolution required for site-specific assessments.

- Habitat or species distribution maps may not accurately reflect microhabitats present in the area.

- Static datasets do not capture migration or seasonal variations in species distribution.
- Secondary data may overrepresent certain areas or species due to researcher interest or accessibility.
- Surveys may exclude nocturnal, fossorial or migratory species, leading to underrepresentation.
- Secondary data often lack behavioural, ecological or physiological context to assess impacts on fauna.
- Inconsistencies of data due to data collection methods, accuracy and sampling effort across studies.
- It is assumed that ecological and environmental conditions have remained fairly stable since data collection.
- A risk-averse and cautious approach is applied to take into account the limits of current knowledge.

The **botanical assessment (vegetation and flora)** is a screening-level, predominantly desktop assessment, aimed at identifying potential, botanically related environmental sensitivities based on existing spatial data. The predominantly desk-top approach used here was regarded as adequate for the purpose of an SEA.

- No detailed fieldwork was done and limited raw data were collected and analysed. Species records were obtained from P. van Wyk and supplemented by existing databases. However the entire site has not been intensively sampled or surveyed in the past because of the limited access to the mining area.
- The site visit was conducted from 31 August - 3 September 2024 which is normally the most favourable time of year for botanically related field work in the Succulent Karoo Biome and winter-rainfall Desert Biome. Most of the Richtersveld as well as the current assessment area suffered from an extreme drought from 2011 to 2022 (peak in 2019) which killed many plants and entire populations. Recovery may take many years and it is likely that the complete species pool was not present in 2024. Furthermore, the low rainfall during the winter of 2024 was not ideal for annual and geophytic plant species.
- Sensitivity ratings were applied per plant community due to a lack of point data covering the entire area.
- Because many of the plant communities are large, the current analysis and mapping of sensitive features is at a broad scale and many small or localised features were not mapped.

**Disclaimer 1:** The final update on the red list status of all plant species was on 18 December 2024 following data supplied by SANBI. At the time of finalising this report (20 May 2025) no further updates of the red list status of plant species had been received. The final red list status update for the animal species supplied by SANBI was 7 May 2025. We kindly acknowledge SANBI for the use of their data. This work forms part of the Boegoebaai Strategic Environmental Assessment (CSIR project EEMS086). The scientific material for this publication was developed through a collaborative effort involving various stakeholders and datasets contributed by the South African National Biodiversity Institute.

**Disclaimer 2:** This report is based on the 2016 Northern Cape Critical Biodiversity Areas map available from the Biodiversity GIS website. The 2024 Northern Cape CBA map has undergone several revision, but at the time of finalising this report (20 May 2025) Version 3 was not yet publicly available on SANBI BGIS.

## 3.2 RESEARCH APPROACH AND METHODOLOGY

This section outlines the methodology used to conduct the Terrestrial and Aquatic Ecology SEA detailing the steps taken to develop an integrated decision-making framework to guide the planning of the proposed development.

### *3.2.1 Approach*

The findings of the **aquatic** assessment were based mainly on a desktop review of available literature and spatial mapping products, with limited ground-truthing. The study area was visited in early summer, when pans and other watercourses would not be expected to be inundated. The purpose of the site visit was to ground-truth the presence, rough extent and type of wetlands indicated in the 2018 NBA data (Van Deventer *et al.,* 2019).

**The (i) bird, (ii) bat, (iii) mammal, reptile and amphibian** assessments were desktop studies relying on available databases and distribution maps. The bat assessment was supported by an on-site visit.

The **vegetation and flora** assessment commenced as a desktop study, followed by a reconnaissance site visit to undertake a screening level site sensitivity evaluation to ground-truth the Screening Tool's environmental sensitivity as provided by the DFFE. No provision was made for a detailed survey of the vegetation in the scope of work.

### *3.2.2 Data Sources*

A full list of the data sources is provided in the individual specialist reports and is not repeated here:

- **Inland and estuarine aquatic ecology; Supplementary material 1:** Day, L. 2025. Strategic Environmental Assessment for the proposed Boegoebaai Port and Strategic Economic Zone, Northern Cape, South Africa, Work Package 1: Aquatic Ecosystems Assessment – Inland Aquatic Ecosystems and Estuaries.

- **Fauna: Avifauna; Supplementary material 2:** Froneman, A., Colyn, R., Oosthuizen, M. & Loftie-Eaton, M. 2025. Strategic Environmental Assessment for the proposed Boegoebaai Port and Strategic Economic Zone (SEZ): Avifaunal Specialist Assessment.

- **Fauna: Bats; Supplementary material 3:** Marais, W. 2025. Bat Specialist Assessment for the Strategic Environmental Assessment of the Proposed Boegoebaai Port and SEZ (Special Economic Zone), Northern Cape, South Africa.

- **Fauna: Mammals, reptiles and amphibians; Supplementary material 4:** Niemandt, C. 2025. Strategic Environmental Assessment (SEA) for the Proposed Boegoebaai Port and SEZ: Fauna Desktop Assessment.

- **Vegetation and Flora:**

    - **Supplementary material 5a:** Van Rooyen, G., Van Rooyen, N. & Van Wyk, P. 2025. Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone, Northern Cape, South Africa: Vegetation and Flora Component.

    - **Supplementary material 5b:** Van Wyk, P. 2025. Boegoebaai Strategic Environmental Assessment: Exploring the floral richness of the Boegoebaai Port development site and surrounding areas, Richtersveld Municipal Area, Western Gariep Desert, Northern Cape, South Africa.

### *3.2.3 Methodology*

**Aquatic:** Inland aquatic habitats were mapped using the 2018 NBA data (Van Deventer *et al*., 2019). Ground-truthing eliminated a few of these wetlands while adding some others. In total, 16 inland aquatic habitats were mapped, these included three major pan systems, some smaller wetlands and a few artificial scrapes or depressions. Runoff from steep, rocky areas, where rainfall is likely to run as multiple fast flows or trickles to the sand below, were mapped as the entire rocky structure and the area immediately surrounding it, as far as visible runnels extend.

**Fauna - Avifauna:** Bird distribution data from the SABAP2 was obtained to ascertain which species occur in the pentads where the proposed Boegoebaai development is located. A target species list was generated by assessing SABAP2, BirdLasser citizen science data and intersecting species distribution models with a 5 km buffer around the proposed site. This assessment of all available data yielded a priority list of 13 threatened and/or endemic avian species that were included in the analysis. A weighted sensitivity model was used for all 13 SCC identified. Data input to the model included: a species distribution model (SDM) for each SCC; nest sites; confirmed species presence (BirdLasser®, tracking data, SABAP2); freshwater body/aquatic ponding GIS layer; and habitat suitability models.

**Fauna - Bats:** The site was evaluated by considering man-made structures, surface rock (possible roosting space), topography (influencing surface rock in most cases), climate (can influence insect numbers), and presence of surface water and drainage areas (influences insects and acts as a source of drinking water) to identify habitats that may be frequently used by bat species. These considerations principally involved studying the literature, available satellite imagery and vegetation descriptions. One site visit was conducted on 18 February 2025 to obtain an understanding of the environmental setting of the site. Google Earth satellite imagery and verification during the site visit were used to spatially demarcate areas on site with **Very High, High** and **Medium** sensitivities relating to bat species ecology and habitat preferences. The map considers man-made structures and habitat alterations (such as dams), as well as natural terrain features that are likely to offer roosting and foraging opportunities for bat species found in the broader area. With regards to hydrology features, a distinction was made between permanent and seasonal water sources.

**Fauna - Mammals, reptiles, amphibians:** The study adopted a spatially focused assessment to ensure high-resolution environmental sensitivity mapping. To generate an expected species list, observation data in iNaturalist, the Global Biodiversity Information Facility (GBIF), the Virtual Museum (VM of ADU) of African Mammals, Frog Atlas of southern Africa and Reptile Atlas of Africa were sourced. Existing data layers were incorporated into QGIS to establish how the proposed development would interact with important terrestrial features. Emphasis was placed on the following spatial datasets: Vegetation Map of South Africa, Lesotho and Swaziland (SANBI, 2012–2024); Northern Cape Critical Biodiversity Areas (2016); National Protected Area Expansion Strategy (NPAES, 2018); Red List of Ecosystems (RLE) (NEMBA, 2022; SANBI, 2022); Protected and Conservation areas of South Africa (SAPAD; SACAD). The study design integrated spatial data from existing surveys and secondary sources into GIS; literature review; and collaboration with fauna specialists. No on-site fauna assessments were undertaken but based on habitat and vegetation descriptions, key habitats for fauna could be described. Coupled with secondary data collection, sensitive areas were mapped for SCC.

**Vegetation and flora:** A provisional checklist for the proposed development site was generated from data collected by P. van Wyk (Van Wyk, 2025; Supplementary Material 5b); the current site visit in August/September 2024; iNaturalist; SANBI NewPOSA database; and data supplied by SANBI (2024). Prior to the site visit a satellite image of the site was stratified into homogeneous terrain/vegetation units or habitats and as many of these units as feasible were visited during the site visit. Fieldwork was limited to recording the most prominent plant species at 37 sites spread across the study area. Floristic data of these sites were classified into groups of associated species representing plant communities on site. To allocate a sensitivity rating to a plant community, the presence of plant species of conservation concern (SCC); CR ecosystems; presence of CBAs; and the occurrence within the NPAES were assessed.

## 3.3 DESCRIPTION OF THE RECEIVING ENVIRONMENT

The Boegoebaai Port and SEZ site is located in the Namaqualand District, Richtersveld Local Municipality, on the West Coast in the northwestern corner of the Northern Cape province, approximately 18 km south

of the small mining town of Alexander Bay. For a full description of the receiving environment see Day (2025), Froneman *et al*., (2025), Niemandt (2025), Van Rooyen *et al.* (2025) in the supplementary material. A brief summary of the outstanding features is provided below.

## *3.3.1 Abiotic environment*

### 3.3.1.1 Climate

According to the Köppen-Geiger climate classification both Alexander Bay and Port Nolloth have a BWk climate i.e. a cool, desert climate with a winter rainfall. The mean annual rainfall at Alexander Bay is 80 mm. The aridity of this coastal area can be ascribed to the South Atlantic anticyclone and the cold Benguela current. There is a general decrease in rainfall from south to north along the West Coast, with a concomitant increase in the unreliability of the rainfall.

Most of the Richtersveld, as well as the current Boegoebaai assessment area, suffered an extreme drought from 2011 to 2022. The year 2019 was the peak of this longest and most intense drought recorded in the Richtersveld since 1902.

A distinctive feature of the desert climate on site is the occurrence of fog. The sea fog results from the advection of relatively warm moist air over the cold water of the Benguela-upwelling zone (Olivier, 2002). The extent of this upwelling zone varies seasonally and depends on prevailing climatic conditions. The highest fog day frequency is found at the coast and there is a decrease with distance from the sea. The fog supplements the meagre rainfall in the region and is a more reliable source of moisture than rainfall (Gottlieb *et al.,* 2019). Heavy dew further supplements the rainfall.

The area experiences strong winds that cause dust and sand storms with associated erosion of topsoil material and sandblasting, which has a destructive effect on the vegetation. This destructive wind action is particularly prominent in areas where the vegetation has been degraded and is sparse (Desmet, 1996). Hot, dry eastern berg winds with associated sand storms, cause a rapid increase in temperature and have a desiccating effect on the vegetation.

### 3.3.1.2 Inland and estuarine aquatic environment

There are no major drainage lines on site. The Orange River is the only perennial river in the region and is located approximately 20 km north of the site. The Holgat River lies approximately 2 km south of the site and is ephemeral, flowing only after high rainfall events mostly occurring in its upper catchment, which is remote from the coast. Other drainage lines and watercourses within the study area peter out and dissipate into the sands, with no surface outlets into the sea. Neither the Orange River estuary nor the Holgat River estuary are on site.

The study area lies wholly in the Department of Water and Sanitation (DWS)'s quaternary catchment F10C, within the Coastal Orange sub-Water Management Area (Sub-WMA), which is nested within the Lower Orange Water Management Area. The Coastal Orange sub-WMA does not drain into the Orange River, but drains west towards the coastline by way of multiple ephemeral watercourses. According to the ecoregional classification of South African rivers (Kleynhans *et al.,* 2005) the study site falls entirely within the Western Coastal Belt Ecoregion.

There are no Freshwater Ecosystem Priority Areas (FEPAs) or Strategic Water Source Areas (SWSAs) within the study area with the closest SWSA (groundwater) south of the study area. FEPAs are strategic priority subcatchments that are needed for conserving freshwater ecosystems and supporting the sustainable use of water resources (Driver *et al*., 2011). River FEPA ratings assign levels of conservation importance to rivers, associated with requirements for protection, rehabilitation and/or management of aquatic resources.

Data from the National Biodiversity Assessment (NBA) of aquatic ecosystems (Figure 3-2; Van Deventer *et al*., 2019) classify all aquatic ecosystems within the study area as part of the Namaqualand Sandveld Bioregion. Furthermore, all the inland aquatic ecosystems mapped were classified as wetland depressions

(Ollis *et al.,* 2013) and are referred to as Namaqualand Sandveld Bioregion Depressions. Within the Namaqualand Sandveld Bioregion, depressions (including pans) have been rated as **Critically Endangered (CR)** with a protection status of Not Protected.

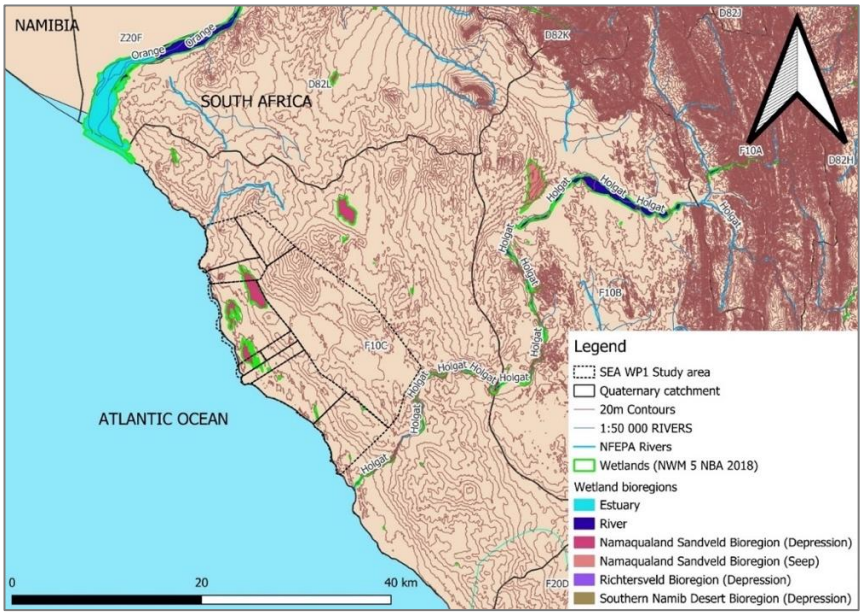


Figure 3-2**:** National Wetland Map (Version 5) (Van Deventer *et al*., 2019) for the Boegoebaai Port and SEZ.

### 3.3.1.3 Terrain types

A terrain type describes the terrain or relief of an area by means of the percentage level land and local relief. The Port section is covered predominantly by 'level plains with some relief' (Figure 3-3). Most of the SEZ is covered by 'plains with open low hills or ridges', while along the coast 'plains with open high hills or ridges' can be found.

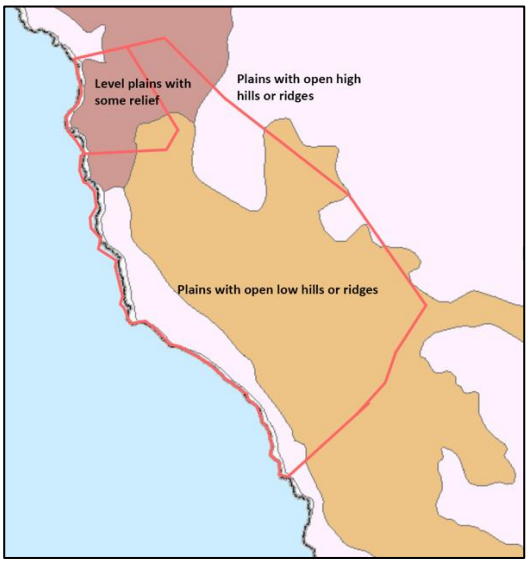


Figure 3-3**:** Terrain types in the Boegoebaai Port and SEZ site (source: https://ndagis.nda.agric.za/).

### 3.3.1.4 Geology

There is a close relationship between the geology, soils and vegetation. The Boegoebaai Port and SEZ site falls in the Gariep Supergroup, Holgat Formation, which lies to the south of the Schakalsberge Thrust (Figure 3-4; Council for Geoscience, 2011). The Boegoeberg Twins and Namakwakop are prominent outcrops on site and consist of schist, greywacke, quartzite and arkose (Nho) of the Holgat Formation. The bedrock is exposed along the rocky shore in the Port section. To the east of the R382 tar road some coarse-grained porphyritic granite outcrops occur (ϵsw).

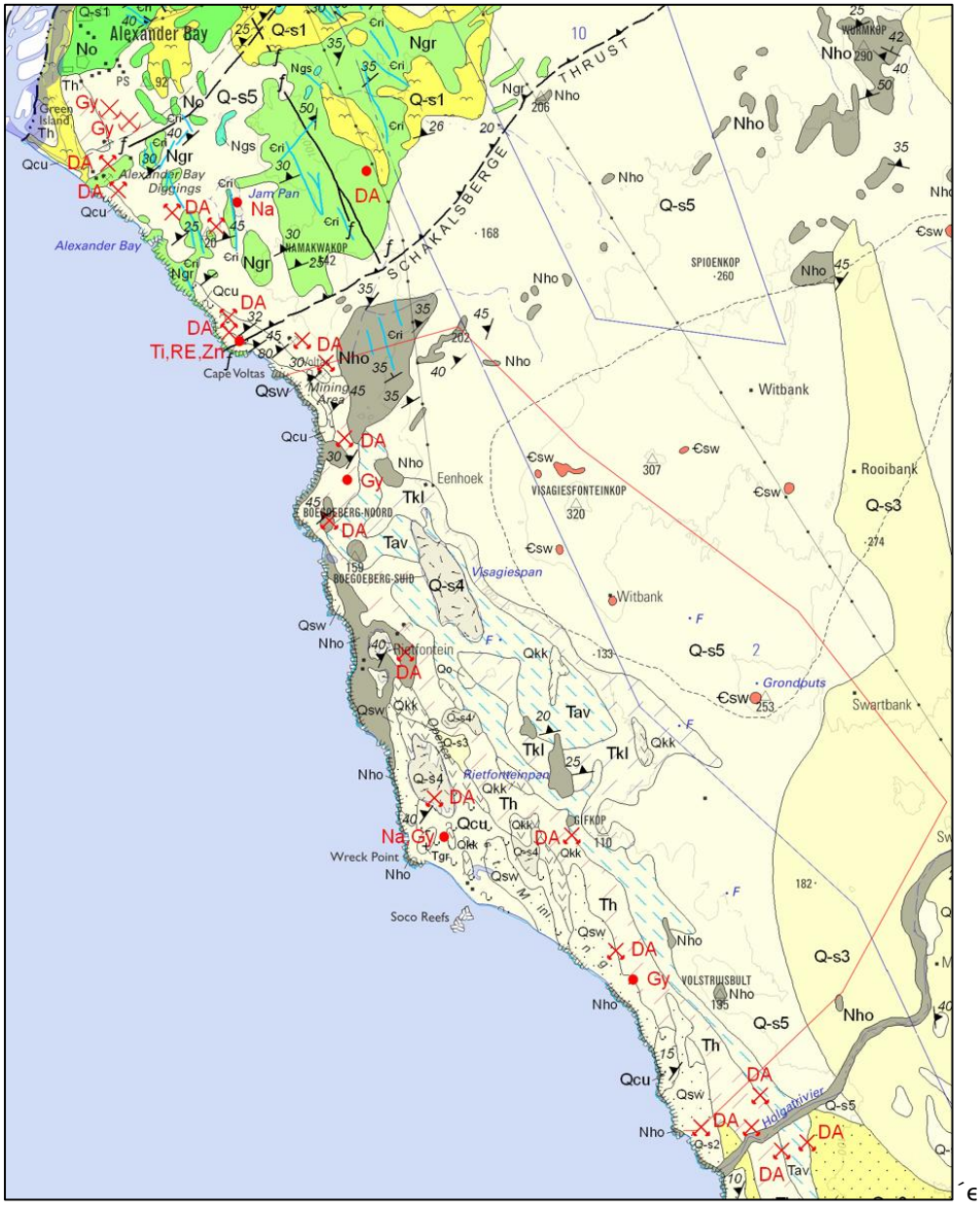


Figure 3-4: Detailed geology in the Boegoebaai Port and SEZ site (Council for Geoscience, 2011).

Most of the site is covered by sediments of Tertiary and Quaternary age (Q-s2 = white aeolian sand; Q-s3 = red aeolian sand; Q-s4 = saline soil; Q-s5 = surficial sandy soil; Qsw = white to grey dune sand; Qkk = young aeolian, reddish, mobile, vegetated sediment; and Qcu = coarse gravels; Van Rooyen *et al*., 2025). Large areas of saline soils (Q-s4) occur at Visagiespan, Rietfontein and Rietfonteinpan which are nearly permanently dry. The Tertiary sediments are represented by three shoreline terraces also referred to as 'packages': Th = 30 m shoreline terrace (or Hondeklip Bay Member); Tav = 50 m terrace (Avontuur Member); and Tkl = 90 m shoreline terrace (Kleinsee Member) (Roberts *et al.,* 2006).

### 3.3.1.5 Soils

Soils on site are sandy soils with little or no profile development. The sand particles are loosely packed and the soils are well-aerated and well-drained. The sandy soils have a low clay and silt content and consequently a low water holding capacity (Henschel & Jürgens, in press) and a low nutrient content and are not favourable for plant growth. Below a 30 cm depth in dune sand there is little evaporative water loss and this water is available to deep-rooted perennial plants.

Mobile dune soils have little or no vegetation mainly because of the strong winds and associated sandblasting. Once plains become vegetated, soil particles may be trapped by plant canopies, initiating the development of phytogenic mounds (also referred to as nebkhas). The ability of some dune vegetation to stabilise wind-driven dunes is a practical tool for protecting industrial and urban infrastructure placed in dune pathways, however, further research is needed to apply this principle effectively (Henschel & Jürgens, in press). Once the silt and clay content of the top sand layer reaches a certain level, a biological crust can develop.

Replacement commonly occurs in the sandy soils along the West Coast when soluble components are eluviated and later crystallised in the subsoil to form cemented hardpan formations (Desmet, 1996). Calcrete, dorbank and silcrete are the most prominent replacement products along the West Coast of South Africa.

### 3.3.1.6 Land Types

Land types are areas with a uniform climate, terrain form and soil pattern. The study area falls in the Ah, Ai, Fc, and Ha Land Types (Du Plessis, 1987) (Figure 3-5).


Figure 3-5: Land types in the Boegoebaai Port and SEZ site (https://ndagis.nda.agric.za/).

- The Ah Land Type includes red and yellow apedal, freely drained soils with a high base status and <15% clay, whereas the Ai Land Type comprises yellow apedal, freely drained soils with a high base status and <15% clay.

- Land Types Fa - Fe accommodate pedologically young landscapes that are not predominantly rock and not predominantly alluvial or aeolian. Fc refers to land where lime is generally present in the entire landscape. Land Type Fc129 occurs mainly on greywacke, schist and arkose of the Holgat Suite of the Gariep Complex.

- The Ha Land Type refers to grey, regic sands and accommodates areas where deep, grey sands are dominant. Land Type Ha32 occurs on young aeolian sands.

#### 3.3.1.7 Land Cover

According to the 2022 land cover map of South Africa Figure 3-6; DFFE, 2022), the western portion of the Boegoebaai Port section is covered predominantly by mine tailings and dumps with some patches of 'other bare areas'. Further inland the Port section consists mostly of 'other bare areas' with only a small section of low shrubland of the Succulent Karoo. The Conservancy Area is additionally partly covered by the dry Visagiespan and an artificially flooded mine dam. The SEZ section is dominated by mine tailings and dumps as well as other bare areas to the west of the tar road (R382), while to the east of the R382, the land cover is primarily low succulent shrubland.

Comparing the 2022 land cover map to the 2020 and 2018 land cover maps, the most prominent change is the increase in the area mapped as bare area and this has mostly been to the detriment of low succulent shrubland. This trend could probably largely be attributed to the severe drought conditions that the region had experienced since 2011. In 2000 (see map [Figure 8, Chapter 3e] in the Supplementary Material: Van Rooyen *et al.*, 2025) the areas classified as mines and quarries were even smaller than in 2018.

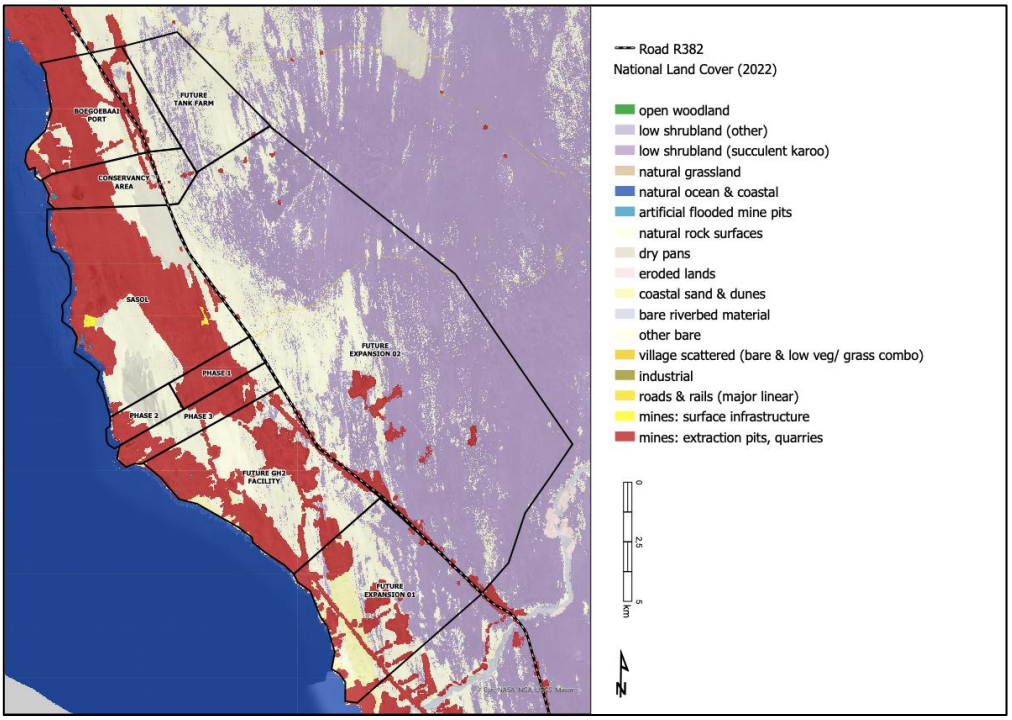


Figure 3-6: The 2022 land cover map of the Boegoebaai Port and SEZ site (DFFE, 2022).

### *3.3.2 Biodiversity attributes*

#### 3.3.2.1 Biomes and National Vegetation Types

The study area includes two biomes, *viz*. Desert and Succulent Karoo Biomes. When compared to other deserts with the same level of aridity globally, the Desert Biome in South Africa is exceptionally rich in plant species and hosts a large number of endemic plant species (Mucina & Rutherford, 2006). The Succulent Karoo is renowned for its unrivalled levels of diversity and endemism for an arid region (Cowling & Hillton-Taylor, 1999; Cowling *et al.*, 1999; Desmet & Cowling, 1999; Desmet, 2007) and is recognised by the International Union for Conservation of Nature (IUCN) as a global hotspot of diversity (CEPF, 2003;

Mittermeier *et al*., 2000; Myers *et al.,* 2000), and one of only two global hotspots that are entirely arid (https://www.cepf.net/our-work/biodiversity-hotspots).

Five National Vegetation Types are represented in the study area, belonging to two different biomes and an Azonal Coastal Vegetation Type (Mucina & Rutherford, 2006; mapping as presented in 2024 by SANBI) (Figure 3-7).

- Succulent Karoo Biome:
  - Richtersveld Coastal Duneveld (SKs 1)
  - Northern Richtersveld Yellow Duneveld (SKs 2)
  - Richtersveld Sandy Coastal Scorpionstailveld (SKs 4)
- Desert Biome:
  - Western Gariep Plains Desert (Dn 3)
- Azonal Coastal Vegetation Type:
  - Namib Seashore Vegetation (AZd 1)

*Richtersveld Coastal Duneveld (SKs 1)*

This vegetation type occupies a belt of 1–12 km broad along the Atlantic coast from approximately Alexander Bay in the north to halfway between Port Nolloth and Kleinzee in the south. The landscape is generally flat with some large, gently rolling coastal dunes. The dominant succulent shrubs are *Cephalophyllum ebracteatum* (VU), *Euphorbia mauritanica, Crassothonna sedifolia, Salsola nollothensis* and *Roepera morgsana.* Other noteworthy succulents include *Amphibolia rupis-arcuatae, Drosanthemum luederitzii, Jordaaniella cuprea, Lampranthus stipulaceus, Stoeberia utilis* and *Roepera cordifolia*. Non-succulent shrubs include *Asparagus capensis* and *Pteronia glabrata* and herbs are represented by *Grielum grandiflorum, Mesembryanthemum dinteri* and *Fenestraria rhopalophylla*. The most prominent graminoid is *Cladoraphis cyperoides* (Mucina & Rutherford, 2006). The Richtersveld Coastal Duneveld supports an array of fauna uniquely adapted to its challenging environment e.g. Namaqua chameleon (*Chamaeleo namaquensis*); brown hyaena (*Parahyaena brunnea*); Cape fur seal (*Arctocephalus pusillus pusillus;* see marine report); fog-dependent reptiles e.g. the Namib web-footed gecko (*Pachydactylus rangei*); and desert-adapted skinks.

The Richtersveld Coastal Duneveld is **Critically Endangered** with a conservation target of 26%. It is poorly protected and sustained conservation efforts are needed to protect its unique landscapes and species for future generations.

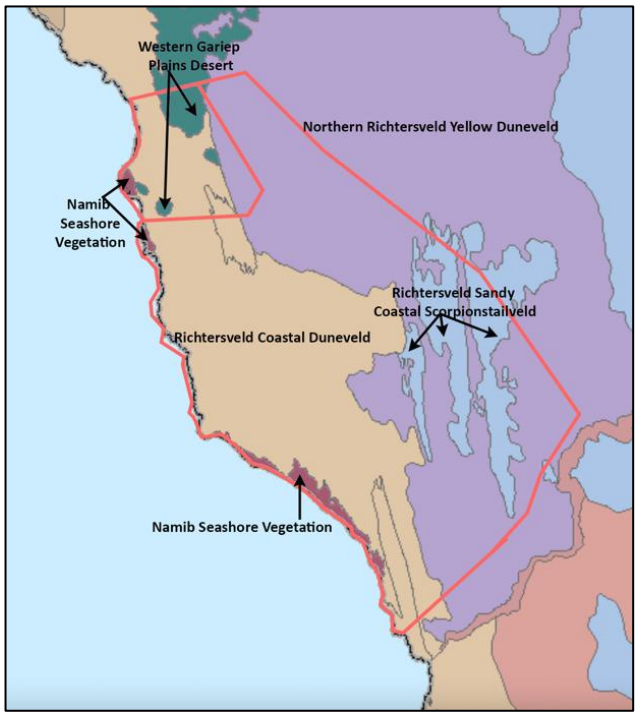


Figure 3-7: National Vegetation Type map of the Boegoebaai Port and SEZ site (Mucina and Rutherford, 2006 as updated in 2024 by the South African National Biodiversity Institute).

### *Northern Richtersveld Yellow Duneveld (SKs 2)*

SKs 2 occupies the land 5–25 km from the coast from southern Namibia to the Holgat River. The dune ridges and accompanying valley systems of the ancient dune fields are still partly visible. This region experiences a high frequency of coastal fog, providing vital moisture to sustain life in this arid environment. The dominant succulent shrubs are *Euphorbia* spp., *Crassothonna cylindrica* with associated species e.g. *Cephalophyllum ebracteatum* (VU), *Cheiridopsis robusta, Didelta carnosa, Jordaaniella cuprea, Lampranthus stipulaceus, Salsola tuberculata* and *Roepera morgsana*. Non-succulent shrubs include *Asparagus capensis, Calobota cinerea* and *Calobota angustifolia* and herbs are represented by *Grielum humifusum, Oncosiphon piluliferum* and *Mesembryanthemum schlichtianum*. The most prominent grass is *Cladoraphis cyperoides* (Mucina & Rutherford, 2006).

The Northern Richtersveld Yellow Duneveld has a **Least Concern** status with a conservation target of 26%. The vegetation type is not statutorily protected.

### *Richtersveld Sandy Coastal Scorpionstailveld (SKs 4)*

In the study site, SKs 4 occurs as three north-south trending bands. The unit is clearly visible on satellite images due to the dark colour caused by the biological soil surface crusts. The dominant succulent shrubs are *Mesembryanthemum pseudoschlichtianum* (locally known as groot skerpioenbos), *Cephalophyllum ebracteatum* (VU), *Crassothonna cylindrica, Mesembryanthemum serotinum, Cheiridopsis robusta,* various *Euphorbia* spp. and *Roepera morgsana*. Non-succulent shrubs are represented by *Calobota angustifolia* and *Asparagus capensis* and herbs include *Oncosiphon piluliferum* and *Trachyandra falcata*. The most prominent graminoid is *Cladoraphis cyperoides* (Mucina & Rutherford, 2006). Overall, prominent species in SKs 4 agree well with those in the Northern Richtersveld Yellow Duneveld (SKs 2).

The Richtersveld Sandy Coastal Scorpionstailveld (SKs 4) has a **Least Concern** status with a conservation target of 26%. The vegetation type is represented in the Richtersveld Cultural and Botanical Heritage Landscape.

*Western Gariep Plains Desert (Dn 3)*

The landscape is dominated by plains with undulating hills and rocky outcrops, the most notable of which are the Boegoeberg Twins. Dn 3 houses several near-endemic species that occur more frequently in Namibia. Common succulent shrubs are *Crassothonna sedifolia, Cephalophyllum ebracteatum* (VU)*, Mesembryanthemum* spp.*, Othonna lasiocarpa, Stoeberia beetzii, Amphibolia rupis-arcuatae, Cheiridopsis brownii* (EN), *Conophytum saxetanum* (EN)*, Crassula deceptor, Dracophilus dealbatus* (CR)*, Drosanthemum luederitzii, Euphorbia* spp.*, Monsonia patersonii* (VU)*, Psammophora modesta* (VU) and *Tylecodon schaeferianus* (VU). Low shrubs include *Asparagus capensis, Hermannia gariepina* and *Lycium decumbens* with herbs represented by *Pelargonium sibthorpiifolium* (CR) and grasses by *Cladoraphis cyperoides* (Mucina & Rutherford, 2006). The vegetation supports desert-adapted fauna, including the gemsbok (*Oryx gazella*); rodents e.g. *Gerbillurus* spp*;* and a rich variety of geckos, skinks and snakes e.g. Namaqua dwarf adder (*Bitis schneideri)*.

The Boegoeberg Twins deserve a very high protection level. From Angola to Port Nolloth there are only two mountainous structures located right next to the Atlantic Ocean viz. the two Boegoeberg Twins and the Laguneberg, 800 km further north. Only these qualify as fog oases comparable to the Lomas of the Atacama. The unique environmental setting supports a high probability that this environmental filter gave rise to an unique collection of plant and lichen species (Jürgens[2], review comment).

The Western Gariep Plains Desert is not statutorily protected. It has a **Least Concern** status with a conservation target of 28%. However, the threatened status of the Richtersveld Vegetation Types are currently being re-assessed. The current **Least Concern** status for the Western Gariep Plains Desert is inadequate and it is likely that it will be upgraded by the responsible authority.

*Namib Seashore Vegetation (AZd 1)*

This vegetation type is found along the Richtersveld coast between the Orange River mouth in the north and the Holgat River in the south. The sandy beaches are slightly sloping and bordered by mobile or fixed sand dunes and occasional coastal cliffs. Dominant shrubs are *Lycium tetrandrum*, *Tetragonia fruticosa, Didelta carnosa* and *Roepera clavata*. Low shrubs include *Asparagus capensis* and *Hebenstretia cordata* and the most prominent graminoid is *Cladoraphis cyperoides* (Mucina & Rutherford, 2006). Fauna likely to occur in this vegetation type include Grant's golden mole (*Eremitalpa granti granti*); Cape fur seal (*Arctocephalus pusillus pusillus;* see marine report); and various fog-dependent geckos and lizards. Adaptations to obtain moisture from the coastal fog are key in this environment.

The Namib Seashore Vegetation has a **Critically Endangered** status with a conservation target of 26%. It is not statutorily protected and has almost totally been transformed by mining.

### 3.3.2.2 Centres of Endemism

The Boegoebaai Port and SEZ site falls in the Gariep Centre of Endemism as defined by Van Wyk & Smith (2001). This centre of endemism is a combination of two quite distinct climatic, biogeographic and evolutionary units (Jürgens, 1991; Jürgens *et al.,* 1997; Mucina & Rutherford, 2006). Jürgens (1991, 1997) studied the distribution ranges of a very large number of species and proposed to split the Gariep Centre into 'East Gariep Centre' for the palaeotropical summer rainfall elements and a 'West Gariep Centre' for the Greater Cape winter rainfall elements, incidence of fog and floristic affinities with the Succulent Karoo Biome. At a lower hierarchical level within the West Gariep Centre, a 'Western Gariep Circle' has been identified as a local centre of endemism stretching from Alexander Bay to Sendelingsdrift/Lorelei. Several SCC on site are endemic to South Africa, although a large proportion of SCC are distributed from southern Namibia into the northwestern Richtersveld.

### 3.3.2.3 Protected Areas and National Protected Area Expansion Strategy

The study site is not part of a protected area (https://egis.environment.gov.za/data_egis/data SAPAD_IR_2024_Q2_01). The closest protected area to the site is the Richtersveld Cultural & Botanical

[2] Prof. Norbert Jürgens, Professor Emeritus, University of Hamburg, Germany.

Landscape, which has a Natural Heritage Site status declared in terms of the World Heritage Convention Act. To the north of the site lie the Orange River Mouth Nature Reserve and Orange River Mouth Wetland, a Ramsar Site (https://rsis.ramsar.org/ris/526).

Although the Boegoebaai Port section has not been included in the NPAES, a substantial portion of the SEZ section has been included in NPAES (2018) (Figure 3-8).

Figure 3-8: Map of the National Protected Areas Expansion Strategy around the Boegoebaai Port and SEZ site (NPAES, 2018).

#### 3.3.2.4 Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs)

Critical Biodiversity Areas (CBAs) are areas required to meet biodiversity targets for ecosystems, species or ecological processes. They are regarded as areas of high biodiversity and ecological value and need to be kept in a natural or near-natural state, with no further loss of habitat or species to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. The definitions for CBAs are (SANBI, 2018):

- CBA 1: Areas that are irreplaceable for meeting biodiversity targets. There are no other options for conserving the ecosystems, species or ecological processes in these areas.

- CBA 2: Areas that are the best option for meeting biodiversity targets, in the smallest area, while avoiding conflict with other land uses.

Permissible land uses in CBAs are those that are compatible with maintaining the natural vegetation cover in a healthy, ecological state and that do not result in a loss or degradation of natural habitat (Pool-Stanvliet *et al*., 2017). Undesirable land uses cause a loss of natural habitat or ecosystem functionality, e.g.: (i) industrial, commercial or residential developments; (ii) mining or prospecting; and (iii) intensive agriculture. It is thus clear that the Boegoebaai development would constitute an undesirable land use that would not be permissible in a CBA (Oosthuyzen & Geldenhuys, 2024).

An Ecological Support Area (ESA) is not essential for meeting biodiversity targets, but plays an important role in supporting the ecological functioning in a CBA. ESAs need to be maintained in a functional and often natural state, but some limited habitat loss may be acceptable. Other Natural Areas (ONAs) have not been identified as a priority and retain most of their natural character and perform a range of biodiversity and ecological functions.

Almost the entire proposed development site, not affected by mining, has been classified as either CBA 1 or CBA 2 (CBA map, 2016), with a single small ESA and ONA occurring near the southern boundary (Figure 3-9). The mining transformed areas were not classified. The main reasons provided for the mapping were the presence of: (a) threatened ecosystems; (b) NPAES; (c) threatened species; (d) high value climate resilience area; (e) SKEP expert area; and (f) natural wetlands.

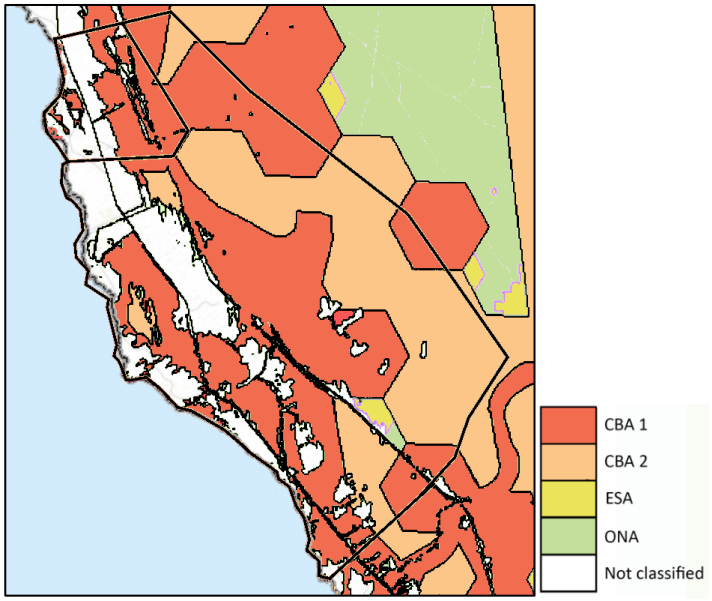


Figure 3-9: 2016 Northern Cape Critical Biodiversity Area map of the Boegoebaai Port and SEZ site.

### 3.3.2.5 Key Biodiversity Areas

The Key Biodiversity Area (KBA) Partnership (https://www.keybiodiversityareas.org) provides biodiversity information to assist governments and other stakeholders in decision-making on where to avoid development and how best to manage the land. A site qualifies as a global KBA if it meets one or more of 11 internationally agreed scientific criteria. The Boegoebaai Port and SEZ site is located in the Namaqualand Sandveld North KBA (Figure 3-10) that met 10 criteria (A1a[3], A1b, A1d, A2, B1, B2, B3a, B4, D1a and E).

[3] A1a: ≥0.5% of the global population size AND ≥5 reproductive units of a CR or EN species; A1b: ≥1% of the global population size AND ≥10 reproductive units of a VU species; A1d; ≥0.2% of the global population size AND ≥10 reproductive units of a species assessed as VU due only to population size reduction in the past or present; A2; holds a significant proportion of the global extent of an ecosystem type facing a high risk of collapse; B1: Site regularly holds ≥10% of the global population size AND ≥10 reproductive units of a species; B2: Site regularly holds ≥1% of the global population size of each of a number of restricted-range species in a taxonomic group, determined as either ≥2 species OR 0.02% of the global number of species in the taxonomic group, whichever is larger; B3a: ≥0.5% of the global population size of each of a number of ecoregion-restricted species within a taxonomic group, determined as either ≥5 species OR 10% of the species restricted to the ecoregion, whichever is larger; B4: Site holds ≥20% of the global extent of an ecosystem type; D1a: An aggregation representing ≥1% of the global population size of a species, over a season, and during one or more key stages of its life cycle; E: Site has a level of irreplaceability of ≥0.90 (on a 0–1 scale), measured by quantitative spatial analysis, and is characterised by the regular presence of species with ≥10 reproductive units known to occur (or ≥ 5 units for EN or CR species).

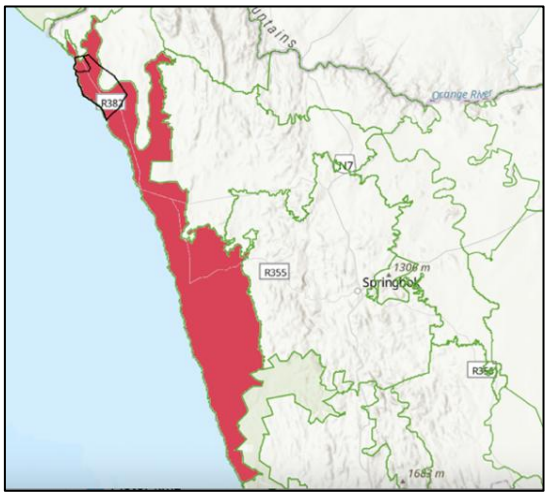


Figure 3-10: Location of the Namaqualand Sandveld North Key Biodiversity Area.

### 3.3.2.6 Areas with high concentrations of threatened species

The South African National Biodiversity Institute (SANBI) produced a map depicting areas within the Richtersveld with a high concentration of threatened species (Van Wyk, 2025; Figure 3-11). Two of these areas were mapped on site corresponding to the Boegoeberg Twins and Visagiesfonteinkop. Most of the areas with a concentration of threatened species occur further north of the site in the environs of the Orange River at Kortdoorn and Grootderm. Should accommodation be provided to employees in Alexander Bay, this would encroach on the areas with a high concentration of threatened species. The influx of people will increase air pollution levels from road traffic and the region will likely experience increased pressure of illegal plant harvesting.

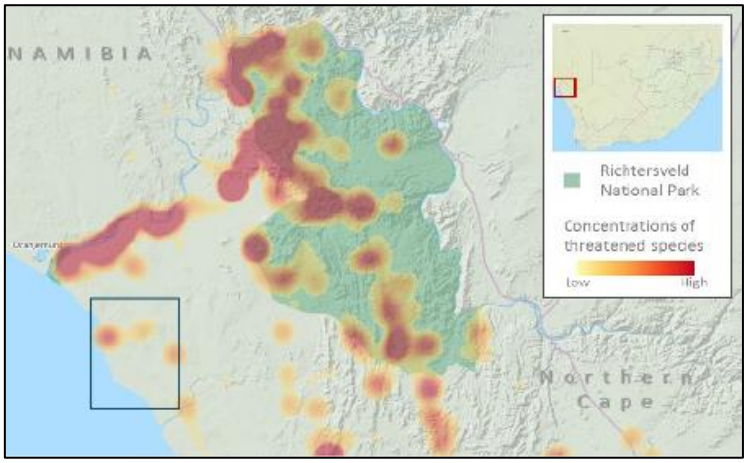


Figure 3-11: Map indicating areas with a concentration of threatened species in the Richtersveld with the Boegoebaai Port and SEZ shown as a rectangle (source: Van Wyk, 2025).

### 3.3.2.7 Lichen fields

The Namib Lichen Fields vegetation type, which lies approximately 13 km north of the proposed Boegoebaai Port and SEZ, is a **CR** ecosystem. It covers <80 ha, but represents a globally unique habitat and has been proclaimed as a Natural Heritage Site. Compared to the lichen fields in Namibia, these fields, the only in South Africa, have a higher diversity and biomass of lichens than those in Namibia and merit a very high conservation status (Jürgens & Niebel, 1991; Jürgens & Niebel-Lohmann, 1995).

Several environmental elements can be detrimental to lichens e.g. mobile sands (Jürgens & Niebel, 1991; Jürgens & Niebel-Lohmann, 1995); as well as dust and air pollution produced by road traffic. Most species live for decades and because they take up water and nutrients directly from the atmosphere they are exposed to the cumulative effects of pollutants (Nash, 2008). The Boegoebaai development is likely to exacerbate the negative effects of pollution and mobile sand.

### 3.3.2.8 Sensitive areas as indicated by local knowledge

Several localities (Figure 3-12) were identified as sensitive (Van Wyk, 2025) for the reasons provided below.

- It is critical that the **Boegoeberg Twins** (no 1, Figure 3-12) are fully conserved in the Conservation Area (Figure 3-1). **According to the current delineation, Boegoeberg North is not entirely included in the Conservation Area.** These two mountains host many threatened higher plant taxa and the lichen and microbiome richness is exceptional. Lichens are sensitive to air pollution and with the predominant southerly winds, air pollution coming from the proposed SEZ may negatively impact lichens on the Boegoeberg Twins.

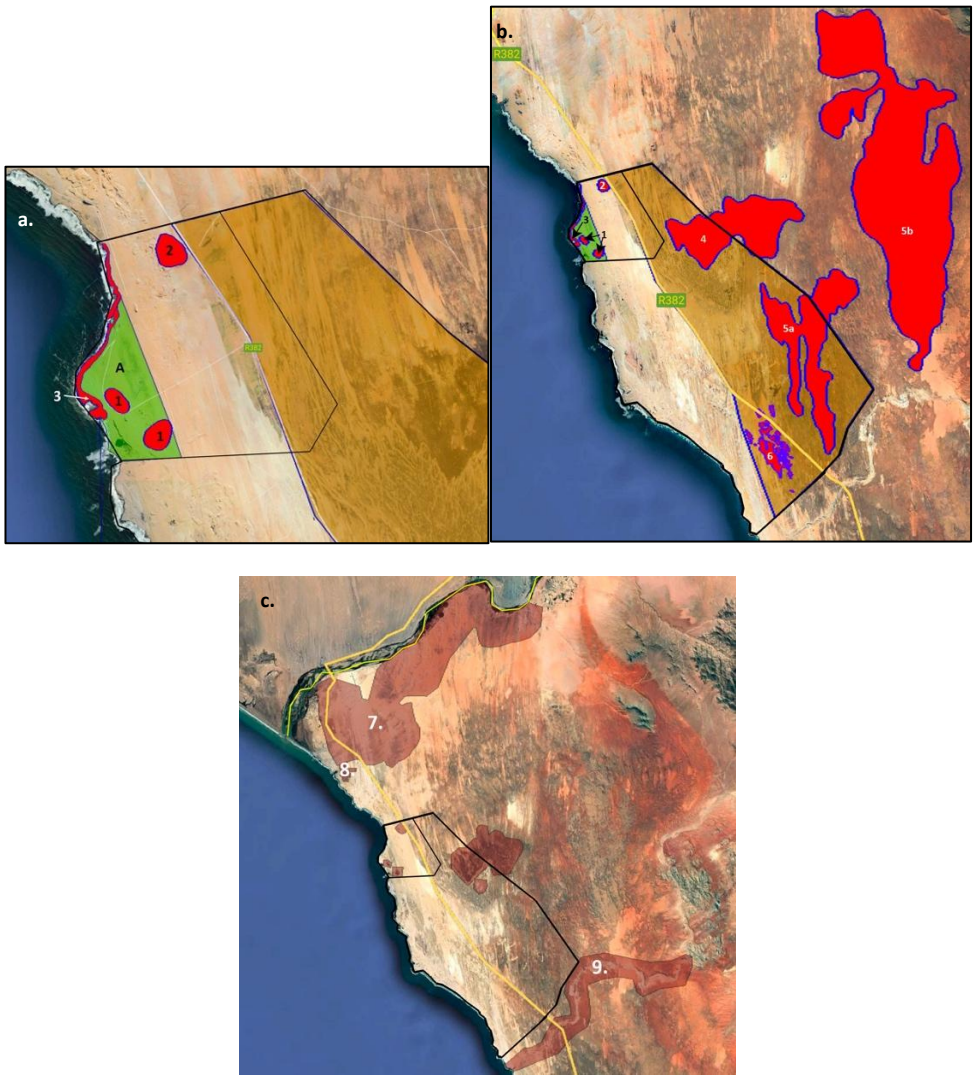


Figure 3-12**:** (a) Detail of Boegoebaai Port showing areas of **High** sensitivity as indicated by local knowledge. (b) Areas of **High** sensitivity in the Boegoebaai Port and SEZ site; and (c) Sensitive areas in the environs of the site. 1 = Boegoeberg Twins; 2 = Namakwakop; 3 = Northern coastline; 4 = Visagiesfonteinkop; 5a = Swartbank heuweltjies; 5b = Rooibank heuweltjies; 6 = Brant's whistling rat colonies 7. Pagvlei, Grootderm and Brandkaros; 8. outcrops near Alexander Bay; and 9. Holgat River (Van Wyk, 2025).

- **Namakwakop** (no 2, Figure 3-12) is a small hill, sharing several SCC with the Boegoeberg Twins.

- **The coastline north of Collins Jetty** (no 3, Figure 3-12), is the most sensitive section of shoreline left after the 98 years of diamond mining, from both a biodiversity and heritage point of view (Van Wyk, 2025; email comm.). It includes rocky sections containing the highest concentration of Sensitive species 305 **(CR)** within the species' distribution range. Moreover, the **EN** Bank cormorant is known to breed on these rocky cliffs. It also includes sections of the **CR** Namib Seashore Vegetation. Furthermore, it is home to a breading population of the Cape fur seal, a protected species.

- **Visagiesfonteinkop** (no 4, Figure 3-12) is an important habitat for the desert rain frog, *Breviceps macrops* **(VU).** It is also habitat to an undescribed *Pelargonium* sp.; a new *Crassula* sp.; populations of *Ruschia pallens;* Sensitive species 720 **(VU)**; *Ceropegia pulvinata (=Stapelia pulvinata);* Sensitive species 734 **(VU)**; and unique lichen flora, with several lichen species not found on the Boegoeberg Twins nor in the Namib lichen fields. Visagiesfonteinkop is also home to insects that have not been recorded elsewhere on the coastal plains.

- The **Rooibank & Swartbank Heuweltjies** (no 5, Figure 3-12) are associated with termites (Southern harvester termite, *Microhodotermes viator*) that are regarded as ecosystem engineers creating nutrient-rich loamy soil. At the Buffels River, Namaqualand, the termite nests were the oldest active termite features ever dated (Francis *et al.,* 2024).

- A large colony of **Brant's Whistling Rats** (*Parotomys brantsii*) (no 6, Figure 3-12) occurs in the SEZ site. The presence of these rats is often associated with an increase in reptile, raptor and small predator species.

### 3.3.2.9 Development proposals that have been approved for the site

There are currently two approved development proposals within the proposed Boegoeberg Port and SEZ site (Figure 3-13):

- The 225 MW Richtersveld Wind Energy Facility (dark blue line, Figure 3-13); and

- The Namakwa Prospecting proposal to establish the presence of economic deposits of heavy minerals by non-invasive and invasive prospecting over a period of five years (green line, Figure 3-13).

Other development applications/proposals include: the prospecting proposal (light blue line, Figure 3-13), mining right application by Whale Head Minerals (not indicated in Figure 3-13) and construction of a water supply pipeline between Alexanderbaai and Port Nolloth (not indicated in Figure 3-13).

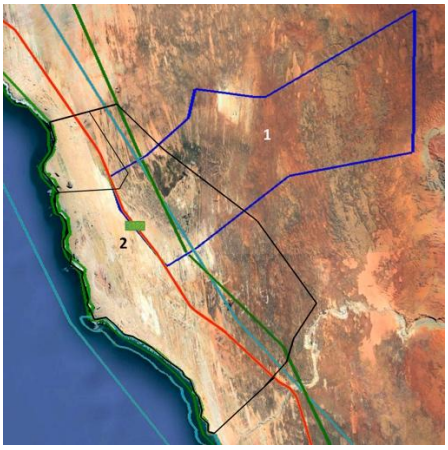


Figure 3-13: Location of the approved Richtersveld Wind Energy Facility (1) and the prospecting proposal (2).

### 3.3.2.10 Current land use

The main land uses in the region are mining and small stock farming. The Boegoebaai Port and SEZ land is owned by the Richtersveld Sida !Hub Community Property Association (CPA). Alexkor SOC Limited (Alexkor) and the Richtersveld Mining Company (Pty) Ltd (RMC) formed a Pooling and Sharing Joint Venture (PSJV) to oversee mining activities relating to Alexkor's mining rights. The PSJV outsources most of the marine prospecting and mining operations to contractors.

Currently, sand due primarily to soil disturbance by past diamond mining activities probably poses one of the greatest environmental threats to the natural environment, both in the mined areas and on adjacent land. The sand plume development is ascribed to prevailing winds and sand supply as well as coast line form. Early in this century a distinction could still be made between natural coastal sand plumes and mining-induced plumes, however, at present this distinction is lost and natural and mine-induced plumes have merged. Currently, a major cause for concern is the sand dune/plume threatening Boegoeberg South.

Severe overgrazing in many areas of the Richtersveld has led to widespread land degradation and a reduction in overall species diversity Jürgens *et al.* (in press). Some vegetation types are more vulnerable than others, with heuweltjieveld being one of the vulnerable types. Signs of overgrazing are particularly noticeable around stockposts.

In a recent publication by Jürgens *et al.* (in press) the observed vegetation degradation in the Richtersveld (as well as in the current assessment area) was interpreted as a combination of anthropogenic causes and climate change. Jürgens *et al*. (in press) presented a conceptual model of how the vegetation in the coastal region of the Richtersveld is degraded by the anthropogenic impacts of farming (e.g. overgrazing), mining and roads. These human activities all degrade or remove the vegetation and thus trigger either the erosion of silt or the mobilisation of aeolian sand with associated sand abrasion and the formation of sand plumes. In the original vegetation state the silty soils are stable and often covered by a biological surface crust. Further grazing, trampling, drought and sandblasting drives the development of an entirely new vegetation state composed of a different complement of species. Eventually the vegetation becomes buried in the sand. There is thus a retrogression from a species-rich, stable and productive Succulent Karoo vegetation state to a species-poor, unstable and less productive grassy Desert vegetation state.

### 3.3.2.11 Ecosystem processes

The Boegoebaai Port and SEZ site lies in a hyper-arid region and years with below average annual rainfall are a common occurrence. Terrestrial ecosystems in the study area are subject to high wind speeds that result in severe aeolian erosion, transport and sedimentation. These processes have been exacerbated by the extreme transformation of the land by mining. The destructive action of the wind is particularly prominent in areas where the vegetation has been degraded and is sparse (Desmet, 1996). The sandblasting reduces photosynthetic activity and affects plant reproduction with young plants being particularly vulnerable. Eventually the vegetation becomes buried under the aeolian sand.

It is critical that the trajectories of sand and dust transport from the proposed development is modelled. Mitigation measures to stabilise the sand before it impacts on priority ecosystems (e.g. the Namib Lichen Fields and the Orange River Estuary) further north are crucial.

Ecological processes such as primary production, decomposition, nutrient cycling and fluxes of nutrients and energy will all be altered by the clearing of the vegetation at the footprints of the infrastructure. Disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions will depend on the presence of ecological corridors and the size of the disturbed area in relation to the adjacent landscape where no change to the ecological processes is anticipated. Seed dispersal in many species occupying arid areas is often characterised by adaptations that hinder seed dispersal. In such species, recolonisation of an area after a disturbance is likely to be very slow.

Psammophytes are plants or animals that thrive in sandy environments. Psammophilous plants exhibit many survival strategies such as mechanisms to reduce water loss by having small leaves or the shedding of plant parts. A noteworthy adaptation of some Namib psammophytes is their ability to harvest fog, while other species produce succulent leaves, stems and/or roots. Some psammophilous plants survive wind

erosion due to the possession of thick sheaths around their roots that withstand root exposure and sandblasting, while others produce a thick bark or wax layers. Some psammophilous species exhibit epidermis adaptations that allow them to fix a protective layer of sand grains to the leaf surface. Yet other species disappear seasonally below the sand surface by shrinking their succulent tissue during the dry summer months, and re-emerging during the rainy season. A unique set of psammophilous animals has also evolved in the Namib dunes, with sand moisture being the most important driver of their adaptations (Henschel & Jürgens, in press).

#### 3.3.2.12 Climate change

Depending on the model parameterisation and climate scenarios used, widely divergent projections are produced for the Succulent Karoo Biome. Early projections predicted a substantial contraction of the Succulent Karoo (Midgley *et al*., 2001), while more recent models suggest that the biome will be rather resilient to climate change and will in future not differ substantially from its current distribution (Driver *et al.,* 2012). Repeat photography studies indicate that modelled projections and observed measurements of vegetation change differ significantly (Davis *et al*., 2016, Hoffman *et al*., 2019). For most southern African biomes, there is little evidence yet of the catastrophic shifts in ecosystem structure and function that are envisaged for the future due to climate change.

The 2018 NBA projected a limited switch from Succulent Karoo to Desert in its northern reaches and its expansion in the southern coastal region to replace parts of the Fynbos Biome (Skowno *et al.,* 2019). A study by Broennimann *et al.* (2006) found that geophytes and succulents, were particularly vulnerable to climate change and Midgley & Thuiller (2007) also contended that succulents could be susceptible to the impacts of climate change. The risk to dwarf succulents, in particular *Conophytum* spp., was highlighted by Young *et al*. (2016).

It is widely recognized that vegetation degradation is occurring at an alarming rate in the region due to a combination of anthropogenic factors and climate change. This habitat deterioration will inevitably also impact avifaunal, bat and mammal, reptile and amphibian diversity and abundance. Mapping of land use dynamics and change trends over time relating to aquatic, avifauna, bat and other fauna is not feasible for these primarily desktop studies.

## 3.4 KEY FINDINGS OF THE ASSESSMENTS

### *3.4.1 Aquatic Ecology*

Overall, the assessment showed that the study area is not rich in inland aquatic ecosystems. However, in such an arid area, these ecosystems are likely of very high importance to terrestrial fauna (Niemandt, 2025), and the ephemeral pans are assumed to support interesting and rare aquatic macroinvertebrates, including crustacean zooplankton fauna. The larger pans, such as Visagiespan, Rietfontein and Rietfonteinpan (BB1, BB2 and BB3 in Figure 3-14) afford wetland and pan habitat, with links to primary and/or secondary aquifers, which form springs (Visagiespan), creating permanent standing water. These are utilised by terrestrial fauna, either directly as a brackish to saline water source or indirectly, for grazing of wetland plants. Other inland aquatic ecosystems of assumed high biodiversity importance are ephemeral pools (rock pools) located in rocky outcrops, some of which are likely to support invertebrate communities with potentially high levels of regional endemism and of a high conservation importance. These rock pools have, however, been mapped in this study with low confidence.

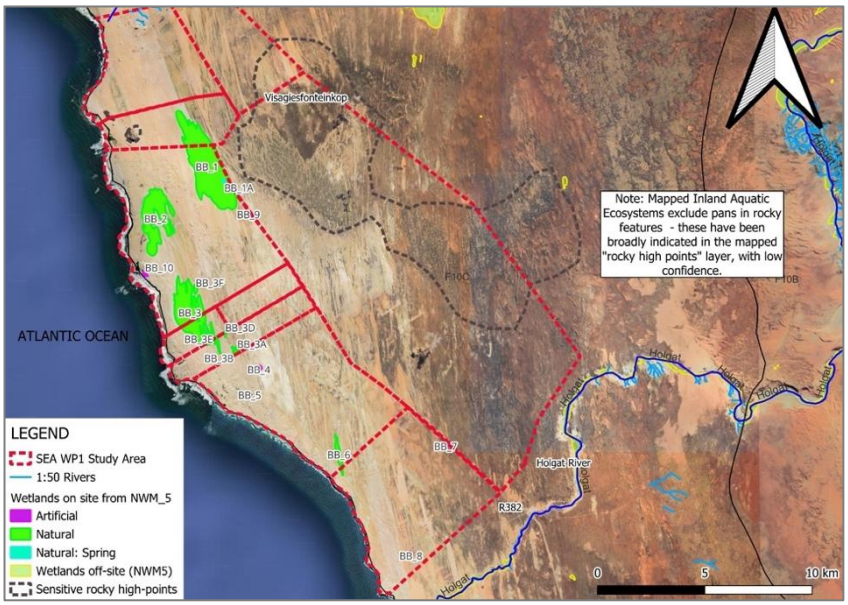


Figure 3-14: Coded, mostly ground-truthed inland watercourses in the study area, with extent based on NWM Ver 5 (Van Deventer *et al*., 2019). Rocky high points have been mapped at desktop level with low confidence.

At least one species of fish is supported in the waters of Visagiespan. The species is currently unconfirmed. The mullet (*Chelon richardsonii*) has supposedly been introduced into excavated channels in the Holgat Estuary, and it is possible that it might also have been introduced into the spring environment. None of the other pans are likely to support fish as they all dry out in summer, with even Rietfontein, which still had some hypersaline, hypertrophic pools in December 2024, being likely to dry out completely over summer.

Ephemeral pans and pools in the study area; various artificial scrapes; and temporary pools in rocky areas could all potentially support communities of invertebrate fauna that are adapted to life in transient aquatic conditions. Such fauna could include branchiopod crustaceans, with taxa from four orders associated with temporary freshwater habitats (Conchostraca (clam shrimps); Cladocera (water fleas – e.g. daphnia); Notostraca (tadpole shrimps of the genus *Trips* (Rayner, 1996); and Anostraca (fairy shrimps)). Species richness in temporary waterbodies relates to the size and habitat diversity of the water body and to habitat duration (Ebert & Balko, 1987; Hamer & Rayner, 1996; Mabidi *et al.,* 2016).

## *3.4.2 Terrestrial Ecology*

### 3.4.2.1 Avifauna

Eighty-seven (87) bird species were recorded in the broader area of which 47 are priority species. Of the 87 bird species, 13 species are either terrestrial SCC and/or SA endemics/near-endemics or range-restricted. Seabirds are discussed in the marine report.

**Black harrier *(Circus maurus):*** The black harrier (Globally and Regionally **EN**) is one of southern Africa's rarest near-endemic raptors. The regional population has been quantified at <1 000 mature individuals with an estimated continuing decline of *ca*. 20% within the next two generations (Taylor *et al.,* 2015). Although they are unlikely to breed on site, suitable foraging habitat is present. An isolated population of about 10 mature individuals occurs in northern coastal Namibia, where they may breed.

**Cape long-billed lark *(Certhilauda curvirostris):*** The Cape long-billed lark is **near-endemic** to South Africa, occurring from the south of Namibia through the western parts of the Northern and Western Cape. It generally prefers coastal scrub with sparse vegetation (Hockey *et al.,* 2005) and could therefore occur on

site within scrubland habitat. Their population is suspected to be in decline as a result of the effects of agriculture and mining (BirdLife International, 2025).

**Caspian tern *(Sterna caspia):*** The regional population of Caspian tern (Regionally **VU**) is estimated to be <1 000 mature individuals. The species has a restricted number of breeding locations which makes it prone to the effects of human activities and stochastic events (Taylor *et al.,* 2015). Within the region, it is concentrated at estuaries and sheltered bays on the coast and at large, permanent inland waterbodies (Hockey *et al*., 2005). During their breeding period Caspian terns are susceptible to egg collecting and predation by domestic dogs (Crawford *et al.,* 2012) as well as extreme weather events (Du Toit *et al.,* 2003). Lesser threats include the bioaccumulation of heavy metals, pesticides and other chemical pollutants (Crawford *et al.,* 2012).

**Curlew sandpiper *(Calidris ferruginea):*** The curlew sandpiper (Globally **VU**) occurs on coastal brackish lagoons, tidal mud- and sand-flats, estuaries, saltmarshes, exposed coral, rocky shores and tidewrack on sandy beaches (Hockey *et al.,* 2005). Inland it occurs on the muddy edges of marshes, flooded areas, dams and saltpans (Dodman, 2014). Within the PAOI it is likely to use estuarine habitats.

**Damara tern *(Sterna balaenarum):*** The Damara tern (Globally **LC**; Regionally **CR**) is locally common along the coast of Namibia and the Northern Cape (Hockey *et al.,* 2005). It prefers arid/desert shores, especially sheltered bays and reefs, while it mainly breeds on gravel plains between dunes and on salt pans. They are known to have bred in dune fields along the coast in the PAOI (Taylor *et al.,* 2015). Off-road vehicles threaten colonies by causing nest abandonment and crushing nests (Braby *et al*., 2009). Increased jackal and gull populations driven by human activity, as well as the growing numbers of seals and seal colonies in South Africa and Namibia, have increased the risk of predation (Braby *et al.,* 2011).

**Dune lark (Coastal) *(Calendulauda erythrochlamys patae)*** (Globally **LC**)*:* The regional subspecies of the dune lark that occupies the coastal plain in the north-western Northern Cape, was until recently regarded as a unique species, Barlow's lark *Calendulauda barlowi* (Ryan & Kirwan, 2022). This regional range-restricted subspecies was treated as a priority species because of its high local abundance and its distinct habitat requirements. It is estimated that approximately 30% of its South African distribution falls with the PAOI. The regional subspecies is found anywhere within the PAOI with suitable shrubland. It is restricted to natural habitats and generally absent from transformed areas. Habitat loss in this key area could significantly impact the subspecies.

**Eurasian curlew *(Numenius arquata):*** This **NT** (Global and Regional) species is a non-breeding Palaearctic migrant, present in South Africa from September to March (Taylor *et al.,* 2015). In southern Africa, Eurasian curlews frequent muddy coasts, bays and estuaries with tidal mudflats and sandflats (Snow & Perrins, 1998) and rocky and sandy beaches (Navedo *et al.,* 2013). Curlews are likely to occur in estuarine habitats along the coast within the PAOI. Several key populations of the Eurasian curlew, are suspected to be experiencing moderately rapid declines.

**Greater flamingo *(Phoenicopterus roseus):*** The greater flamingo (Globally **LC;** Regionally **NT**) generally prefers coastal mudflats, inland dams, sewage treatment works, small temporary pans and river mouths, while it breeds at recently flooded, large eutrophic shallow salt pans (Hockey *et al.,* 2005). Within the PAOI flamingos are likely to use freshwater pans and estuarine habitats. Population declines are largely due to lowering water tables at breeding sites and collisions with powerlines and wind turbines.

**Great white pelican *(Pelecanus onocrotalus):*** The regional population of the great white pelican (Regionally **VU**) has been quantified at *ca.* 2 500 pairs, restricted to less than five breeding locations. Freshwater pans and estuarine habitats along the coast are habitats that pelicans are likely to use. Threats include human disturbance at breeding colonies (Berry *et al*., 1973), pollution (Crawford *et al*., 1995), collisions with power lines and the effects of drought.

**Jackal Buzzard *(Buteo rufofuscus):*** The jackal buzzard is classified as **near-endemic** with its range including South Africa, Lesotho, Namibia, extreme southern and southwestern parts of Mozambique and Botswana (Kemp & Kirwan, 2020). They are abundant in the central and north-western Karoo (Tippett, 2024). They are well adapted to diverse environments, from fairly wet habitats to semi-desert coastal regions of Namibia. Threats include habitat loss, and collisions with man-made structures such as wind turbines, powerlines and drowning in steep-sided reservoirs or farm dams (Nkomo *et al*., 2024). Additionally, their scavenging behaviour exposes them to the risk of poisoned carcasses.

**Lanner falcon *(Falco biarmicus):*** The Lanner falcon (Regionally **VU**) is widely distributed across Africa, the Arabian Peninsula and the Western Palaearctic (Ferguson-Lees & Christie, 2001). It occurs mostly in open grassland, cleared woodlands and agricultural areas. Breeding pairs tend to favour cliffs as nesting and roosting sites; however, they will also use alternative structures such as trees, pylons and buildings (Hockey *et al*., 2005). Within the PAOI they would use the powerline in the west and could potentially hunt over the entire area.

**Ludwig's bustard *(Neotis ludwigii):*** Ludwig's bustard (Globally and Regionally **EN**) occurs mainly in western Namibia and western South Africa (Taylor *et al.,* 2015). It prefers semi-arid shrublands of the Karoo, Namib Desert and Nama Karoo. It could occur throughout the PAOI within shrubland habitat. The main threat to Ludwig's Bustards originate from collisions with power and telephone lines causing unsustainable mortality rates in the Karoo (Jenkins *et al*., 2011). Poisoning and displacement due to disturbance are also threats to this bird species.

**Martial eagle *(Polemaetus bellicosus):*** Martial eagles (Globally and Regionally **EN**) occur in much of sub-Saharan Africa. In southern Africa, it is widespread but uncommon, generally preferring flat, open woodland. Within the PAOI, they would utilise the powerline in the west and potentially cover the entire area for hunting. Key threats include direct persecution through shooting and trapping by small-stock farmers, indirect poisoning, drowning in sheer-walled farm reservoirs, loss of natural prey due to habitat degradation, nest site disturbance, electrocution on electricity pylons and rangeland degradation affecting the distribution, abundance and accessibility of prey (Taylor *et al.,* 2015).

Mitigation measures to minimise impacts on avifauna at specific developments within the SEZ should be identified during an avifaunal specialist study. These measures should include strategic planning to avoid nests of large raptors and core breeding habitat areas of smaller passerine species, thereby minimizing disturbances at breeding, feeding, and roosting sites. Additionally, marking powerlines with flight diverters is a widely adopted approach to reduce collision risks, as these devices improve the visibility of powerlines for birds in flight. Incorporating such measures into development plans not only helps safeguard avian populations but also aligns with sustainable environmental principles.

#### 3.4.2.2 Bats

Based on literature sources ten (10) bat species have previously been recorded in the area or may occur in the region. One of these species has a regional **NT** status (2016) and three have a **NT** status in the 2004 listing. The Angolan wing-gland bat (*Cistugo seabrae*) (regional **NT**) may roost in buildings, the Holgat ravine or Boegoeberg Twins.

Four impacts on bats were identified: (i) light pollution affecting light-averse bat species and creating artificial foraging habitats; (ii) possible bat mortalities or injuries due to hot steam/water discharge at the water-cooling tower blowdown; (iii) foraging habitat destruction; and (iv) roosting habitat destruction. Of these impacts light pollution would be the most significant. However, if the water-cooling towers are equipped with exposed radiator designs, acute and high bat mortalities may occur. It is therefore critical that a bat specialist be consulted on the intended design of the water-cooling towers.

Mitigation measures proposed include (i) keeping artificial lighting on infrastructure to a minimum, while still adhering to safety and security requirements; (ii) closing up water-cooling radiators with a mesh/grid with a diameter of 10 mm or less, to prevent bats and other wildlife from taking refuge inside radiator spaces; and (iii) adhering to the bat sensitivity map should adequately mitigate against foraging and roosting habitat destruction.

According to available information consulted during this study, there are no fatal flaws from a bat sensitivity perspective which should prevent the proposed development from proceeding towards the Environmental Impact Assessment process.

### 3.4.2.3 Mammals

Approximately 40 mammal species occur in the broader region (Virtual Museum ADU http://vmus.adu.org.za/; iNaturalist records), however, habitat for all these species is not available on site. The site is ideal for smaller mammals and a relatively large number of rodents, shrews, moles and mole rats occur in the surrounding area. Common species observed within the vicinity include *Parotomys brantsii*, *Micaelamys namaquensis* and *Otomys unisulcatus* and some medium to larger species such as *Oryx gazella, Parahyaena brunnea* and *Felis lybica.* The Cape fur seal will be discussed in the marine report. Four species of conservation concern (SCC) could potentially occur on site:

***Cryptochloris wintoni*** **(CR) (De Winton's golden mole)** is known only from the type locality at Port Nolloth and was recently rediscovered after 86 years (Mynhardt, 2023; Mynhardt *et al*., 2024; Figure 3-15). It occurs in an area threatened by habitat transformation by diamond mining. The species was recorded with eDNA samples along the West Coast from Lamberts Bay to Visagiesfontein (Mynhardt *et al*., 2024). The presence of the species on site must still be established through appropriate survey techniques. **If recorded, the presence of the species likely represents a fatal flaw to the project, especially the Richtersveld Coastal Duneveld.**

***Eremitalpa granti granti*** **(VU) (Grant's golden mole)** is endemic to southern Africa, with its distribution focused in the arid western parts of the Northern Cape and Namibia (Figure 3-15). Its narrow habitat requirements and sensitivity make it vulnerable to human and environmental changes. The species was recorded with eDNA samples along the West Coast at Visagiesfontein (Mynhardt *et al*., 2024) and south of the site. The presence of the species on site must still be established through appropriate survey techniques. **If recorded, the presence of the species likely represents a fatal flaw to the project, especially the Richtersveld Coastal Duneveld habitat.**

***Panthera pardus pardus*** **(VU; CITES Appendix I) (African leopard)** is widely distributed across southern Africa occurring at low densities in the Northern Cape (Figure 3-15). Primary threats to leopards include habitat loss and fragmentation, prey depletion, human-wildlife conflict, trophy hunting, poaching for skins and body parts and indiscriminate killing. The species has not been recorded on site but it does occur east of the site. Should it occur on site, it does not represent a fatal flaw as the necessary mitigation measures can be implemented to reduce impacts on the species.

***Parahyaena brunnea*** **(NT) (brown hyaena)** occurs throughout southern Africa, but primarily occupies the western Northern Cape (Figure 3-15). Its distribution is fragmented due to habitat degradation and human activity. The species has been recorded on and surrounding the site. Appropriate mitigation measures are required to reduce direct and indirect impacts on the species and its habitat. The presence of the species does not represent a fatal flaw to the project.

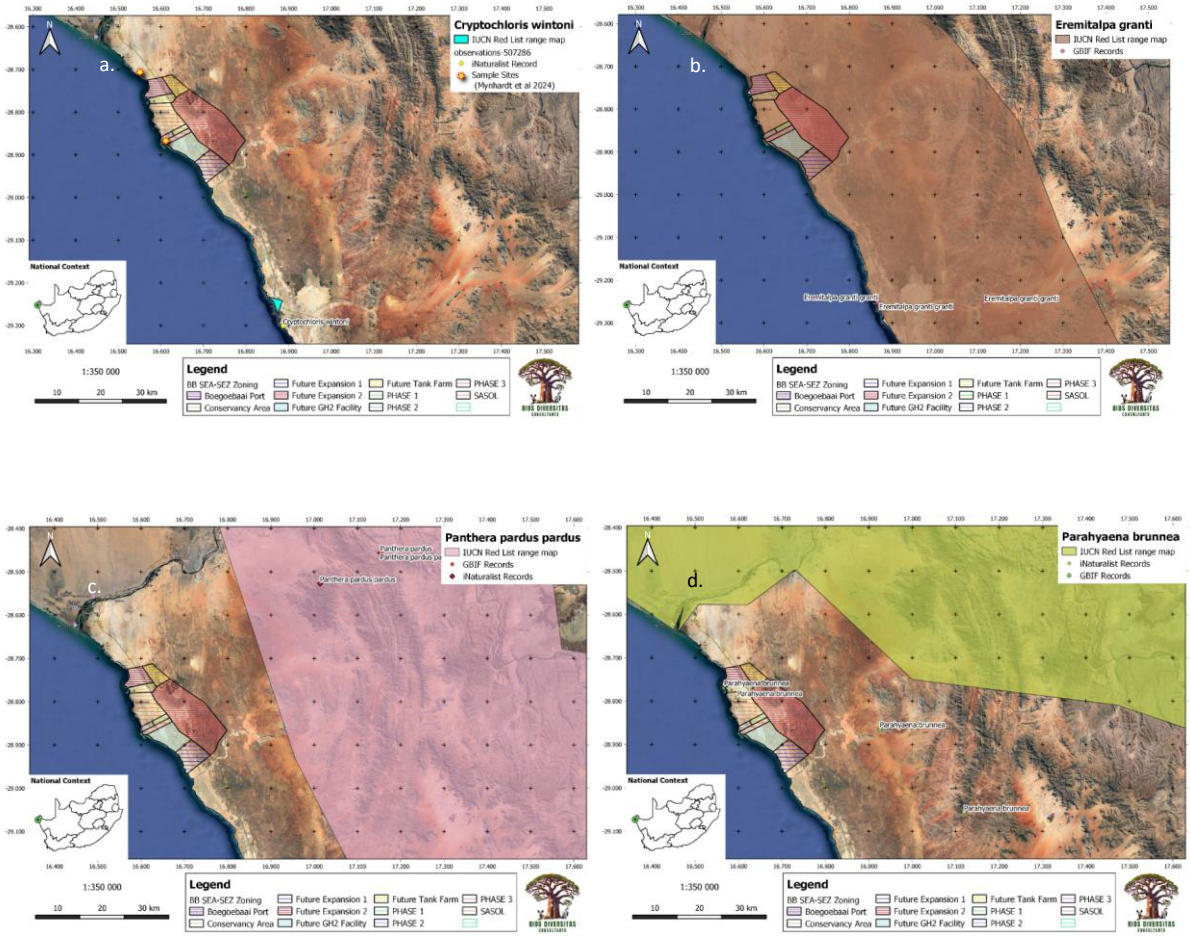


Figure 3-15: IUCN distribution range for (a) *Cryptochloris wintoni*; (b) *Eremitalpa granti*; (c) *Panthera pardus pardus*; and (d) *Parahyaena brunnea* in relation to the study area.

### 3.4.2.4 Reptiles

As many as 58 reptile species may potentially occupy the site. The area is particularly rich in lizards and snakes. Several chameleons, lizards and tortoises are vulnerable to collection, and the increased accessibility resulting from the development would raise the risk for these species. Five SCC have been recorded in the region:

***Psammobates tentorius trimeni*** **(EN; CITES Appendix II) (western tent tortoise)** is restricted to a few vegetation types in the western Succulent Karoo (Figure 3-16), which are under continued pressure from overgrazing, destructive mining, uncontrolled plant harvesting and climate change. Predation by the pied crow (*Corvus albus*) on this taxon is severe. The species is protected in South Africa by provincial nature conservation ordinances and biodiversity laws at regional level. Based on the IUCN range data for the higher taxon group and observational records, the species can potentially occur on site although it is found mainly east of the site. The site is considered to have a **medium sensitivity** for the species.

***Dermochelys coriacea*** **(CR regionally; VU globally) (leatherback sea turtle)** is distributed circumglobally, with its distribution range overlapping the Boegoebaai Port & SEZ site (Figure 3-16), although the site has not been identified as a nesting beach. The Namib Seashore Vegetation could be utilised by the species. It is unlikely that the species would represent a fatal flaw, but in the absence of sufficient field data the precautionary principle must be followed.

***Chersobius signatus*** **(EN) (speckled Cape tortoise)** is endemic to South Africa, with the most northerly records from the Richtersveld (Bauer & Branch, 2001; iNaturalist; Figure 3-16). Based on IUCN range data and iNaturalist records, it is unlikely to occur on site as it prefers rocky terrain east of the site. The site is considered to have a **low to medium sensitivity** for the species.

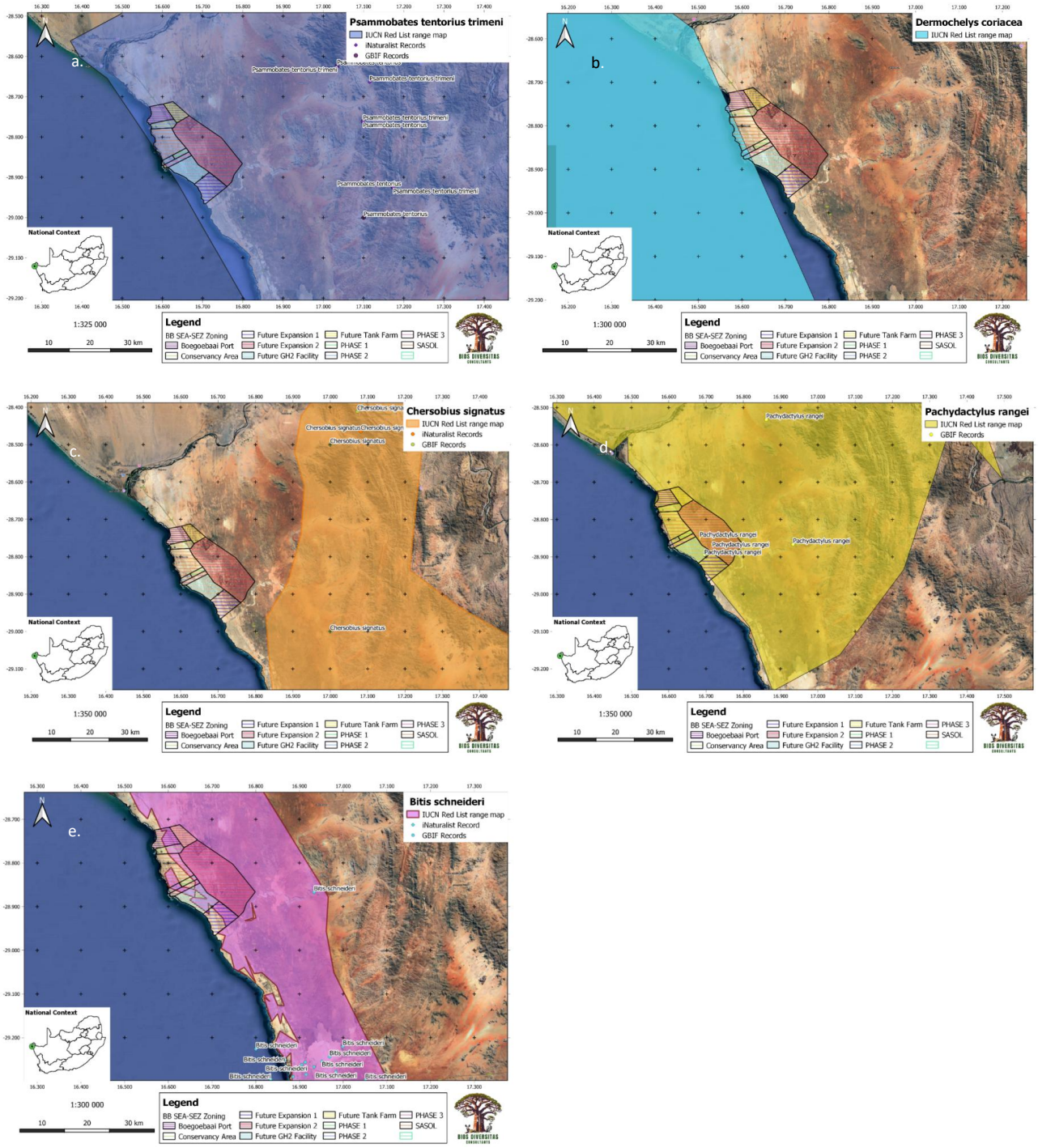


Figure 3-16: IUCN distribution range for (a) *Psammobates tentorius trimeni*; (b) *Dermochelys coriacea*; (c) *Chersobius signatus*; (d) *Pachydactylis rangei*; and (e) *Bitis schneideri* in relation to the study area.

***Pachydactylus rangei* (CR regionally; LC globally) (Namib web-footed gecko)** is a nocturnal, dune-dwelling gecko endemic to southern Africa (Figure 3-16). Its distribution extends marginally into South Africa where it is threatened by diamond mining (Bates *et al*., 2014) but it has an extensive range in Namibia and Angola where it is abundant, with a stable population (Baptista *et al*., 2020). The species has been recorded on site and thus the site is considered to have a **high sensitivity** for the species. Additional mitigation measures will be required in the breeding period during the construction phase.

***Bitis schneideri*** **(NT Regionally, LC globally) (Namaqua dwarf adder)** is endemic to southern Africa (Figure 3-16). It is a habitat specialist and its habitat is impacted by habitat transformation due to mining and urbanisation. The species has been observed on site and the site is considered to have a **moderate sensitivity** for the species.

### 3.4.2.5 Amphibians

As a result of the scarcity of fresh water in the area, only four amphibian species are likely to occur on site with only one species classified as SCC.

***Breviceps macrops*** **(desert rain frog) (VU)** occupies a narrow coastal strip along the northwestern Namaqualand coast (Figure 3-17). It is active during dense fog conditions. The species has been recorded on site. It is unlikely that it presents a fatal flaw to the project, but recorded habitat must be preserved and the appropriate mitigation measures applied.

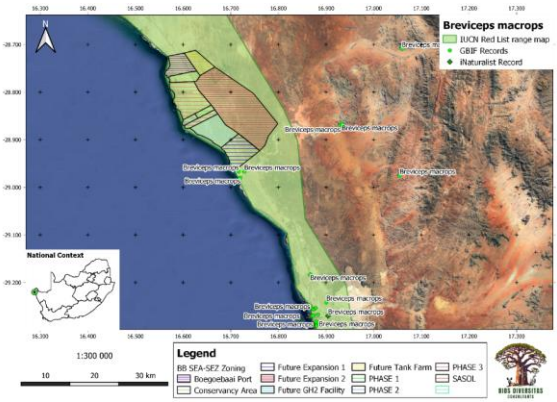


Figure 3-17: IUCN distribution range for *Breviceps macrops* in relation to the study area.

### 3.4.2.6 Vegetation and Flora

The provisional checklist (Supplementary material: Van Rooyen *et al*., 2025) for the Boegoebaai Port and SEZ site contains 390 plant species that have been confirmed as occurring on site from data collected by P. van Wyk; the current site visit in 2024; iNaturalist; data supplied by SANBI (2024) and extracted from SANBI's Brahms database (NewPOSA). The confirmed on-site checklist includes eight species with a **CR** IUCN status; nine **EN** species; 15 **VU** species; seven **NT** species; six **DD** species; and one **Rare** species. Thus, in total 46 species could be classified as SCC representing 11.8% of all species on site. Twenty one species, currently listed as LC could potentially become SCC should the Boegoebaai development proceed (SANBI, 2024).

Considering the limited access to the mining area to the west of the R382, the on-site checklist is probably not a full inventory of plant species occurring on site. Furthermore, the impacts of a large development such as the Boegoebaai Port and SEZ will generally not be limited to the site but will be more widespread and land adjoining the site will also be affected. Areas indirectly impacted by the development could include parts of Kortdoorn and Grootderm along the Orange River, an area with a particularly high concentration of SCC. These areas could also be targeted by plant poaching as a result of increased human activities due to the development.

Plant families contributing most species to the provisional checklist were the Aizoaceae (vygie family) and Asteraceae (daisy family). Seed dispersal in the Aizoaceae is generally restricted in space and time. These plants possess hygrochastic fruits that open when moistened to allow the seeds to disperse by falling raindrops and close again during dry weather. Primary dispersal is usually over very short distances. However, seed dispersal occurs only when it rains and conditions for germination should theoretically be suitable. In contrast, the fruits of the Asteraceae are often well equipped with mechanisms that aid wind

dispersal (e.g. wings or plumes). Habitat fragmentation will therefore have a greater negative effect on the Aizoaceae than the Asteraceae and recolonisation after a major disturbance will be slower in the Aizoaceae. Many of the SCC occurring on site are members of the Aizoaceae.

Although a detailed field assessment of the vegetation was not necessary at the screening level required for the SEA, a broad-scale, high-level, on-site reconnaissance and evaluation of the vegetation was deemed necessary to verify the Screening Tool's site sensitivity. Floristic data gathered during the site visit were classified following phytosociological procedures and nine plant communities (habitats) were identified (Figure 3-18). A full description of the plant communities is provided in the report on the vegetation (Supplementary material: Van Rooyen *et al.,* 2025).

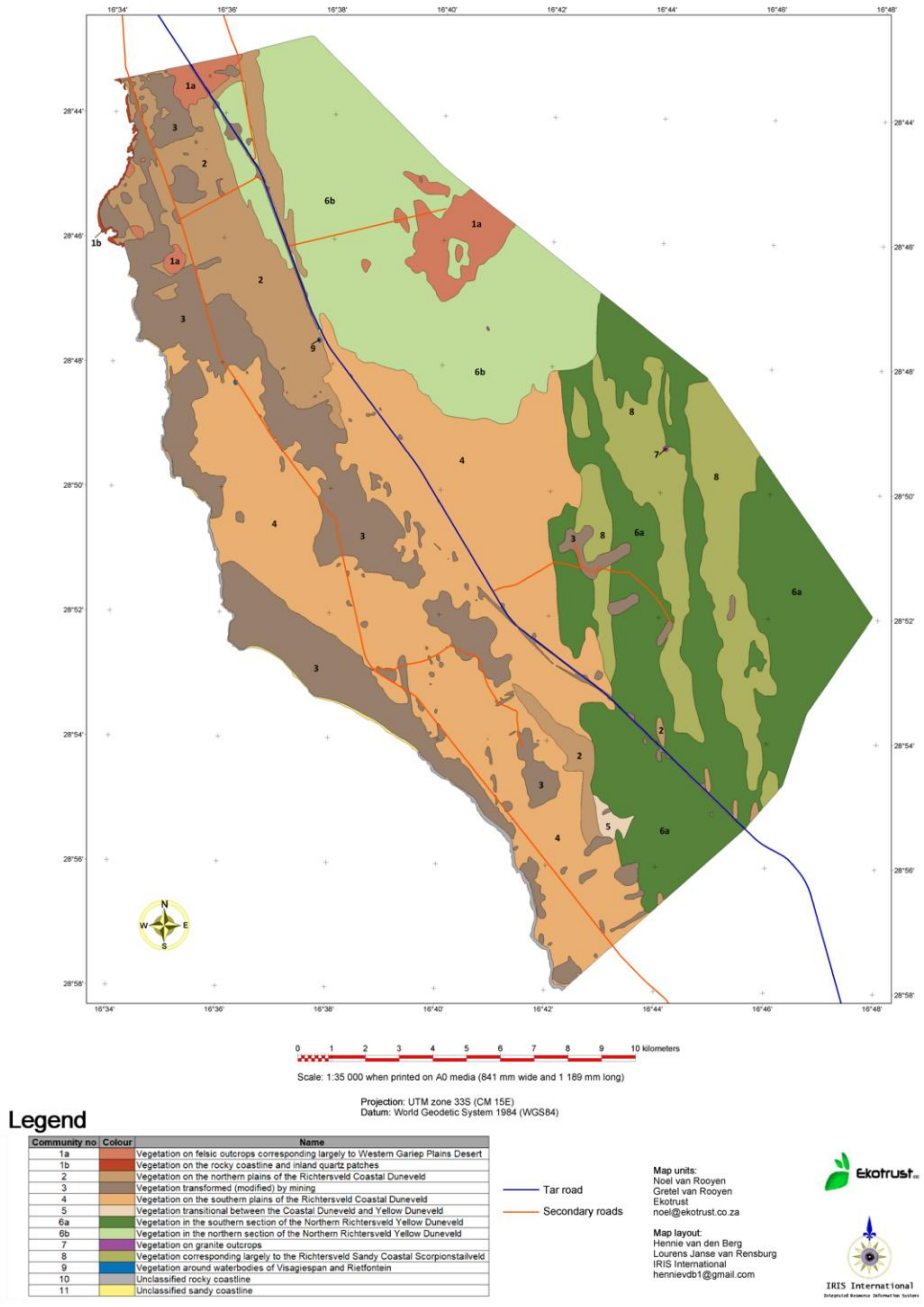


Figure 3-18: Broad-scale vegetation map indicating the location of the plant communities distinguished in this report.

***Plant Community/Habitat 1 (C1):*** This habitat occurs where the basement geology is exposed, most notably on the outcrops such as the Boegoeberg Twins, Namakwakop and around the Telkom tower

(Visagiesfonteinkop). Small outcrops were not all mapped. These rocky outcrops are sensitive environments associated with unique vegetation.

- ***Presence of SCC:*** This plant community contained a wealth of SCC: 6 **CR** plant species; 2 **EN** plant species*;* 6 **VU** plant species*;* 2 **NT** plant species*;* 2 **DDT** plant species*;* and 1 **Rare** plant species.

- ***Occurrence of threatened ecosystems:*** Although Plant Community 1 is typical of the Western Gariep Plains Desert, which has a Least Concern status, sections of this plant community occur in the areas mapped as Namib Seashore Vegetation and in the Richtersveld Coastal Duneveld, both of which have a **CR** status.

- ***Occurrence in a CBA (2016 CBA map):*** Large portions of this community are located in a **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** The area around Visagiesfonteinkop has been included in the **NPAES**.

- ***Degree of disturbance vs intact vegetation:*** In some parts the vegetation is still fairly intact, although some areas are degraded.

- ***Time needed for vegetation to recover:*** Once disturbed, the vegetation in Plant Community 1 will take many decades to recover.

***Plant Community/Habitat 2 (C2):*** These wind-swept plains appear to be a degraded, species-poor variant of C4.

- ***Presence of SCC:*** Plant Community 2 contained the following SCC: 2 **CR** plant species; and 1 **VU** plant species.

- ***Occurrence of threatened ecosystem:*** For the most part it falls in the **CR** Richtersveld Coastal Duneveld.

- ***Occurrence in a CBA (2016 CBA map):*** The unit is largely mapped as a CBA 1.

- ***Located in a Focus Area of the NPAES:*** The area is not included in the NPAES.

- ***Degree of disturbance vs intact vegetation:*** The vegetation is considered to be a degraded variant of the Richtersveld Coastal Duneveld.

- ***Time needed for vegetation to recover:*** Without stabilising the sand and other rehabilitation measures, the vegetation in Plant Community 2 will take very long to recover after a major disturbance.

***Plant Community/Habitat 3 (C3):*** Plant Community 3 has been **transformed** by mining and currently represents modified habitat *sensu* IFC Performance Standard 6 (IFC, 2012, updated 2019). It is floristically strongly related to C2, but differs in the level of transformation. For the most part, the unit is located within the area mapped as Richtersveld Coastal Duneveld (SANBI 2012-2024 as amended), but due to the level of disturbance might never return to its original state.

- ***Presence of SCC:*** No SCC were recorded during the site visit.

- ***Occurrence of threatened ecosystems:*** For the most part the community falls in the Richtersveld Coastal Duneveld. However, due to the transformed nature of the unit, it does not warrant a CR ecosystem status.

- ***Occurrence in a CBA (2016 CBA map):*** The plant community was not classified in the CBA map.

- ***Located in a Focus Area of the NPAES:*** The area is not included in the Expansion Strategy.

- ***Degree of disturbance vs intact vegetation:*** The vegetation is transformed.

- ***Time needed for vegetation to recover:*** Considering the permanent transformation, Plant Community 3 might never return to its original state.

***Plant Community/Habitat 4 (C4):*** The species composition recorded in this plant community during the site visit agrees well with the description of the Richtersveld Coastal Duneveld provided in Mucina & Rutherford (2006).

- ***Presence of SCC:*** Several SCC were recorded during the site visit, with some additional records obtained from iNaturalist: 2 **CR** plant species; 1 **EN** plant species; 2 **VU** plant species*;* and 1 **NT** plant species.

- ***Occurrence of threatened ecosystems:*** This unit falls mainly in the **CR** Richtersveld Coastal Duneveld.

- ***Occurrence in a CBA (2016 CBA map):*** Community 4 has for the most part been classified as **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** Only a small section has been included in the **NPAES**.

- ***Degree of disturbance vs intact vegetation:*** The community is interspersed with mine trenches, diggings and dumps. There are some areas with intact vegetation and other areas that were disturbed a very long time ago that are now in a good condition.

- ***Time needed for vegetation to recover:*** Considering the harsh environment, Plant Community 4 will take a long time to recover fully after a major disturbance.

***Plant Community/Habitat 5 (C5):*** Plant Community 5 represents a transition from the vegetation characteristic of the Richtersveld Coastal Duneveld to the vegetation typically found in the Northern Richtersveld Yellow Duneveld.

- ***Presence of SCC:*** No SCC were recorded during the site visit.

- ***Occurrence of threatened ecosystem:*** This habitat falls in the Northern Richtersveld Yellow Duneveld (**LC**).

- ***Occurrence in a CBA (2016 CBA map):*** Plant Community 5 has been mapped as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has not been included in the NPAES.

- ***Degree of disturbance vs intact vegetation:*** The community consists largely of intact vegetation.

- ***Time needed for vegetation to recover:*** The vegetation will take very long to recover after a major disturbance.

***Plant Community/Habitat 6 (C6):*** The plant community represents the area mapped as Northern Richtersveld Yellow Duneveld within the Boegoebaai Port and SEZ.

- ***Presence of SCC:*** *Subcommunity* 3 **CR** plant species; 7 **VU** plant species; and 3 **NT** plant species.

- ***Occurrence of threatened ecosystem:*** The community falls into the Northern Richtersveld Yellow Duneveld with a **LC** status.

- ***Occurrence in a CBA (2016 CBA map):*** The unit has been mapped partly as **CBA 1** and partly as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has largely been included in the **NPAES.**

- ***Degree of disturbance vs intact vegetation:*** Plant Community 6 is largely intact vegetation used for livestock grazing.

- ***Time needed for vegetation to recover:*** The vegetation will take long to recover after a major disturbance.

***Plant Community/Habitat 7 (C7):*** This small plant community represents a unique habitat, occurring on and around granite boulder outcrops. During the rainy season, the hollows in the granite boulders are filled with water providing an important source of water for wildlife.

- ***Presence of SCC:*** The following SCC were recorded during the site visit: 2 **VU** plant species; 1 **NT** plant species.

- ***Occurrence of threatened ecosystems:*** This unit falls into both the Northern Richtersveld Yellow Duneveld and Richtersveld Sandy Coastal Scorpionstailveld, both of which have a **LC** status.

- ***Occurrence in a CBA (2016 CBA map):*** The unit has been mapped as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has been included in **NPAES.**

- ***Degree of disturbance vs intact vegetation:*** Plant Community 7 represents natural habitat but shows signs of disturbance by humans and livestock.

- ***Time needed for vegetation to recover:*** The vegetation will take very long to recover after a major disturbance.

***Plant Community/Habitat 8 (C8):*** Plant Community 8 agrees with the area mapped as Richtersveld Sandy Coastal Scorpionstailveld and was characterised by the heuweltjies occurring in the unit. The heuweltjies on site lack the typical surface mounding and appear as flat, rather barren patches (McAuliffe *et al*., 2019).

- ***Presence of SCC:*** Only 1 **NT** plant species was encountered during the site visit.

- ***Occurrence of threatened ecosystems:*** This unit falls in the **LC** Richtersveld Sandy Coastal Scorpionstailveld.

- ***Occurrence in a CBA (2016 CBA map):*** The unit has mostly been mapped as **CBA 2**, with parts as **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** Most of Plant Community 8 has been included in the **NPAES.**

- ***Degree of disturbance vs intact vegetation:*** The unit represents natural habitat and is used for livestock grazing.

- ***Time needed for vegetation to recover:*** The vegetation will take a very long time to recover after a major disturbance.

***Plant Community/Habitat 9 (C9):*** Plant Community 9 represents the vegetation around the waterbodies of Visagiespan and Rietfonteinpan.

- ***Presence of SCC:*** No SCC were recorded in Plant Community 9 during the site visit.

- ***Occurrence of threatened ecosystems:*** It is embedded in the Richtersveld Coastal Duneveld with a **CR** status.

- ***Occurrence in a CBA (2016 CBA map):*** Rietfonteinpan's waterbody was mapped as **CBA 1**, the waterbody at Visagiespan was not classified.

- ***Located in a Focus Area of the NPAES:*** The area has not been included in the **NPAES.**

- ***Degree of disturbance vs intact vegetation:*** The waterbody at Visagiespan appears to be highly disturbed, however, Rietfonteinpan is a natural wetland.

- ***Time needed for vegetation to recover:*** The vegetation will take very long to recover after a major disturbance.

## 3.5 SITE SENSITIVITY

This section considers aquatic and terrestrial ecosystems in the context of their likely sensitivity to the various activities associated with the proposed development.

### *3.5.1 Aquatic Ecology*

*Inland aquatic ecosystems* are highly sensitive to changes in hydroperiod, water quality and surface runoff patterns; physical disturbance; and fragmentation from other watercourses and supporting terrestrial areas (Supplementary material: Day, 2025).

*Estuarine aquatic ecosystems:* (i) The *Orange River Estuary* is highly sensitive to activities/impacts that result in: changes in freshwater flows (as a result of increased demand for fresh water, with water demand in Alexander Bay being met in part by flows from the Orange River upstream of the estuary (Hattingh, 2016)); increased road infrastructure across the estuary, affecting flows into the estuarine saltmarshes; increased nutrient input associated with increased treated sewage effluent discharge; increased recreational activities; increase in physical disturbance by vehicle and other traffic into the estuary; and increased dumping of solid waste. (ii) The *Holgat River Estuary* is classified as a micro-outlet. Although its catchment has been rated as near-natural, the estuary itself has been highly altered by mining-associated activities and, coupled with its highly ephemeral character, means that it has little estuarine function.

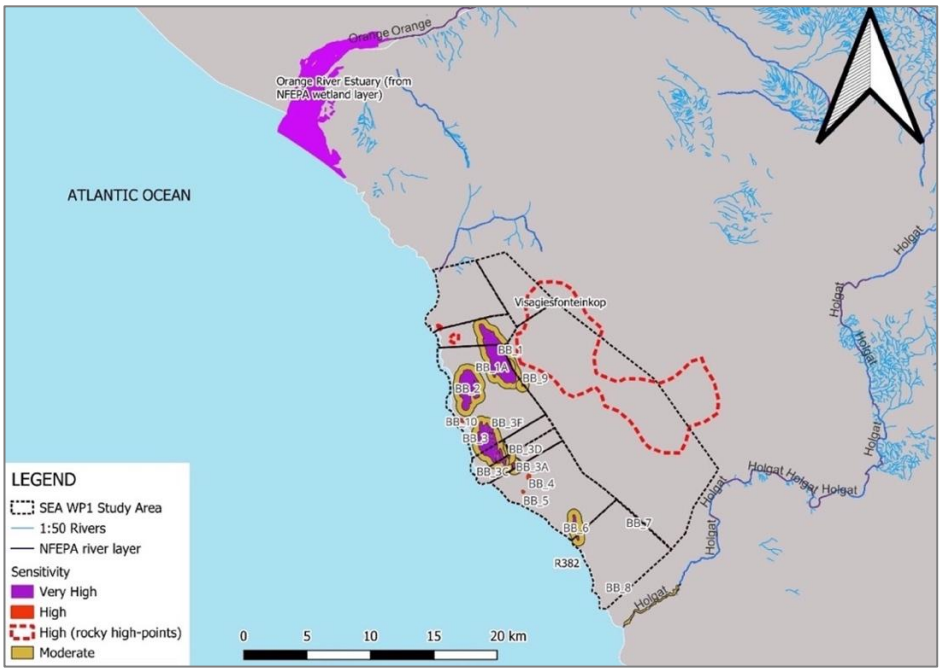


Figure 3-19**:** Inland and estuarine aquatic ecosystems sensitivity (assuming no mitigation measures) of the proposed Boegoebaai Port and SEZ study area. Grey areas are rated as of Low sensitivity to the present proposed project.

The following sensitivity classes were applied for mapping the sensitivity of inland and estuarine aquatic ecosystems in the proposed Boegoebaai Port and SEZ (Figure 3-19):

- **Very High sensitivity:**
  - Natural pans, associated wetlands and springs. Critically Endangered **(CR)** and Endangered **(EN)** wetland types from the NBA (Van Deventer *et al*., 2019) (i.e. depressions/pans);
  - The Orange River Estuary although not on site.
- **High sensitivity:**
  - Artificial pans/excavations;
  - Pan/pool habitat assumed to be included in parts of rocky outcrops such as the Visagiesfonteinkop.
- **Medium sensitivity:**
  - Buffer areas (50 m) outside of all mapped aquatic ecosystems have been included as protective setback to ensure that inland and estuarine aquatic ecosystems are protected from physical developmental impacts;
  - Hydrological buffers (500 m), intended to improve confidence that hydrological linkages required for ensured ecosystem functioning can be maintained. This conservative buffer could be reduced, with an improved, data-driven understanding of surface/groundwater/interflow linages and processes in the area.
  - The Holgat River Estuary lies outside of the proposed development and it is unlikely to be targeted as a water resource.
- **Low sensitivity:**
  - All non-aquatic areas outside of recommended aquatic ecosystem buffer zones.

**Note:** Not included in the sensitivity mapping are corridors to allow for aquatic-to-aquatic and aquatic-to-terrestrial and coastal ecosystems, to ensure sustained ecological connectivity between different habitat types. This issue would need to be developed further during detailed development design.

### *3.5.2 Fauna: Avifauna*

According to the DFFE Screening Tool the Animal Species Theme (Figure 20) for the Boegoebaai Port and SEZ contains portions with a **High** sensitivity linked to the possible occurrence of the Lanner falcon (*Falco biarmicus*) (**VU**).

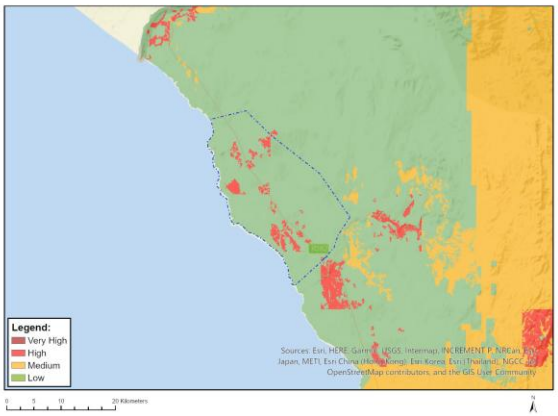


Figure 3-20: Sensitivity map for the Animal Species Theme of the Screening Tool for the Development Site.

To define low, medium, high and very high sensitivity classes for the Boegoebaai Port and SEZ, R-workflow was used to prepare, pre-process and analyse remote sensing, topographical, land-cover and climatic data. A classification modelling framework was used to assess habitat suitability for the target species. The modelling workflow included data partitioning, model training, variable selection, model testing, model optimisation through hyperparameter tuning and final model predictions. Primary models were trained using the Random Forest, ANN and Maxnet algorithms, followed by hyperparameter tuning and model optimisation using the genetic algorithm (Vignali *et al.,* 2020).

A weighted algorithm was scripted and implemented in Python. The weighted algorithm applies greater sensitivity weights to species that are more threatened and are either endemic, near-endemic or highly range-restricted within South Africa. Furthermore, data types that included nests, roosts and/or areas of core occupancy received the highest weights for the respective data/model type criterion. All distribution models, habitat suitability models and other data types are ingested into the weighted algorithm with species and data specific weights applied to generate an overall avian sensitivity map for the Boegoebaai Port and SEZ (Figure 3-21).

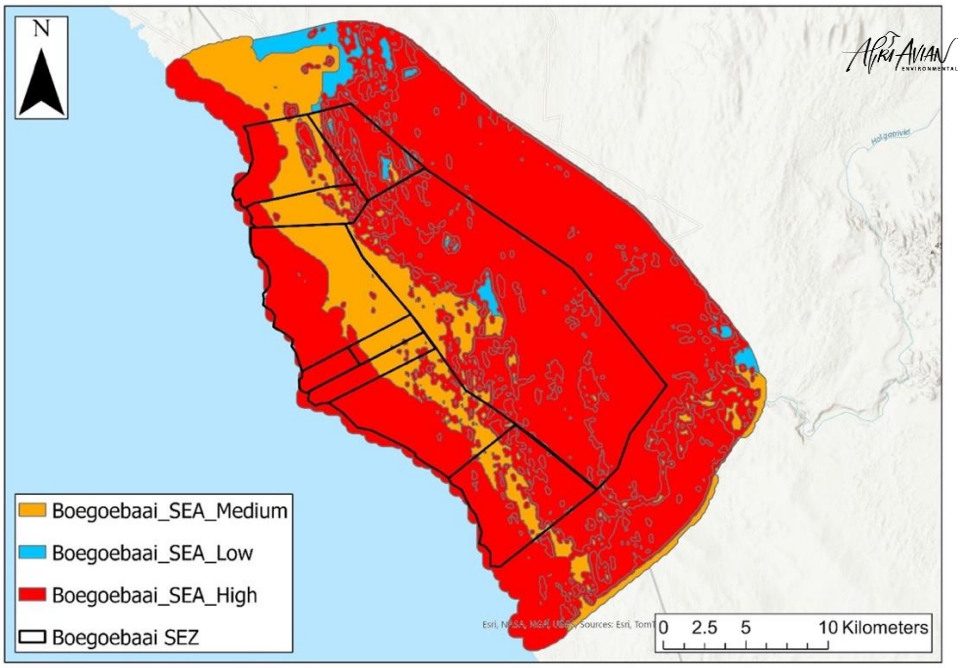


Figure 3-21: The avian sensitivity layer generated from the weighted analysis incorporating 13 avian SCCs. The map does not consider transformed areas.

### *3.5.3 Fauna: Bats*

The sensitivity map (Figure 3-22) is based on features identified to be important for foraging and roosting of bat species that most commonly occur in the area.

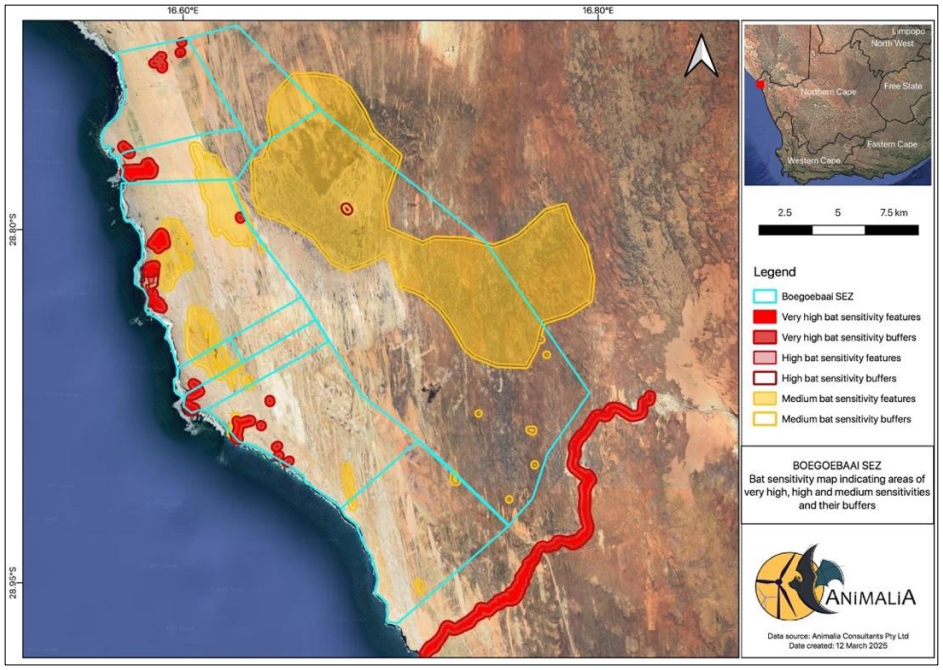


Figure 3-22: Bat sensitivity map of the proposed Boegoebaai Port and SEZ development. The map does not consider transformed areas.

The following sensitivity classes were applied:

- **Very High sensitivity:**
    - Rocky outcrops and the rocky Holgat drainage ravine;
    - Aquatic water sources with exposed surface water;
    - A 200 m no-go zone buffer was applied.

  These areas are 'no-go' zones and infrastructure may not be placed in these areas and their buffers.
- **High sensitivity:**
    - Temporal water sources;
    - A 200 m buffer was assigned.

  Only infrastructure with no artificial lighting may be placed in these areas.
- **Medium sensitivity:**
    - Non-perennial washes, pans and other seasonal water sources;
    - Livestock aggregation areas and kraals;
    - Terrain with regular undulating dunes, interspersed livestock aggregations and occasional high points;
    - A 150 m buffer was assigned.

  Keep development to a minimum in these areas, preferably no outside lighting if practically feasible.

### *3.5.4 Fauna: Mammals, Reptiles and Amphibians*

Based on the precautionary principle and available secondary data a preliminary sensitivity map was produced for the site (Figure 3-23). It must be noted that species-specific baseline assessments are required to verify and update this sensitivity map and delineate buffer zones.

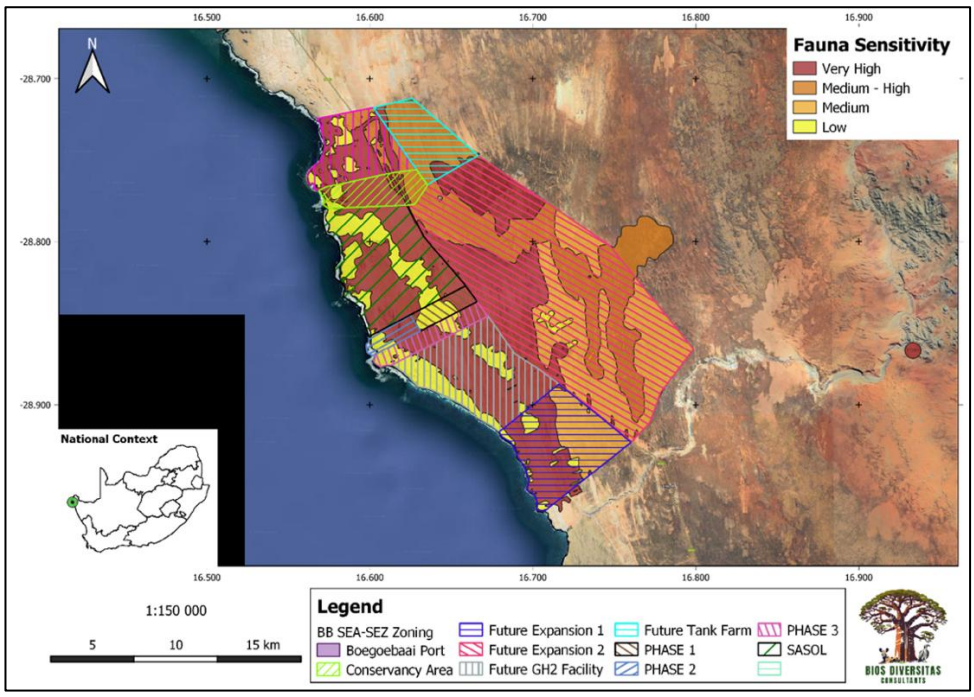


Figure 3-23: Site sensitivity based on the faunal assessment of the mammals, reptiles and amphibians.

The following sensitivity classes were applied:

- **Very High sensitivity:**
  - Remnants of the Richtersveld Coastal Duneveld and Namib Seashore Vegetation which are **CR ecosystems** and potentially harbour several fauna SCC.
  - Suitable habitat for faunal SCC, including *Pachydactylus rangei, Bitis schneideri, Breviceps macrops, Cryptochloris wintoni, Eremitalpa granti granti* and *Parahyaena brunnea.*
  - Unique and important features on site, e.g. Boegoeberg Twins, Visagiesfonteinkop and sandy beaches.

Development within areas of **Very High** sensitivity should be avoided due to the sensitive nature of these areas and potential negative impacts of the development on faunal SCC.

- **Medium to High sensitivity:**
  - Important and unique features of the Northern Richtersveld Yellow Duneveld.
  - Remaining natural habitat of Namaqualand Salt Pans and Western Gariep Plains Desert.
  - The Swartbank Heuweltjies, part of the Richtersveld Sandy Coastal Scorpionstailveld.
  - Corridors connecting coastal to inland habitats, which several SCC could utilise.
  - Include focus areas for protected areas of expansion which intersect sensitive features.

- **Medium sensitivity:**
    - Remaining natural habitat of the Northern Richtersveld Yellow Duneveld and Richtersveld Sandy Coastal Scorpionstailveld, excluding the Swartbank Heuweltjies which are considered more sensitive.
    - Few faunal SCC have suitable habitat in this region, but they could be important ecological corridors and act as high value climate resilience areas (to be confirmed).
- **Low sensitivity:**
    - Transformed or modified habitat due to mining and other human activities. Faunal species use these areas to move between intact habitats, but it is not suitable for breeding and foraging.

### *3.5.5 Vegetation and Flora*

The Screening Tool (DFFE) rated the sensitivity of the Plant Theme as **Medium** and provided a list of 19 plant species with all species rated as of medium sensitivity (Table 3-1, Figure 3-24). The presence of 13 of these species were confirmed on site (data site visit in 2024; P. van Wyk; SANBI, 2024; iNaturalist; NewPOSA database). An additional 33 SCC were confirmed for the site (Appendix A). In total, there are thus **46 confirmed SCC on site**. Moreover, 163 Northern Cape provincially protected/specially protected and 20 CITES-listed species are also present on site.

The criteria used for the current site sensitivity assessment of the Plant Theme per plant community were as follow:

- A plant community was rated as **Very High** if it was habitat for a **CR** species;
- A plant community was rated as **High** if it was habitat for an **EN or VU** species;
- A plant community was rated as **Medium** if it was habitat for a **NT, DD or Rare** species; and
- A plant community was rated as **Low** if it was not habitat for any SCC.

On the basis of these criteria it is recommended that the sensitivity of the Plant Theme should be upscaled to **Very High** (Figure 3-25a). Areas transformed by mining, had no SCC and were rated as modified or transformed habitat.

Table 3-1: Species of Conservation Concern (SCC) listed for the Boegoebaai Port and SEZ site in the Screening Tool and whether their presence could be confirmed on site

| Sensitivity | Feature(s) | IUCN Status | Confirmed on site |
|---|---|---|---|
| Medium | *Bassia dinteri* | CR | Yes (SANBI) |
| Medium | Sensitive species* 305 | Was VU; now CR | Yes |
| Medium | *Mesembryanthemum occidentale (= Aridaria vespertina)* | EN | |
| Medium | Sensitive species 282 | EN | |
| Medium | Sensitive species 407 | Was VU; now EN | Yes |
| Medium | Sensitive species 293 | EN | Yes |
| Medium | Sensitive species 1110 | EN | Yes |
| Medium | *Calobota acanthoclada* | EN | Yes |
| Medium | Sensitive species 827 | VU | Yes |
| Medium | Sensitive species 435 | VU | |
| Medium | Sensitive species 734 | VU | Yes |
| Medium | Sensitive species 1187 | VU | Yes |
| Medium | Sensitive species 720 | VU | Yes |
| Medium | *Adromischus montium-klinghardtii* | VU | Yes |
| Medium | *Nemesia saccata* | VU | Yes |

| Sensitivity | Feature(s) | IUCN Status | Confirmed on site |
|---|---|---|---|
| Medium | *Helichrysum dunense* | VU | Yes |
| Medium | Sensitive species 744 | VU | |
| Medium | *Manulea cinerea* | VU | |
| Medium | Sensitive species 1090 | RARE | |

(*As per best practise guideline that accompanies the Plant Species Protocol for the screening tool, the **name of the sensitive species may not appear in any specialist reports released into the public domain**. It should be referred to as *sensitive plant species* and its threat status may be included, e.g. *critically endangered sensitive plant species* nr.)

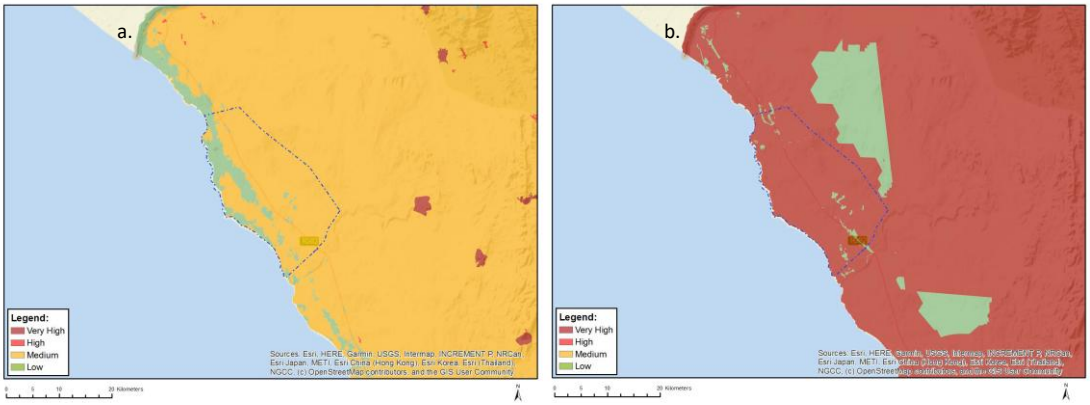


Figure 3-24: Screening Tool's site sensitivity map of (a) the Plant Theme and (b) Relative Terrestrial Biodiversity Theme.

The Screening Tool (DFFE) rated the sensitivity of the Relative Terrestrial Biodiversity Theme as **Very High** based on the features listed in Table 3-2 (Figure 3-24b). Because the 2016 CBA map was used in the Screening Tool the same version was used for the current comparison. The desktop evaluation confirmed the presence of these features and if the same sensitivity ratings were used as in the Screening Tool, the Very High sensitivity for almost the entire site would be supported.

Table 3-2: Features used by the Screening Tool to assess the Relative Terrestrial Biodiversity Theme and the sensitivity rating used by the Screening Tool as well as the adjusted ratings used in the current assessment

| Feature(s) | Sensitivity (Screening Tool) | Sensitivity used in the current assessment |
|---|---|---|
| Low Sensitivity | Low | |
| CBA 1 | Very High | Very High |
| CBA 2 | Very High | High |
| ESA | Very High | Medium |
| National Protected Area Expansion Strategy (NPAES) | Very High | High |
| CR Namib Seashore Vegetation | Very High | Very High |
| CR_Richtersveld Coastal Duneveld | Very High | Very High |
| CR plant species | - | Very High |

The sensitivity ratings were slightly modified in the current assessment to correspond more closely with the 'Best Practice Guidelines for Implementing the Mitigation Hierarchy in South Africa' (EWT, 2023) and the National Biodiversity Offset Guideline (DFFE, 2023). These rating slightly modified the sensitivity map for the Relative Terrestrial Biodiversity Theme (Figure 3-24b) although the overall sensitivity would still be **Very High.**

The criteria used for the current site sensitivity assessment of the Relative Terrestrial Biodiversity Theme per plant community were as follow:

- **Very High sensitivity:**
  - a **CR ecosystem**;
  - an irreplaceable Critical Biodiversity Area (**CBA 1**); and
  - confirmed habitat of a **CR plant species**.

According to the mitigation hierarchy (EWT, 2023) a **Very High** impact rating would indicate that the proposed development must be **avoided/prevented**, since these changes cannot be remedied and offsets or compensation would not be feasible because of the high threat status or irreplaceability of the affected biodiversity or ecosystem services (EWT, 2023).

- **High sensitivity:**
  - an optimal Critical Biodiversity Area (**CBA 2**);
  - an **EN ecosystem**;
  - the inclusion in **NPAES**; and
  - confirmed habitat of an **EN** species, or impacts leading to an increase in their threat status.

Where residual negative impacts of **High** significance remain, biodiversity offsets/compensation can be considered.

- **Medium sensitivity:**
  - an Ecological Support Area (**ESA**);
  - irreversible impacts on Priority Focus Areas in **NPAES**;
  - **VU** ecosystems;
  - **VU** species, or endemic (but not range-restricted) or protected species; and
  - impacts on ecosystems or species which would result in them being listed as threatened.

Avoidance or minimisation of impacts is essential and restoration of degraded areas must be undertaken when the impact rating is Medium. Should significant negative impacts of medium significance remain, biodiversity offsets/compensation can be considered.

- **Low sensitivity:**
  - loss of vegetation of least concern (ONA), supporting no threatened ecosystems or species, and not constituting important ecological process areas or corridors, or providing important ecosystem services.

Impacts with a Low sensitivity rating should as far as possible be minimised and rehabilitation/restoration would minimise residual negative impacts and biodiversity offsets or compensation would not be required.

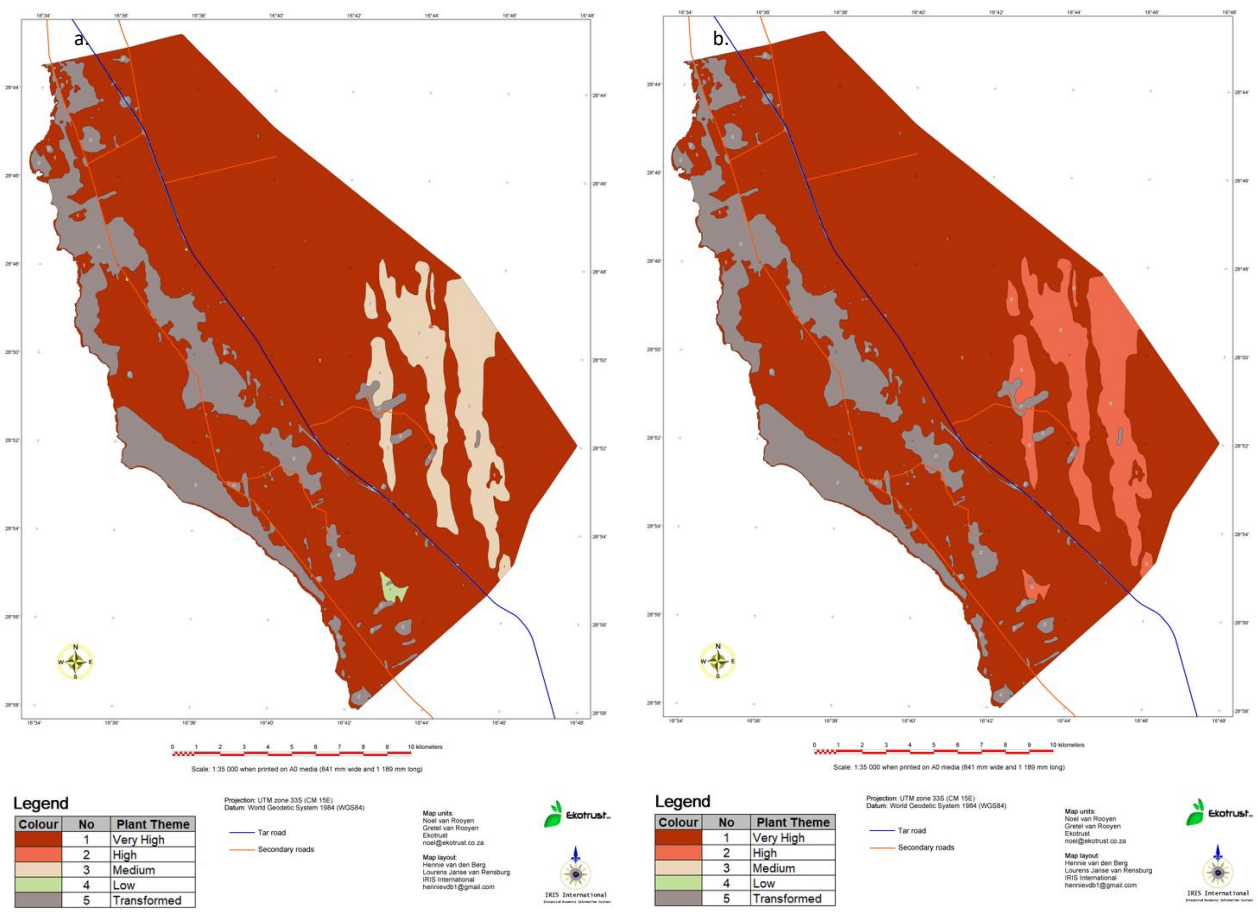


Figure 3-25: Site sensitivity of (a) the Plant Theme and (b) the Relative Terrestrial Biodiversity Theme for the Boegoebaai Port and SEZ site as found in the current study.

The **Very High sensitivity** of the Relative Terrestrial Biodiversity Theme found using the criteria in the current assessment (Figure 3-25b) still agrees well with the sensitivity generated by the Screening Tool. It should be noted that the available information used to produce the sensitivity maps for the current assessment is at a coarse scale and conducting an in-depth, fine-scale analysis of the vegetation and flora is required to verify and refine this sensitivity map.

### *3.5.6 Integrated site sensitivity*

Taking the existing anthropogenically disturbed areas into consideration, the site sensitivity maps for the aquatic and terrestrial ecology assessments are presented in Figure 3-26a. In the case of both the mammal, reptile and amphibian as well as the vegetation and flora themes the anthropogenically disturbed areas were classified as either transformed or of low sensitivity. For the most part, both the inland aquatic and the bat sensitivity assessments also rated as anthropogenically disturbed areas as of low sensitivity. Only in the case of the avifaunal assessment were the disturbed areas classified as either High or Medium sensitivity.

An integrated sensitivity map for terrestrial and aquatic ecology was compiled by die CSIR using the maximum rule, i.e. the highest sensitivity overrides the lower sensitivities (Figure 3-26b). According to this integrated sensitivity map most of the site has a **Very High** sensitivity. The anthropogenically transformed areas could be used for the proposed development.

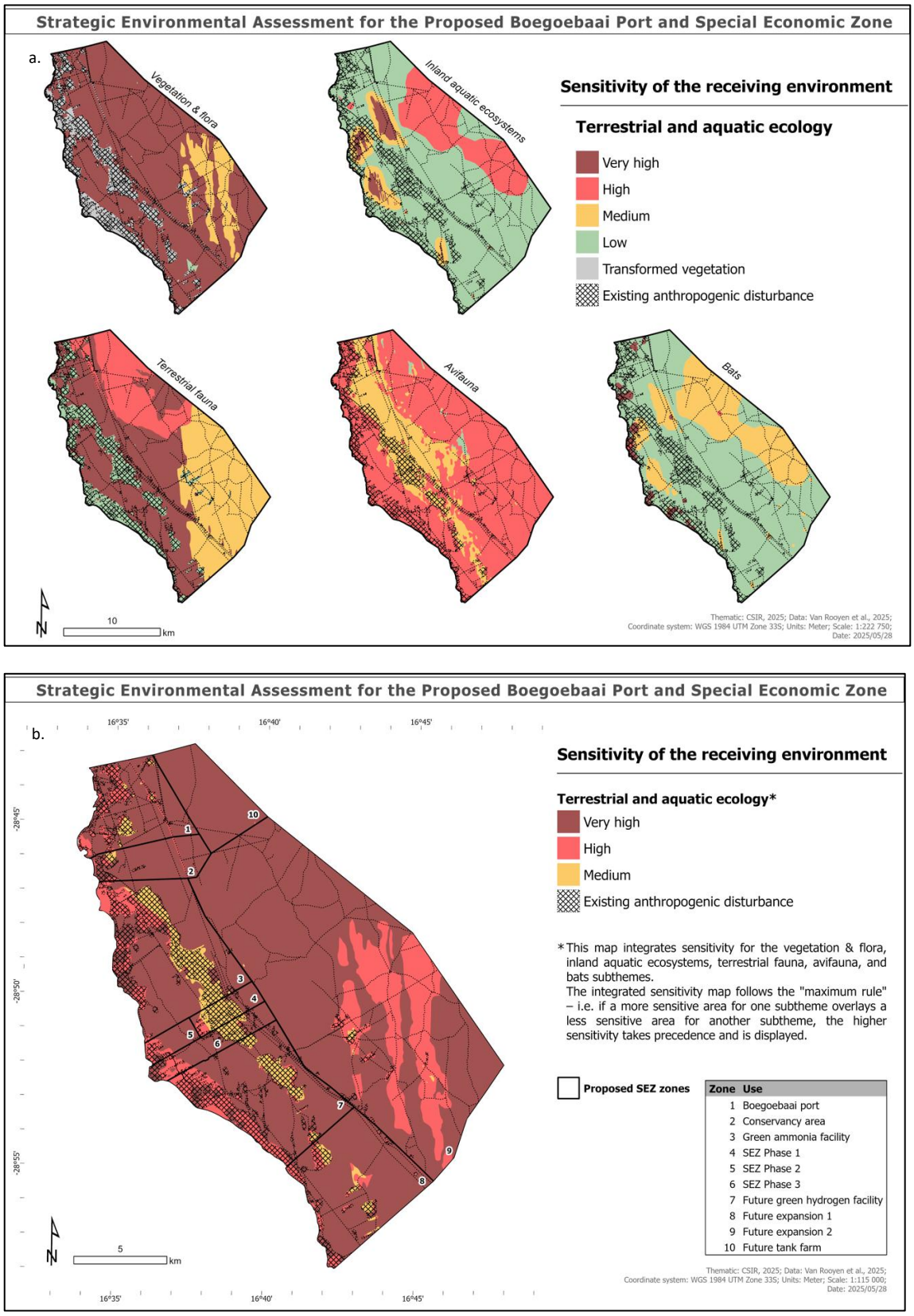


Figure 3-26: (a) & (b) Integrated site sensitivity of the Aquatic and Terrestrial Ecology studies of the Boegoebaai Port and SEZ.

## 3.6 ASPECTS AND IMPACTS REGISTER

An aspects and impacts register (Table 3-3) was compiled based on the project description provided by the CSIR (Schreiner *et al.,* 2024). The major impacts on terrestrial ecology, associated with the development, will occur during the construction phase, with human activity and disturbance levels appreciable lower during the operational phase. Impacts during the operational phase are likely to be carry-over effects resulting from the construction phase. Impacts during the decommissioning phase will be similar to the construction phase. A major risk would be that the site is not adequately rehabilitated to a functioning system and a degraded, vulnerable and disturbed ecosystem is left behind. Cumulatively, the impacts may lead to shifts in local faunal and floristic communities, favouring generalist species over specialists. This could result in reduced biodiversity and changes in ecosystem functioning. The resilience of fauna to these impacts would depend on the availability of nearby suitable habitat and effective mitigation strategies.

Table 3-3: Aspects/impacts register applicable to the Boegoebaai Port and SEZ site

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| **Inland and Estuarine Aquatic Ecosystems (see Section 3.4.1;** Figure 3-14 **&** Figure 3-19**)** | | |
| **Boegoebaai Port:**<br>Development footprint | Given the low certainty about hydrological drivers for wetlands and/or pans, the development footprint of the planned development would extend into the postulated recharge area of these important systems, and could potentially threaten their sustainability. | Extends into potential recharge area for BB1 pan and springs. Also includes Boegoeberg North, which could potentially support inland aquatic biota typical of temporary/ephemeral pools. |
| **Conservancy area:**<br>This includes the northern portion of BB1 (Visagiespan) | Inclusion of the upper section of the mapped pan in the conservancy area would potentially protect recharge areas for the pan, its wetlands and associated spring. | BB1 (including BB1A) |
| **Confirmed Green Hydrogen and Ammonia facility:**<br>This area extends across the three largest pan/wetland/spring areas in the study area. Aspects of concern include:<br>• development footprint;<br>• stormwater management; and<br>• roads (and associated culverts). | • Destruction of **CR** wetlands: These are rare and key wetland systems, which are likely to play a critical role in supporting terrestrial fauna.<br>• Degradation of wetlands, pans and springs as a result of stormwater management systems that contain and divert stormwater; reduce recharge and increase concentration of flows; and potentially "freshen" flows into receiving pans/wetlands, as a result of bypassing sands and other substrate that would normally contribute dissolved salts to runoff.<br>• Degradation by physical disturbance (vehicles). | This area includes the largest and most important pans, associated springs and wetlands within the study area. |
| **SEZ Industrial Park Phases 1, 2 and 3:**<br>This area extends across the Rietfonteinpan (BB3) pan/wetland/spring area, and its hydrological buffer. Aspects of concern include:<br>• development footprint;<br>• stormwater management;<br>• roads; and<br>• treated sewage effluent disposal through septic tanks and use of infiltration systems. | • Destruction of **CR** pan and wetland habitat (BB3) **see Confirmed Green Hydrogen and Ammonia facility.**<br>• Degradation of remaining pan and wetland areas by physical disturbance (e.g. vehicles).<br>• Potential increases in inflows of stormwater and treated sewage effluent into remnant wetlands/ pans, likely to result in nutrient enrichment and possible changes in hydroperiod. These would likely result in changes in vegetation and loss of conditions that support important ephemeral pan biotic assemblages. | Watercourse BB3 (ephemeral pan with wetland elements) |
| **Future Green Hydrogen Facility:**<br>Aspects of concern include: | • Destruction of presumed natural (BB6) and artificial pan (BB4 and BB5) and wetland habitats.<br>• Potential increases of stormwater inflows into remnant | This area includes artificial pans/wetlands, as well as an (not ground-truthed) natural pan (BB6) and its potential recharge area). |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| • development footprint;<br>• stormwater management;<br>• roads; and<br>• treated sewage effluent disposal. | wetlands/pans, likely to result in changes in hydroperiod - **see Phases 1, 2 & 3.**<br>• Degradation from physical disturbance (vehicles). | |
| **Future Expansion 01:**<br>Aspects of concern include:<br>• stormwater management;<br>• roads; and<br>• treated sewage effluent disposal. | • Some destruction of presumed natural pan and wetland habitat (BB6) and artificial pans BB7 & 8.<br>• Potential increases in inflows of stormwater into remnant wetlands/pans, likely to result in changes in hydroperiod - **see Phases 1,2 & 3.** | Includes artificial pans/wetlands (BB7 & BB8) and southern extent of natural pan (BB6). BB6 is rated as **CR** and the artificial systems probably have high ecological importance. |
| **Future Expansion 02:**<br>Aspects of concern would include:<br>• blasting of rocks for construction;<br>• the development footprint;<br>• treatment of stormwater from the site, potentially impacting on downstream systems including those within the confirmed green hydrogen and ammonia facilities site and Phases 1-3 of the propose SEZ Industrial Park | • Destruction of presumed natural temporary pools/pan habitat.<br>• Possible eutrophication of pan habitat by inflows of polluted water.<br>• Degradation of downstream ecosystems due to concentration of flows from upslope areas and/or increased rate of surface flows as a result of stormwater management interventions.<br>• Biodiversity impacts as a result of loss of physical connectivity between high-lying areas and downstream areas. | Includes the high-lying rocky outcrops at Visagiesfonteinkop including areas of ephemeral pans and pool of (undetermined) high biodiversity importance. |
| **Terrestrial Ecosystems** | | |
| **BOEGOEBAAI PORT** | | |
| ***Zone 1: Infrastructure***<br>*Any structure to be built or covering land related to the port facility e.g.:*<br>• buildings;<br>• bulk material stockpiles, warehouses and handling facilities;<br>• ship loaders;<br>• conveyor belt structures; | ***Infrastructure:***<br>***Vegetation clearance:***<br>• Vegetation clearance could cause a loss of part of (i) a **CR** ecosystem; (ii) an **irreplaceable CBA 1** or **optimal CBA 2**; (iii) a Priority Focus Area in NPAES; and (iv) a **KBA,** if the structure is located in one of these systems.<br>• Vegetation clearance will likely cause a loss of individuals of SCC, protected and/or endemic plant or animal species since many such species are present in the port precinct.<br>• Vegetation clearance will be associated with increased sand | Except for areas that have been mapped as modified habitat, the rest of the Port area has been assigned a **Very High** sensitivity and vegetation clearance should thus be avoided (Figure 3-25).<br><br>In support of avoidance as the only option, are the presence of the following:<br>• **CR** Namib Seashore Vegetation as well as Richtersveld Coastal Duneveld which are irreplaceable and cannot be offset (Figure 3-7); |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| • water reservoirs;<br>• sewage systems;<br>• stormwater drainage systems;<br>• electrical substations;<br>• fuel storage facilities;<br>• internal port roads; and<br>• external port roads (only widening of R382 on site is relevant to WP1). | movement and erosion of topsoil material. Transported sand may smother adjacent vegetation, particularly affecting small plant species.<br>• Sand storms may intensify and the effects of sandblasting on the vegetation may increase.<br>• Vegetation clearance is accompanied by a loss of faunal habitat and could eliminate essential habitats for SCC.<br>• Vegetation clearance will decrease ecosystem services and could prevent meeting biodiversity targets.<br>• Vegetation clearance is associated with habitat fragmentation, restricting animal species movement and reducing food availability.<br>***Construction:***<br>• Construction is associated with increased human activity, noise and often artificial lighting. These disturbances negatively affect animal behaviour, particularly in areas where they feed, breed, nest and rest. It can also lead to injuries or mortalities. Trenching could increase animal mortality.<br>• Small mammals, are attracted to infrastructure and may create burrows under the infrastructure. Extensive burrowing may alter vegetation patterns, affecting other ground-dwelling species. | • irreplaceable **CBA 1s** or optimal **CBA 2s**; (Figure 3-9);<br>• **CR** plant and animal species;<br>• focus areas of the **NPAES** (Figure 3-8); and<br>• a **KBA** (Figure 3-10).<br>In areas of Medium to High sensitivity impacts need to be minimised through appropriate mitigation measures to ensure sustainable development.<br>***Construction:***<br>In the case of birds, negative impacts can reach up to a distance of 500 m – 2 km depending on the species. |
| ***Zone 1: Dry bulk material handling***<br>***Manganese:***<br>Manganese will be stored in closed stockpiles, with dust suppression using water spraying. | ***Dry bulk material handling:***<br>***Manganese:***<br>• Manganese is an essential micronutrient for plants but in excess it can be toxic.<br>• Wind can disperse fine particles from stockpiles contaminating the soil and affecting vegetation. **Recommendation:** store manganese in a warehouse or silo and move via piped conveyor.<br>• Water is such a scarce commodity in the area that an alternative method for dust suppression must be sought. Using water for dust suppression is expensive and inefficient and this water will become contaminated. No indication has been given of how the impurities will be extracted or how the water will be disposed of or reused. | Location of the manganese stockpile can impact vegetation and species negatively and all areas listed in **Zone 1: Infrastructure** must be avoided.<br>The stockpiles can only be located in habitat that has been intensively modified by mining.<br>Air quality must be monitored and atmospheric emissions around stockpiles and warehouses must be managed. Ensure that monitoring equipment is adequately maintained. |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| ***Lead and zinc:***<br>Lead and zinc will be stored in enclosed warehouses. | ***Zinc and lead:***<br>• Zinc is an essential micronutrient for plants but in excess it can be toxic. Lead is a toxic heavy metal which negatively affects plant growth.<br>• The bulk storage warehouses must be fully contained to protect against chemical spillage. | |
| ***Zone 1: Conveyor belts***<br>Systems handling zinc and lead must be fully enclosed. Systems handling manganese generally require arched coverage. | ***Conveyor belts:***<br>***Manganese:*** In faulty systems dust can contain manganese particles and other pollutants which may affect plant life if they enter the soil in large amounts.<br>***Lead and zinc:*** Runoff from the conveyor can lead to the leaching of lead/zinc into the groundwater.<br>Conveyors will be barriers to animal movement. | Monitor the air, soil and water quality to manage emissions around the conveyor system and ensure that monitoring equipment is adequately maintained. |
| ***Zone 1: Dust control***<br>Dust suppression and collection systems are incorporated with all material handling equipment to prevent accumulation of material outside the dust collection system. | ***Dust control:***<br>It has not been specified how and where the material accumulated in the dust collection system will be discarded. | Dust control systems should avoid the areas mentioned in ***Zone 1: Infrastructure.***<br>All material collected in the dust suppression system should be disposed of at a registered waste facility. |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| ***Zone 1: Bulk services – Water***<br><br>**Option 1:** Pipeline from Alexander Bay with water treatment plant. The pipeline from Alexander Bay is not assessed since it has not been indicated on site. It has been assumed that the water treatment plant for this option would be at Alexander Bay.<br><br>Option 2 (preferred): On-site desalination plant with 1 ML capacity.<br><br>Elevated reservoirs will provide pressure for fire suppression discharge. | ***Desalination of water:***<br>**For vegetation clearance - see Zone 1: Infrastructure**<br><br>***Option 2: Desalination by reverse osmosis:***<br>• The intake of seawater can harm marine life by impingement and entrainment.<br>• The concentrated brine will have a negative impact on marine ecosystems when discharged into the ocean, especially if done without the necessary diffusion.<br>• The possibility to use the brine solution to produce salt can be investigated. The salt must be purified to achieve the desired quality.<br>• New advances in technology may allow a nearly waste-free zero liquid discharge desalination which crystalises salt and chemicals.<br>• Chemicals used in the desalination process such as defouling and cleaning agents can enter the marine environment. | Desalination plants may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***<br><br>***Option 2: Desalination:***<br>• Marine ecologists should assist with the selection of the site of the seawater intake and discharge.<br>• Continuous monitoring of the discharge site is needed to allow for adjustment if unacceptable negative impacts are found.<br>• Observe compliance with local and international regulations to ensure that discharge practices meet environmental standards. |
| ***Zone 1: Bulk services – Sewage***<br>The site will be divided into separate drainage areas with isolated reticulation systems, on-site treatment and disposal.<br><br>Drainage areas will use a combination of waste-water treatment plants, septic tanks and soak-away systems. | ***Bulk services – Sewage:***<br>• **For vegetation clearance - *see Zone 1: Infrastructure***<br>• Positive impacts could arise if nutrients are recovered and used as fertilizers.<br>• Investigate if wastewater could be used for industrial purposes.<br>• Use of chemicals for disinfection can lead to residual pollutants in treated water.<br>• Sludge disposal can contaminate soil and water.<br>• Inadequate treatment of sewage water poses health risks. | Waste water treatment plants, septic tanks and soak-away systems may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***<br><br>Furthermore, groundwater contamination by these systems must be avoided. |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| ***Zone 1: Stormwater drainage systems***<br>The drainage system will separate clean and dirty water, with clean water runoff diverted around the site. High-risk dirty runoff water will flow into concrete-lined channels to the pollution control pond and low-risk dirty runoff water will flow into block and vegetated channels.<br>Pollution control ponds will be lined with high density polyethylene, and water discharged to the ocean. | ***Stormwater drainage systems:***<br>**For vegetation clearance - see *Zone 1: Infrastructure***<br>For stormwater drainage **see Aquatic ecosystems**.<br>• Favourable habitat for invasive species could be created.<br>• Pollutants can enter the groundwater. | The storm water treatment structures, may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***<br>Pollutants may not enter the groundwater. |
| ***Zone 1: Electrical:***<br>The internal network will include an intake substation, primary and secondary substations and distribution substations. | ***Electrical:***<br>• **For vegetation clearance - *see Zone 1: Infrastructure***<br>• Electrical infrastructure will not be limited to sub-stations. Powerlines need to carry the electricity from the source to the intake substation. Powerlines will add to vegetation clearance.<br>• A lifecycle assessment must include all emissions associated with the construction of renewable energy structures, generation and transport. A life cycle assessment clearly indicates the use of carbon during infrastructure manufacturing, thus the renewable energy is not entirely carbon free.<br>• Electrical infrastructure can act as attractive basking or foraging sites for reptiles. Contact with live components, increases the likelihood of electrocution. Porcupines may dig under transmission towers, compromising foundation stability and increasing maintenance costs.<br>• Powerlines can cause habitat fragmentation, restrict animal movement and reduce food availability. | None of the substations may be located in any of the areas mentioned in ***Zone 1: Infrastructure.***<br>In the case of birds, the impacts of pipelines and powerline can reach up to a distance of 500 m – 1 km depending on the species. |
| ***Zone 1: Fuel storage (Phase 1)***<br>A liquid bulk storage facility with two 35 000 m³ tanks and tanker loading facilities is included.<br>Tanker vessels will discharge into storage tanks via pipeline. | ***Fuel storage (Phase 1):***<br>• **For vegetation clearance - *see Zone 1: Infrastructure***<br>• Fuel spills can contaminate the soil or water bodies and potentially enter the groundwater which will affect plant life and aquatic systems.<br>• Volatile organic compounds, other pollutants and strong odours are emitted, reducing air quality. | The fuel storage structures and loading facilities, may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***<br>Lichens are particularly sensitive to pollution. A study must be conducted on the dominant movement of air from the planned port and SEZ site, to ensure that pollutants from the port and SEZ are not carried onto |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| | • Inadequate compliance, management and monitoring will lead to increased risks of contamination and pollution.<br>• Flammable fuels pose a fire and explosion risk. | the Namib Lichen Fields or the Boegoeberg Twins (also rich in lichens). |
| ***Zone 1: Internal port roads and bridges:***<br>Port Access Interchange for large volumes of heavy vehicles<br><br>Port Access Control: access gateways and weighbridge<br><br>Truck Offloading Area: Three offloading terminals | ***Internal port roads and bridges:***<br>• **For vegetation clearance - *see Zone 1: Infrastructure***<br>• Roads, pipelines and powerlines, fragment habitats and may restrict animal movement, particularly for range restricted and fossorial species. Such barriers disrupt normal foraging, mating and dispersal. This is especially crucial for slow-moving tortoises that are less adapted to fragmented landscapes.<br>• Increased traffic and expanded road networks, raise the likelihood of roadkills. Reptiles using warm road surfaces for thermoregulation are at risk. Roads are death traps for slow moving animals.<br>• Vehicle emissions reduce air quality and negatively affect lichens and some plant species.<br>• Runoff from roads carry pollutants affecting water quality in adjacent areas.<br>• Roads can lead to soil erosion.<br>• Roads can facilitate the spread of alien invasive species.<br>• Roads can change natural water flow patterns.<br>• Gravel roads lead to the production of dust. | The internal port roads and bridges should avoid the areas mentioned in ***Zone 1: Infrastructure*** wherever possible.<br><br>In the case of birds, the impacts of roads can reach up to a distance of 500 m – 1 km depending on the species.<br><br>A study needs to be conducted on the dominant movement of air from the planned Boegoebaai Port and SEZ site, to ensure that the pollutants from the vehicle emissions are not carried onto the Namib Lichen Fields or the Boegoeberg Twins that are also rich in lichens. |
| ***Zone 1: External roads:***<br>In the short-term mining ore will be transported by trucks along the R382, until rail transport viability is considered and established. | ***External roads:***<br>**For vegetation clearance - see *Zone 1: Infrastructure and Internal port roads.***<br>Widening of R382 will increase the area where vegetation is cleared.<br>See internal roads for environmental impact. | The external port roads and bridges should avoid the areas mentioned in ***Zone 1: Infrastructure.***<br><br>See internal roads for receiving environment at risk. |
| ***Zone 2: Conservancy area:***<br>A conservancy area (ca. 1 170 ha) has been set aside based on conservation priorities such as the presence of the Boegoeberg Twins and Cape fur seal colony. There is also an archaeological site *viz.* the Boegoebaai | ***Conservancy area:***<br>Positive impacts include: (i) protection of remnant intact vegetation patches; (ii) protection of CR ecosystems and refugia for animal species; and (iii) opportunity for rehabilitation of mining areas. | **The boundary of the conservation area must be revised to include the entire Boegoeberg North. The Cape fur seal colony should also be included in the Conservancy area. The CSIR is to provide a new delineation of the Conservation area.** |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| cave/lair. | Air pollution from the neighbouring SEZ could negatively affect the lichens in the Conservation Area.<br><br>Negative impacts include: (i) all habitats and sensitive features are not represented in the conservancy area; (ii) it only partially protects CBA1s and the CR ecosystems and will not meet biodiversity targets; (iii) it crosses the R382 and without appropriate crossings for fauna an increased mortality of SCC will result. | All development must avoid the Conservancy area. A study must be conducted on the dominant air movement from the planned port and SEZ site, to ensure that pollutants from the port and SEZ are not carried onto the Boegoeberg Twins that are rich in lichens. |
| **BOEGOEBAAI: SPECIAL ECONOMIC ZONE (SEZ)** | | |
| ***Zones 3 – 10: Infrastructure***<br>*Any structure to be built or covering land related to the SEZ e.g.:*<br>• ammonia facilities; desalination plants; electrolyser;<br>• offices and warehouses;<br>• manufacturing infrastructure;<br>• water treatment units & reservoirs; and<br>• $N_2$, $H_2$, and $O_2$ storage facilities | **For vegetation clearance - see above in Terrestrial Ecosystems: Boegoebaai Port - *Zone 1: Infrastructure*** | The SEZ infrastructure should avoid the areas mentioned above in Terrestrial Ecosystems: Boegoebaai Port - in ***Zone 1: Infrastructure.*** |
| ***Zone 3: Desalination plant:***<br>Desalination plant and associated infrastructure | ***Desalination plant* - see *Zone 1: Desalination plant*:**<br>**Vegetation clearance - see *Zone 1: Infrastructure*** | Desalination plants may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** |
| **Zone 3: Electrolyser:**<br>Electrolyser will split water into hydrogen and oxygen to produce Green $H_2$.<br><br>Hydrogen and oxygen storage<br><br>Lye solution purge from the $GH_2$ plant will be discharged with the other return streams to the sea. | **Electrolyser:**<br>• **For vegetation clearance - see *Zone 1: Infrastructure***<br>• Electrolysers require large amounts of water to produce hydrogen. Desalination of seawater is costly and the discharge of the brine is environmentally harmful.<br>• If chemicals are used, there are risks of pollution.<br>• Large areas of land are needed to generate renewal power by wind and solar for desalination and subsequent electrolysis. Alternatively, small nuclear power reactors could be used as carbon-free source, however these systems are expensive and | The electrolyser may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
|---|---|---|
| | also come with risks.<br>• In many systems the lye solution can be recycled for re-use. If the lye solution is discharged it must undergo treatment to neutralise its alkalinity and remove contaminants before releasing into the environment or wastewater treatment systems.<br>• Hydrogen is a very light, non-toxic, flammable gas. When released in gaseous form, it will typically rise and disperse rapidly. If, however, it is released into the atmosphere and it is not dispersed it may ignite.<br>• Because hydrogen is colourless and odourless, sensors must be appropriately positioned to detect leakages. It burns with a pale blue flame that is nearly invisible in daylight, so detection by human senses is difficult. | |
| ***Zone 3: Ammonia facility:***<br>The ammonia facility will be located near the TNPA port and adjacent to the coast and desalination plant.<br><br>***Associated infrastructure:***<br>• Air separation unit;<br>• liquid air energy system (LAES) for nitrogen storage;<br>• ammonia processing unit and liquid ammonia storage tank;<br>• pipelines required for hydrogen, its derivatives and by-products, and a control room;<br>• cooling tower blowdown; and<br>• gasses expected to be safe to vent to the atmosphere. | ***Ammonia facility:***<br>• For vegetation clearance - *see Zone 1: Infrastructure*<br>• The facility has some positive impacts such as (i) a reduction in fossil fuel use; (ii) production of green ammonia as fertiliser without greenhouse gas emissions; (iii) ammonia is an energy carrier that allows the storage and transport of renewable energy; (iv) production from $GH_2$ produces less harmful pollutants than traditional ammonia production.<br>• The negative impacts of the facility include: (i) electrolysis and ammonia production require large amounts of energy from renewable resources; (ii) large areas of land are needed to generate renewable energy by wind and solar; (iii) large amounts of water are needed for electrolysis; (iv) strict safety measure to prevent leaks and accidents are essential.<br>• Ammonia is a hazardous substance and leaks can cause air pollution and pose serious health risks.<br>• Ammonia can contaminate the soil, although it would act as fertiliser to plants.<br>• Cooling tower blowdown may contain accumulated solids (minerals). Treatment of blowdown prior to release is | The ammonia facility and associated infrastructure may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***<br><br>It is essential to monitor the atmospheric emissions around the ammonia facility.<br><br>A study needs to be conducted on the dominant movement of air from the planned SEZ, to ensure that the pollutants from the SEZ are not carried onto the Namib Lichen Fields or the Boegoeberg Twins that are also rich in lichens.<br><br>Potentially, acute localised impacts on bat mortality at water-cooling towers if appropriate mitigation measures are not applied. |

| PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE | POTENTIAL IMPACT | RECEIVING ENVIRONMENT OF CONCERN |
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| | essential.<br>• Possible bat mortalities/injuries due to hot steam discharge. | |
| ***Zone 3: Firewater:***<br>Firewater will be stored in firewater tanks.<br><br>Seawater will be used as backup source when stored firewater is not adequate. | ***Firewater:***<br>• Firewater runoff can introduce pollutants into the soil and water bodies.<br>• If firefighting foams are used, toxic substances can persist in the environment.<br>• When using seawater, discharge will have a high salinity and increased pollutant load. | Firewater infrastructure may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***<br><br>The point of seawater intake needs to be selected by marine ecologist. |
| ***Zone 4 – 6: Industrial Park***<br>Designated for mixed-use purposes; offices; desalination plant; manufacturing cluster; and warehouses. | **Vegetation clearance - see *Zone 1: Infrastructure***<br>See discussion on desalination in ***Zone 1: Bulk services - water*** | The Industrial Park may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** |
| ***Zones 7, 8 & 9. Future Green Hydrogen facility; Future Expansion Zone 01 & 02***<br>Replication of Green Ammonia Facilities | ***Ammonia facility - See SEZ Zone 3*** | Facility may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** |
| ***Zone 10. Future tank storage*** | ***See Zone 1: Fuel storage*** | No structures may be located in areas mentioned in ***Zone 1: Infrastructure.*** |
| ***Common to all zones:*** **Increased Predation by Corvids** | ***Common to all zones***<br>The proposed development will create habitat for corvids that predate heavily on small, slow-moving tortoises. Predation can lead to population declines in tortoises. | ***Common to all zones*** |
| ***Common to all zones:*** **Disturbance from Noise, Dust, and Lights** | ***Common to all zones***<br>• Construction is associated with increased human activity, noise and often artificial lighting. These disturbances negatively affect animal behaviour, particularly in areas where they feed, breed, nest and rest. It can also lead to injuries or mortalities.<br>• Trenching could increase animal mortality. | ***Common to all zones*** |
| ***Common to all zones:*** **Earthworks during construction in the Port and SEZ** | ***Common to all zones***<br>Destruction of roosting habitat of bats and birds. | ***Common to all zones*** |

## 3.7 DISCUSSION AND RECOMMENDATIONS

### *3.7.1 Aquatic*

The study area is not rich in inland aquatic ecosystems, but those that do occur are important for terrestrial wildlife and the ephemeral pans are assumed to support rare aquatic invertebrate communities. The larger pans afford substantial wetland and pan habitat, with Visagiespan providing permanent standing water pools. Ephemeral rock pools in rocky outcrops could support invertebrate communities (possibly endemic) of high biodiversity value and adapted to ephemeral conditions.

The study area abuts two estuaries, namely the ephemeral Holgat River estuary, classified as a micro-outlet, and the Orange River Estuary. The condition of the Orange River Estuary, a Ramsar Wetland site, falls well short of its Recommended Ecological Category, requiring active interventions to improve estuarine condition. This is important, because the proposed Boegoebaai development could directly or indirectly threaten its condition, which would have negative implications for meeting the estuary's Resource Quality Objectives.

The proposed development would result in the potential loss of all inland aquatic ecosystems in the study area including natural pans and depressions that are Critically Endangered systems. The following **recommendations** are made:

- **Avoid** development of Zone 3; western parts of Phases 2 & 3 of the SEZ Industrial Park; the south-western portion of the Future $GH_2$ Facility; and the northern corner of Future Expansion Area 01 because development in these areas would not be compatible with the required conservation of important inland aquatic ecosystems. **Avoid** rock blasting, flattening of slopes and/or loss of rocky outcrops that could include ephemeral rock pool and pan habitat.

- Furthermore, if approved, development of the Boegoebaai Port and SEZ, would need to allow for **increased resources** at the Orange River Estuary, to control and police fishing, hunting and vehicle access and movement within the estuary and associated saltmarshes. It would also need to match any provision of fresh water from desalination plants to any communities/urban areas with an equal increase in infrastructure and human resources capacity to treat the additional wastewater that would be generated, to a level that would not impact negatively on any receiving watercourse, and the Orange River Estuary in particular.

- **Mitigation** measures include (i) no-development areas being tied to corridors that allow for faunal connectivity within and between terrestrial and aquatic habitats; (ii) addressing potential impacts associated with concentrated stormwater flows through areas of increasingly hardened surfaces, which could result in concentration of flows or bypassing dependent aquatic ecosystems; (iii) waste water treatment would need to ensure that waste streams from these activities do not pass, by way of seepage or flows, into pans, wetlands or their buffer area, unless treated to levels that would have negligible impact on aquatic habitat (as determined by an aquatic ecologist); (iv) provision must be made for the management of solid waste in expanding urban settlements associated directly or indirectly with the proposed development; and (v) designing new and/or upgraded access roads that they do not result in downstream erosion or blockages of flows in flood conditions.

**Going forward** the following additional information would be needed: (i) investigation of surface/groundwater linkages at major pan/spring/wetland areas, potentially by way of a hydropedological study and/or geohydrological assessment; (ii) wet-season assessment of ephemeral wetland invertebrate faunal communities; (iii) identification and mapping of key temporary rock pool/pan habitat in rocky outcrops; (iv) detailed stormwater management plans; and (v) measures dealing with impact avoidance, mitigation and management issues.

### *3.7.2 Fauna: Avifauna*

The Second Southern African Bird Atlas Project (SABAP2) recorded 87 bird species in the broader area. Of the 87 species, 47 are considered priority species and 13 species were selected for further assessment. This selection includes species of conservation concern as well as those that are endemic, near-endemic or range-restricted in South Africa.

Although the region does not host a wide diversity of birds, it is home to the range-restricted regional subspecies of the dune lark (previously classified as Barlow's lark). The sheltered bays and dunefields along the coast could provide suitable habitat for the **CR** (regional) Damara tern, while freshwater pans and estuarine habitats along the coast could support various species of conservation concern, including the **VU** (global) curlew sandpiper; **VU** (regional) great white pelican; **VU** (regional) Caspian tern; **NT** (global and regional) Eurasian curlew; and **NT** (regional) greater flamingo. Suitable habitat is also present on site for the **EN** (global and regional) black harrier; **EN** (global and regional) Ludwig's bustard; endemic Cape long-billed lark; and near-endemic jackal buzzard. The site could also potentially support the **EN** (global and regional) martial eagle and **VU** (regional) Lanner falcon.

From an avifaunal perspective the Boegoebaai Port and SEZ development site exhibits predominantly **High** and **Medium** sensitivity. All proposed developments within the Port and SEZ should incorporate an avifaunal specialist study.

### *3.7.3 Fauna: Bats*

Overall, the impacts on bat species for the proposed development are expected to be low and limited to four impacts: (i) light pollution affecting light-averse bat species and creating artificial foraging habitats; (ii) possible bat mortalities or injuries due to hot steam/water discharge at the water-cooling tower blowdown; (iii) foraging habitat destruction; and (iv) roosting habitat destruction. Of these impacts light pollution would be the most significant. However, if the water-cooling towers are equipped with exposed radiator designs, acute and high bat mortality impacts may occur. It is therefore critical that a bat specialist be consulted on the intended design of the water-cooling towers.

The outlined mitigation measures must be adhered to, and the sensitivity map observed when considering infrastructure components.

According to the currently available information, there are no fatal flaws from a bat sensitivity perspective which should prevent the proposed development from proceeding towards the Environmental Impact Assessment phase.

### *3.7.4 Fauna: Mammals, reptiles and amphibians*

The proposed Boegoebaai development presents a range of potential environmental impacts on fauna and SCC. The confirmed or potential presence of sensitive species such as *Pachydactylus rangei, Cryptochloris wintoni* and *Eremitalpa granti granti* combined with CBA 1s and CBA 2s, and two threatened ecosystems (both listed as **CR**) underscore the ecological sensitivity of the project area. While comprehensive mitigation measures can reduce the severity of some impacts, **avoidance** of highly sensitive features should be the first and best option.

Some of the proposed **mitigation** measures, e.g., habitat offsets, wildlife corridors, predator deterrence, are effective in theory but challenging to implement in practice. Many SCC, such as De Winton's golden mole and the desert rain frog, have specific microhabitat requirements that are difficult to replicate or restore. Ensuring the success of mitigation measures also requires sustained monitoring and adaptive management, which may not always be feasible or adequately resourced. Despite mitigation, residual impacts on fauna and habitats are likely in highly sensitive areas.

**Going forward** the following additional information would be needed: (i) fine-resolution spatial data generated through on-site ground-truthing; (ii) comprehensive baseline biodiversity surveys for impacted SCC; (iii) collaboration with taxa-specific specialists and conservation organisations to refine impact assessments and conservation actions; and (iv) install a rainfall, temperature and relative humidity logger

at a relevant trap location to record the prevailing temperature and relative humidity at 30-minute intervals. Herpetofauna are ectothermic and their behaviour is strongly influenced by temperature and rainfall. To interpret survey data more comprehensively, it is necessary to present herpetofauna survey data in the context of the prevailing weather conditions.

At this stage it is recommended to assume the presence of SCC under the precautionary principle and develop appropriate mitigation and management considerations to limit any anticipated impacts, with avoidance being the best possible approach.

### *3.7.5 Vegetation and flora*

The proposed Boegoebaai Port and SEZ development poses major risks to plant diversity. The proposed site hosts many features that emphasise the ecological sensitivity and indicate priority habitat for biodiversity conservation, such as: (i) two Critically Endangered ecosystems; (ii) large areas classified as irreplaceable CBA 1s or optimal CBA 2s (2016 Northern Cape CBA map); (iii) habitat for Critically Endangered plant species; (iv) portions included in the National Protected Area Expansion Strategy (NPAES); (v) inclusion into an internationally recognised KBA; (vi) the presence of 46 SCC; and (vii) the Critically Endangered Namib Lichen Fields, *ca* 13 km north of the site.

From a vegetation and flora perspective the major source of impacts of the Boegoebaai development will result directly or indirectly from vegetation clearance which will lead to habitat loss and transformation and loss of the priority diversity features mentioned above. On the positive side, the Boegoebaai Port and SEZ site is not included in a protected area and the level of infestation by alien invasive plant species is low. A large portion of the site was previously mined and the vegetation in these areas is transformed (modified habitat *sensu* IFC). Furthermore, mine-induced sand plumes cover large sections of land. The transformed habitats, west of the R382, could be used for the Boegoebaai Port and SEZ development **provided adjacent areas of priority habitat are not negatively impacted by the development.**

Although the Screening Tool rated the sensitivity of the Plant Theme as Medium, the current assessment recommends an upscaling of the Plant Theme to **Very High**. The Screening Tool rated the sensitivity of the Relative Terrestrial Biodiversity Theme as Very High and the current assessment largely concurs with a **Very High** rating.

**Going forward** the screening-level sensitivity maps provided in this report must be improved when major revisions of the underlying data are produced or when detailed studies of the site become available. Considering the large areas with a Very High sensitivity rating, it would be prudent to conduct an in-depth, fine-scale analysis of the vegetation and flora on the entire port and SEZ area as soon as possible to verify and/or update the sensitivity maps. These fine-scale maps could be used to guide planning the layout of the port and SEZ to avoid placing development footprints in areas that could possibly not receive Environmental Authorization.

### *3.7.6 Practical recommendations for future EIA studies; rehabilitation; sand stabilisation and monitoring*

**Practical recommendations for future EIA studies:**

All EIA studies will have to adhere to national and provincial environmental legislation, standards, protocols, guidelines and norms as relevant at the time of the assessments. The assessments should also consider relevant agreements or conventions e.g. African-Eurasian Waterbird Agreement; CBD; Convention on the Conservation of Migratory Species of Wild Animals; CITES; Ramsar Convention on Wetlands if International Importance; and Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia.

It is recommended that the aquatic, terrestrial fauna (avifauna, bat, other fauna) and terrestrial botanical specialist studies should provide:

- A description of the biodiversity at ecosystem level including (i) CBAs, ESAs (provide reasons for CBA mapping); (ii) threatened ecosystems; (iii) NPAES Focus Areas; and (iv) main vegetation types

and their environmental determinants; (v) NFEPA Priority Catchments, rivers, wetlands and estuaries within the site.

- A fine-scale map of plant communities/habitats, wetlands, rivers and estuaries that occur on site.
- Avifaunal assessments should consult existing avifaunal data resources such as SABAP2 and Birdlasser® to obtain known records of avifauna for the proposed area of influence (PAOI).
- Perform comprehensive avifaunal baseline monitoring within the proposed development footprint to establish the avian species composition with specific reference to SCC. In high and very high sensitivity areas multiple surveys, spanning different seasons, would be required. Surveys are to be designed in line with best practise guidance.
- A fine-scale 4-tier sensitivity map should be compiled with specified criteria for allocating units to the different sensitivity classes.
- A description of species biodiversity including (i) distribution of threatened fauna and flora; (ii) if possible, viability and estimated population size of threatened species and, if possible, a likely reduction in population size and viability due to the development.
- A description of any other significant landscape features such as (i) rocky outcrops; (ii) seasonal wetlands; (iii) quartz patches; (iv) lichen fields; (v) salt marshes; (vi) rare or important vegetation.
- An assessment of the level of alien invasive plant infestation.
- An assessment of site condition based on current or previous land uses.
- A description of biodiversity patterns and processes and the potential impacts of the proposed development and related activities on these patterns and processes.
- Recommendations on preventing, mitigating or restoring disturbed vegetation, aquatic features, or ecological processes.
- Evidence of how the layout of the development incorporated biodiversity considerations.
- A list of all relevant legislation, permits and standards that would apply to the development.
- If applicable, list additional studies that should be conducted to avoid/ameliorate impacts to sensitive features.
- Indicate mitigation/avoidance measures to be implemented to ensure that the development does not generate impacts beyond the footprint area.
- Recommendations on design and implementation of monitoring.

### Revegetation/Rehabilitation:

Hyper-arid areas such as the Richtersveld coast are very difficult to rehabilitate successfully where rehabilitation aims to ensure the long-term stability of soils, landforms and hydrology required to establish and sustain a natural ecosystem that supports the approved future land use. Rehabilitation also aims to partially or fully repair the capacity of ecosystems to provide habitats for biota and services for people. A rehabilitation specialist, with expertise in the rehabilitation and ecological restoration along the West Coast of South Africa (e.g. Nurture, Restore, Innovate), should be consulted to advise on the possibilities of rehabilitating and potentially even restoring the vegetation. The rehabilitation specialist should be able to advise on setting rehabilitation targets and objectives and which locally occurring species of different functional types could be used in rehabilitation (Desmet, 1996; De Villiers *et al*., 2004; Carrick *et al.,* 2022) and whether the use of restoration packs or transplanting would be feasible in the area.

**Sand stabilisation:**

Because the predominant wind direction is from the south the damaging wind effects will impact areas downwind (i.e. north) of the source area. For planning purposes it will be essential to model the trajectories of sand and dust transport. Mitigation measures to effectively stabilise the sand will be crucial to avoid negative impacts on threatened ecosystems further north. Although sand stabilisation can be achieved by revegetation/rehabilitation it will take many decades. Sand stabilisation by chemical means or the use of geotextiles should be investigated.

**Monitoring:**

A full monitoring programme should be development during the EIA phase. Such a monitoring programme should include:

- Populations of key fauna and plant SCC, that could potentially be impacted by the proposed development, should be monitored throughout construction and operation to ensure that these SCC are not negatively impacted by the development or being poached. Any identified impacts must be mitigated. Monitoring frequency will depend on the phenology and life cycle of the particular species.

- A monitoring program for the early detection of alien invasive plant species should be implemented and a control program to combat declared alien invasive plant species must be employed.

- Rehabilitation progress should be monitored annually.

### *3.7.7 Concluding integrated recommendations*

- The current SEA reports on the terrestrial and aquatic ecology were primarily desktop studies based on available data. However, due to the restricted access to large areas, the site is still relatively under-sampled and available databases of the area are incomplete as demonstrated by ongoing discoveries of new species. We therefore need to emphasise that a desktop report in an under-sampled area cannot be a sufficient foundation to take far-reaching decisions.

- The potential benefits of the Boegoebaai development, (e.g. renewable energy production and economic development) must be evaluated against the irreversible loss of biodiversity and ecosystem services.

- The development should only proceed if it can demonstrate net ecological benefit or neutrality through rigorous mitigation strategies.

- The aquatic assessment contended that there are no positive environmental impacts associated with the proposed Boegoebaai Port and SEZ development.

- The current high-level evaluations of the botanical and faunal components (with the exception of the bat assessment) demonstrated **High** to **Very High** sensitivity for most of the proposed site and consequently the proposed development requires a cautious approach with a strong emphasis on the conservation of biodiversity.

- While mitigation can reduce some of these risks, it cannot eliminate irreversible losses of critical habitats and species, where avoidance is the only option.

- Should the proposed development proceed, it is strongly recommended to establish all planned infrastructure in the already transformed mining landscapes, west of the tar road, **provided adjacent areas of priority habitat are not negatively impacted by the development.**

- The possibility of designating the areas east of the tar road (R382) as set-aside could be considered.

- Due to the **High to Very High** sensitivities associated with the proposed development at the Boegoebaai site, **it is strongly recommended to revisit alternative sites where the impacts on the receiving environment may have lower sensitivities.** Sites with lower ecological sensitivities can achieve development goals with minimal environmental trade-offs.

- The **impacts** of such a large development such as the Boegoebaai Port and SEZ **will generally not be limited to the site but will be more widespread and land adjoining the site will likely also be affected.** Neighbouring areas could thus be targeted by plant poaching as a result of increased human activities due to the development.

- Populations of key fauna and plant SCC, potentially impacted by the proposed development, must be monitored and if impacts are identified, they must be mitigated.

- Sand stabilisation should be addressed by biological, chemical or mechanical means or the use of geotextiles.

- Because hyper-arid areas are very difficult to rehabilitate successfully, a major risk would be that the site is not adequately rehabilitated to a functioning system and a degraded, vulnerable and disturbed ecosystem is left behind. Consult a rehabilitation specialist, with West Coast expertise, to advise on the possibilities of revegetating and potentially restoring the vegetation.

## 3.8 REFERENCES AND BIBLIOGRAPHY


Alexkor EMP, 2008. *Revised Environmental Management Programme*. Prepared by Site Plan Consulting.

Baptista, N., Bauer, A.M., Becker, F., Conradie, W. & Ceríaco, L.M.P. 2020. *Pachydactylus rangei*. *The IUCN Red List of Threatened Species* 2020: e.T196947A120595584. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T196947 A120595584.en.

Barnes, K.N. 2000. Martial Eagle *Polemaetus bellicosus*. In: Barnes, K.N. (Ed.) *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg, South Africa, pp. 83–85.

Barnes, K.N. & Jenkins, A.R. 2000. Lanner Falcon *Falco biarmicus*, In: Barnes, K.N. (Ed.) *BirdLife South Africa*: 141.

Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (Eds) 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. *Suricata 1.*

Bauer, A.M. & Branch, W.R. 2001. The herpetofauna of the Richtersveld National Park and the adjacent northern Richtersveld, Northern Cape Province, Republic of South Africa. *Herpetological Natural History* 8: 111–160.

Berry, H.H., Stark, H.P. & Vuuren, A.S. 1973. White Pelicans *Pelecanus onocrotalus* breeding on the Etosha Pan, South West Africa, during 1971. *Madoqua* 7: 17–31.

BirdLife International. 2025a. Species factsheet: Cape Long-billed lark *Certhilauda curvirostris*. https://datazone.birdlife.org/species/factsheet/cape-long-billed-lark-certhilauda-curvirostris.

BirdLife International 2025b. Species factsheet: Curlew sandpiper *Calidris ferruginea*. https://datazone.birdlife.org/species/factsheet/curlew-sandpiper-calidris-ferruginea.

Botha, M. 2025. *Chapter 4: Biodiversity offset framework* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Botha, M. & Desmet, P. 2022. *Boegoebaai Port & Namakwa Satellite SEZ Biodiversity Offset Strategic Perspective*. Report to NCEDA by Conservation Strategy Tactics & Insight.

Bourne, A., Donatti, C., Holness, S. & Midgley, G.F. 2012. *Climate change vulnerability assessment for the Namakwa District Municipality*. Cape Town: Conservation South Africa.

Braby, J., Braby, S.J., Braby, R.J. & Altwegg, R. 2011. Immature survival and age at first breeding of Damara terns: conservation from a non-breeding perspective. *Ardea* 99: 185–190.

Braby, J., Braby, R.J., Braby, N. & Simmons, R.E. 2009. Protecting Damara terns *Sterna balaenarum* from recreational disturbance in the Namib Desert increases breeding density and overall success. *Ostrich* 80: 71–75.

Branch, B. 2008. *Tortoises, terrapins & turtles of Africa*, Cape Town: New Holland Publishing.

Branch, W.R. 1998. *Field Guide to Snakes and other Reptiles of Southern Africa.* Third Edition. Cape Town: Struik.

Broennimann, O., Thuiller, W., Hughes, G., Midgley, G.F., Alkemade, J.R. & Guisan, A. 2006. Do geographic distribution, niche property and life form explain plants' vulnerability to global change? *Global Change Biology* 12:1079–1093.

Bronner, G.N. & Asher, R. 2016. A conservation assessment of *Cryptochloris wintoni*. In: Child, M.F.R.L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (Eds). *The Red List of Mammals of South Africa, Swaziland and Lesotho.* SANBI and EWT.

Buchanan, C.A., Eifler, M.A., Kanyanga, M.K., Utsumi, K.L., Liu, E.F., Luyanda, B., Muradzikwa, T.E. & Eifler, D.A. 2023. The lizard with kaleidoscope eyes: Population characteristics of the Namib web-footed gecko, *Pachydactylus rangei*. *Journal of Arid Environments* 214, 104985.

Carrick, P.J., Botha, M.S. & Krüger, R. 2022. *Ecological restoration in Namaqualand: a practical guide. (Ekologiese restourasie in Namaqualand: 'n praktiese gids.)* Cape Town: Nurture, Restore, Innovate.

Channing, A. & Rödel, M.O. 2019. *Field guide to the frogs and other amphibians of Africa*. Cape Town: Struik Nature.

Channing, A. & Wahlberg, K. 2011. Distribution and conservation status of the desert rain frog *Breviceps macrops*. *African Journal of Herpetology* 60: 101–102.

Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (Eds). 2016. *The Red List of Mammals of South Africa, Swaziland and Lesotho.* SANBI and EWT.

Crawford, R.J.M., Cooper, J. & Dyer, B.M. 1995. Conservation of an increasing population of great white pelicans *Pelecanus onocrotalus* in South Africa's Western Cape. *South African Journal of Marine Science* 15: 33–42.

Crawford, R.J.M., Dyer, B.M., Kotze, P.G.H., McCue, S., Meÿer, M.A., Upfold, L. & Makhado, A.B. 2012. *Status of seabirds breeding in South Africa in 2011*. Oceans and Coasts, Department of Environmental Affairs. Technical report.

Cunningham, S.J., Madden, C.F., Barnard, P. & Amar, A. 2016. Electric crows: powerlines, climate change and the emergence of a native invader. *Diversity and Distributions* 22: 17–29.

Council for Geoscience. 2011. Geological Map 2816 Alexander Bay. Pretoria: Government Printer.

Cowling, R.M., Esler, K.J. & Rundel, P.W. 1999. Namaqualand, South Africa – an overview of an unique winter-rainfall desert ecosystem. *Plant Ecology* 142: 3–21.

Cowling, R.M. & Hilton-Taylor, C. 1999. Plant biogeography, endemism and diversity. Pp 42–56. In: Dean, W.R.J. & Milton, S.J. (Eds). *The Karoo, ecological patterns and processes.* Cambridge: Cambridge University Press.

Cowling, R.M., Richardson, D.M. & Pierce, S.M. (Eds). 1997. *Vegetation of southern Africa.* Cambridge: University Press.

CEPF (Critical Ecosystem Partnership Fund). 2003, *Ecosystem Profile: The Succulent Karoo hotspot*, Namibia and South Africa, Critical Ecosystem Partnership Fund report.

De Villiers, A.J., Van Rooyen, M.W. & Theron, G.K. 2004. The restoration of Strandveld Succulent Karoo degraded by mining: an enumeration of topsoil seed banks. *South African Journal of Botany* 70: 717–725.

Du Plessis, H.M. (Ed.) 1987. Land Types of the maps: 2816 Alexander Bay; 2818 Warmbad; 2916 Springbok; 2918 Pofadder; 3017 Garies; 3018 Loeriesfontein. *Memoirs on the Agricultural Natural Resources of South Africa* 9.

Du Preez, L.H. & Carruthers, V.C. 2017. *Frogs of Southern Africa: A Complete Guide*. 2nd Revised edition, Struik Nature.

Davis, C.L., Hoffman, M.T. & Roberts, W. 2016. Recent trends in the climate of Namaqualand, a megadiverse arid region of South Africa. *South African Journal of Science* 112: Art. 2015–0217, 9 pp.

Day, L. 2025. *Chapter 3a: Aquatic ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

DFFE (Department of Forestry, Fisheries and the Environment) 2022. South Africa Protected Areas Database (SAPAD_OR_2021_Q4). http://egis.environment.gov.za.

DFFE (Department of Forestry, Fisheries and the Environment). 2023. National Environmental Management Act, 1998 (Act No. 107 of 1998) The National Biodiversity Offset Guideline. *Government Gazette No.* 48841, Government Notice No. 3569. 23 June 2023.

Desmet, P.G. & Cowling, R.M. 1999. Biodiversity, habitat and range-size aspects of a flora from a winter-rainfall desert in north-western Namaqualand, South Africa. *Plant Ecology* 142: 23–33.

Desmet, P.G. 1996. *The vegetation and restoration potential of the vegetation of the arid coastal belt between Port Nolloth and Alexander Bay, Namaqualand, South Africa.* MSc dissertation. Cape Town: University of Cape Town.

Desmet, P.G. 2007. Namaqualand—A brief overview of the physical and floristic environment. *Journal of Arid Environments* 70: 570–587.

Dodman, T. 2014. *Status, Estimates and Trends of Waterbird Populations in Africa:* AEWA-listed African populations. Wetlands International.

Driver, A., Nel, J.L., Snaddon, K., Murray, K., Roux, D., Hill, L., Swartz, E.R., Manuel, J. & Funke, N. 2011. *Implementation Manual for Freshwater Ecosystem Priority Areas*. WRC Report No. 1801/1/11. ISBN 978-1-4312-0147-1. Pretoria.

Driver, A., Sink, K.J., Nel, J.L., Holness, S.H., Van Niekerk, L., Daniels, F., Jonas, Z., Majiedt, P.A., Harris, L. & Maze, K. 2012. *National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems*. Synthesis report. Pretoria: South African National Biodiversity Institute & Department of Environmental Affairs.

Department of Water and Sanitation (DWS), South Africa. 2017a. Determination of Ecological Water Requirements for surface water (river, estuaries and wetlands) and Groundwater in the Lower Orange WMA. *Report on consequences of scenarios*. Rivers for Africa eFlows Consulting (Pty) Ltd. DWS Report No: RDM/WMA06/00/CON/COMP/0117.

Department of Water and Sanitation (DWS), South Africa. 2017b. Determination of Ecological Water Requirements for Surface water (river, estuaries and wetlands) and Groundwater in the Lower Orange WMA. *Ecological Specifications and monitoring report*. Rivers for Africa eFlows Consulting (Pty) Ltd. DWS Report No: RDM/WMA06/00/CON/COMP/0217.

Ebert, T. & Balko, M. 1987. Temporary pools as islands in space and in time: the biota of vernal pools in San Diego, Southern California, USA. *Arch. Hydrobiol.* 110:101–123.

Eckert, K.L., Wallace, B.P., Frazier, J.G., Eckert, S.A. & Pritchard, P.C.H. 2012. *Synopsis of the biological data on the leatherback sea turtle* (*Dermochelys coriacea*). Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication BTP-R4015-2012.

EWT (Endangered Wildlife Trust). 2023. *Best Practice Guidelines for Implementing the Mitigation Hierarchy in South Africa*. EWT.

Ferguson-Lees, J. & Christie, D.A. 2001. *Raptors of the World.* Houghton Mifflin Company.

FitzPatrick Institute of African Ornithology. 2024. MammalMAP. https://vmus.adu.org.za/?vm=MammalMAP.

FitzPatrick Institute of African Ornithology. 2024. FrogMAP. https://vmus.adu.org.za/?vm=FrogMAP.

Francis, M.L., Palcsu, L., Molnár, M., Kertész, T., Clarke, C.E., Miller, J.A. & Van Gend, J. 2024. Calcareous termite mounds in South Africa are ancient carbon reservoirs. *Science of the Total Environment* 926: DOI:10.1016/j.scitotenv.2024.171760.

Froneman, A., Colyn, R., Oosthuizen, M. & Loftie-Eaton, M. 2025. *Chapter 3b: Avifauna* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR .

Frost, D.R. 2024. Amphibian Species of the World: An Online Reference. Version 6.1 (February 2023). https://amphibiansoftheworld.amnh.org/index.php. American Museum of Natural History, New York, USA. doi.org/10.5531/db.vz.0001.

GBIF.org (02 December 2024) GBIF Occurrence Download https://doi.org/10.15468/dl.7bax2v.

Goldberg, S.R. 2008. Note on reproduction of the web-footed gecko, *Pachydactylus rangei* (Squamata: Gekkonidae) from Namibia. *Bull. MDHS* (Md. Herpetol. Soc.) 44: 15–17.

Gottlieb, T.R., Eckardt, F.D., Venter, Z.S. & Cramer, M.D. 2019. The contribution of fog to water and nutrient supply to *Arthraerua leubnitziae* in the central Namib Desert, Namibia. *Journal of Arid Environments* 161:35–46.

Haacke, W.D., 1976. The burrowing geckos of southern Africa, 2 (Reptilia: Gekkonidae). Ann. *Transvaal Mus.* 30: 13–29.

Hamer, M. & Rayner, N.A. 1996. A note on the unusual crustacean community of a temporary pool in the northern Cape. *South African Journal of Aquatic Science* 22: 100–104.

Hattingh, J. 2016. *Surface and Groundwater Assessment.* Report to PHS Consulting for VAST Mineral Sands (Pty) Ltd.

Henschel, J.R. & Jürgens, N. In press. Ecology of psammophily in the Namib dunes. In: Eckardt, F.D., Livingstone, I., Thomas, D.S.G. (Eds). *Southern African Dunes*. Springer.

Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (Eds). 2005). *Roberts – Birds of Southern Africa, VIIth edition*. Cape Town: The Trustees of the John Voelcker Bird Book Fund.

Hoffman, M.T., Rohde, R. & Gillson, L. 2019. Rethinking catastrophe? Historical trajectories and modelled future vegetation change in southern Africa. *Anthropocene* 25. https://doi.org/10.1016/j.ancene.2018.12.003.

Hofmeyr, M.D., Leuteritz, T. & Baard, E.H.W. 2018. *Psammobates tentorius* ssp. *trimeni*. *IUCN Red List of Threatened Species* e.T121936835A121936853. https://dx.doi.org/10.2305/IUCN.UK.20182.RLTS.T121936835A121936853.en

Hofmeyr, M.D., Loehr, V.J.T. & Baard, E.H.W. 2018[b]. *Chersobius signatus*. The IUCN Red List of Threatened Species 2018: e.T10241A115650943. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T10241A115650943.en

Holness, S., & Oosthuysen, E. 2016. Critical Biodiversity Areas of the Northern Cape: Technical Report.

IFC PS6. 2019. *International Finance Corporation's Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. International Finance Corporation. World Bank Group. ww.ifc.org/ps6.

IUCN SSC. Amphibian Specialist Group & South African Frog Re-Assessment Group (SA-FRoG). 2017. *Breviceps macrops*. *The IUCN Red List of Threatened Species* e.T3070A2794989. https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T3070A2794989.en.

IUCN. 2021. *IUCN Red List Categories*. Prepared by the IUCN Species Survival Commission. Gland: Switzerland.

Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards *Neotis ludwigii*. *Bird Conservation International* 21: 303–310.

Jürgens, N. 1991 A new approach to the Namib Region: Phytogeographic subdivision. *Vegetatio* 97: 21–38.

Jürgens, N., Burke, A., Van Wyk, P., Gröngröft, A. & Oldeland, J. Preprint. A perfect storm: Unprecedented expansion of the Namib Desert and cascading desertification processes in the northernmost Succulent Karoo (Richtersveld, South Africa, Namibia). https://ssrn.com/abstract=5189871 or http://dx.doi.org/10.2139/ssrn.5189871

Jürgens, N., Burke, A., Seeley, M.K. & Jacobsen, 1997. Desert. In: Cowling, R.M., Richardson, D.M. & Pierce, S.M. (eds). *Vegetation of southern Africa* pp. 189-214. Cambridge: Cambridge University Press.

Jürgens, N. & Niebel, A. 1991. The unknown lichen hill. *Journal of the Botanical Society of South Africa* 77: 24–26.

Jürgens, N. & Niebel-Lohmann, A. 1995. Geobotanical observations on lichen fields of the Southern Namib Desert. *Mitteilungen aus dem Institut für Allgemeine Botanik in Hamburg* 25, 135–156.

KBA. 2024. Key Biodiversity Areas factsheet: Namaqualand Sandveld North. Extracted from the World Database of Key Biodiversity Areas. Key Biodiversity Areas Partnership. https://keybiodiversityareas.org<.

Kemp, A.C. & Kirwan, G.M. 2020. Jackal Buzzard *(Buteo rufofuscus*), version 1.0. In: Del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. & de Juana, E. (Eds) Birds of the World. Cornell Lab of Ornithology, Ithaca, NY, USA.

Kleynhans, C.J., Louw, M.D., Thirion, C., Rossouw, N.J. & Rowntree, K. 2005. *River EcoClassification: Manual for EcoStatus determination* (Version 1). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. KV 168/05.

Kot, C.Y.,. Fujioka, E., DiMatteo, A.D., Bandimere, A., Wallace, B.P., Hutchinson, B.J., Cleary, J., Halpin P.N. & Mast, R.B. 2023. *The State of the World's Sea Turtles Online Database: Data provided by the SWOT Team and hosted on OBIS-SEAMAP.* Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG) and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu/swot.

Land Type Survey Staff, 1986. Land Type Map 2816 Alexander Bay.

Le Maitre, D., O'Farrell, P., Milton, S., Atkinson, D., De Lange, W., Egoh, B., Reyers, B., Colvin, C., Maherry, A. & Blignaut, J. 2009. *Assessment and Evaluation of Ecosystem Services in the Succulent Karoo Biome.* Report 27 prepared by CSIR for the Succulent Karoo Ecosystem Programme (SKEP) Coordination Unit, SANBI.

Le Maitre, D.C., Seyler, H., Holland, M., Smith-Adao, L.B., Nel, J.L., Maherry, A. & Witthüser, K. 2018. *Strategic Water Source Areas for groundwater* (Vector data). WRC Report No TT 754/1/18, Water Research Commission, Pretoria.

Loehr V.J.T. 2002. Population characteristics and activity patterns of the Namaqualand speckled padloper (*Homopus signatus signatus*) in the early spring. *Journal of Herpetology* 36: 378–389.

Loehr M.D. & Henen B.T. 2007. Annual variation in the body condition of a small, arid-zone tortoise, *Homopus signatus signatus*. *Journal of Arid Environment,* 71: 337–349.

Loehr M.D. & Henen B.T. 2009. Small and sensitive to drought: consequences of aridification to the conservation of *Homopus signatus signatus*. *African Herpetology* 58: 116–125.

Loehr B.T. & Hofmeyr M.D. 2011. Reproductive responses to rainfall in the smallest tortoise, *Homopus signatus signatus*. *Copeia* 2011: 278–284.

Mabidi, A., Bird, M.S., Perissinotto, R. & Rogers, D.C. 2016. Ecology and distribution of large branchiopods (Crustacea, Branchiopoda, Anostraca, Notostraca, Laevicaudata, Spinicaudata) of the Eastern Cape Karoo, South Africa. *ZooKeys* 618: 15–38.

Marais, W. 2025. *Chapter 3c: Bats* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Maree, S., Bronner, G.N. 2016. A conservation assessment of *Eremitalpa granti granti*. In: Child, M.F., Roxburgh, L., Raimondo, D., Davies-Mostert, H.T. (eds). *The Red List of Mammals of South Africa, Swaziland and Lesotho.* SANBI & EWT.

Mavurayi, A. 2014. *Geohydrological Impact Assessment for Alexkor Diamond Mine along the west coast between Port Nolloth and Alexander Bay, Northern Cape Province.* Report for Myezo Environmental Services.

McAuliffe, J.R., Hoffman, M.T., McFadden, L.D., Jack, S., Bell, W. & King, M.P. 2019. Whether or not heuweltjies: Context-dependent ecosystem engineering by the southern harvester termite, *Microhodotermes viator*. *Journal of Arid Environments* 163: 26–33.

MDT 2018. *Boegoebaai Environmental Screening Report*. Part of Phase 2 of a pre-feasibility study for the Boegoebaai Port. Report to TNPA.

Midgley, G.F., Rutherford, M.C., Bond, W.J. & Barnard, P. 2001. *The heat is on – impacts of climate change on plant diversity in South Africa.* Pretoria: South African National Botanical Institute.

Midgley, G.F. & Thuiller, W. 2007. Potential vulnerability of Namaqualand plant diversity to anthropogenic climate change. *Journal of Arid Environments* 70: 615–628.

Milton, S.J., Zimmermann, H.G. & Hoffmann, J.H. 1999. Alien plant invaders of the Karoo: attributes, impacts and control. In: Dean, W.R.J. & Milton, S.J. (Eds). *The Karoo: Ecological Patterns and Processes.* Cambridge: Cambridge University Press.

Mittermeier, R.A., Myers, N., Robles, G.P. & Mittermeier, C.G. 2000. *Hotspots: Earth's biologically richest and most endangered terrestrial ecoregions*, CEMEX, Mexico.

Mucina, L. & Rutherford, M.C. (Eds). 2006. Vegetation of South Africa, Swaziland and Lesotho. *Strelitzia* 19.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., De Fonseca, G.A.B. & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 402: 853–858.

Mynhardt, S., Matthew, E., le Roux, J.P., Little, I., Bloomer, P. & Theron, C. 2024. Environmental DNA from soil reveals the presence of a "lost" Afrotherian species. *Biodiversity and Conservation* 33: 31–50.

Mynhardt, S. 2023. Golden mole that swims through sand is rediscovered in South Africa after 86 years. Published in *The Conversation*, December 5, 2023. https://theconversation.com/golden-mole-that-swims-through-sand-is-rediscovered-in-south-africa-after-86-years-219022.

National Environmental Management: Biodiversity Act (10/2004). 2022: *Revised national list of ecosystems that are threatened and in need of protection* (Government Gazette No. 47526 – Government Notice No. 2747))

Nash, T.H. 2008. *Lichen Biology.* 2nd Edition, Cambridge: Cambridge University Press.

National Environmental Management: Biodiversity Act (10/2004). 2022: Revised national list of ecosystems that are threatened and in need of protection (Government Gazette No. 47526 – Government Notice No. 2747).

Navedo, J.G., Arranz, D., Herrera, A.G., Salmón, P., Juanes, J.A. & Masero, J.A. 2013. Agroecosystems and conservation of migratory waterbirds: importance of coastal pastures and factors influencing their use by wintering shorebirds. *Biodiversity and Conservation* 22: 1895–1907.

NCNCA. 2009. *Northern Cape Nature Conservation Act (Act No. 9 of 2009).* Provincial Gazette Extraordinary, Vol 17, No. 1374, Kimberley: 21 January 2010.

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, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. & Nienaber, S. (2011). *Technical Report for the National Freshwater Ecosystem Priority Areas project*. WRC Report No. K5/1801

NFA. 2024. The publication of the annual list of all tree species which are protected under Section 12 of the National Forest Act, 1998 (Act No. 84 of 1998). *Government Gazette No.* 50291, Government Notice No. 4496. 13 March 2024. Pretoria: Government Printer.

Nkomo, M.N., Murgatroyd, M., Ralston-Paton, S. & Amar, A. 2024. Using stakeholder knowledge to co-produce research priorities for a raptor species vulnerable to impacts of wind energy facilities. *Ostrich* 95: 200-212.

Niemandt, C. 2025. *Chapter 3d: Fauna* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Northern Cape Department of Environment and Nature Conservation. (2016). Northern Cape Critical Biodiversity Areas [Vector] 0. Available from the Biodiversity GIS website.

National Protected Areas Expansion Strategy. 2018. NPAES PA Negotiated Focus Areas 2018. https://egis.environment.gov.za/data_egis/data

Olivier, J. 2002. Fog-water harvesting along the West Coast of South Africa: a feasibility study. *Water SA* 28: 349–360.

Ollis, D.J., Snaddon, C.D., Job, N.M. & Mbona, N. 2013. *Classification System for Rivers and other Aquatic Ecosystems in South Africa.* User Manual: Inland Systems.

Oosthuysen, E. & Geldenhuys, L. 2024. *Northern Cape Biodiversity Spatial Plan: Technical Report.* Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform, Springbok.

Pool-Stanvliet, R., Duffel-Canham, A., Pence, G. & Swart, R. 2017. *Western Cape Biodiversity Spatial Plan Handbook.* Stellenbosch: CapeNature.

Rayner, N.A. & Bowland, A.E. 1985 Notes on the taxonomy and ecology of *Triops granaries* (Lucas) (Notostraca: Crustacea) in South Africa. *South African Journal of Science* 81: 500–505.

Rayner, N. 1999. Notostraca. Pp. 7-13. In: Day, J.A., Stewart, B.A., de Moor, I.J. & Louw, A.E. (eds.) *Freshwater Invertebrates of Southern Africa. Crustacea I: Notostraca, Anostraca, Conchostraca and Cladocera* Water Research Commission Report TT 121/00, Pretoria.

ReptileMAP. 2024. The Southern African Reptile Conservation Assessment (SARCA, now ReptileMAP. http://vmus.adu.org.za/.

Roberts, D.L., Botha, G.A., Maud, R.R. & Pether, J., 2006, Coastal Cenozoic deposits. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds), *The geology of South Africa.* Johannesburg: Geological Society of South Africa, pp. 605–628.

Rutherford, M.C., Midgley, G.F., Bond, W.J., Powrie, L.W., Roberts, R. & Allsopp, J. 2000. Plant biodiversity: Vulnerability and adaptation assessment. In: Kiker, G. (Ed.). *Climate change impacts in southern Africa*. Report to the National Climate Change Committee. Pretoria: Department of Environment Affairs and Tourism.

Ryan, P.G. & Kirwan, G.M. 2022. Dune Lark (*Calendulauda erythrochlamys*), version 1.0. In Billerman, S.D. (Ed.) Birds of the World. Ithaca: Cornell Lab of Ornithology, NY, USA.

SANBI. 2012-2024. *The Vegetation Map of South Africa, Lesotho and Swaziland*, Mucina, L., Rutherford, M.C. & Powrie, L.W. (Eds), Online, http://bgis.sanbi.org/Projects/Detail/186, Version 2024.

SANBI. 2018. *Using CBA Maps to support land-use planning and decision-making*. SANBI Factsheet Series. Pretoria: South African National Biodiversity Institute.

SANBI. 2022. *Species Environmental Assessment Guideline.* Guideline for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for Environmental Impact Assessments in South Africa. Version 3.1.Pretoria: SANBI.

SANBI. 2022. *Red List of Ecosystems (RLE) for terrestrial realm for South Africa*.

SANBI. 2024. Red List of South African Plants version 2024.1. Provided by SANBI, accessed on 2024/11/22.

Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, Y. & Maluleke, J. 2024. *Strategic Environmental Assessment for the proposed Boegoebaai Port, SEZ and Namakwa Region: Briefing note for research partners.* Note produced by CSIR, NCEDA and TNPA.

Screening Tool. 2024. *Screening Report for an Environmental Authorization as required by the 2014 EIA Regulations – Proposed Site Environmental Sensitivity*. Department of Forestry, Fisheries and the Environment.

Simmons, R.E., Curtis, O.E. & Jenkins, A.R. 2005. *Black Harrier Circus macrourus*, In: Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (Eds). The Trustees of the John Voelcker Bird Book Fund: 502–503.

Skowno, A.L., Poole, C.J., Raimondo, D.C., Sink, K.J., Van Deventer, H., Van Niekerk, L., Harris, L.R., Smith-Adao, L.B., Tolley, K.A., Zengeya, T.A., Foden, W.B., Midgley, G.F. & Driver, A. 2019. *National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report*. Pretoria: South Africa. 214 pp.

Snow, D.W. & Perrins, C.M. 1998. *The Birds of the Western Palearctic, Volume 1: Non-Passerines*. Oxford: Oxford University Press.

Swart, E. & Geldenhuys, L. 2020. *Preliminary Report: Environmental concerns associated with the proposed Boegoebaai Harbour and refinery developments*. Internal departmental report No. 4/2020. Confidential.

Taylor, M., Peacock, F. & Wanless, R.M. (Eds). 2015. *The 2015 Eskom Red Data Book of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

Tippett, R.M. 2024. Jackal Buzzard (*Buteo rufofuscus*). Biodiversity and Development Institute. Available online at https://thebdi.org/2024/07/02/jackal-buzzard-buteo-rufofuscus/

Todd, S. 2011. *Ecological and Biodiversity Assessment: Terrestrial vertebrate fauna and botanical Specialist Study*. Report to G7 Renewable Energies for Richtersveld Wind Farm.

Tolley, K.A. & Burger, M. 2007. *Chameleons of Southern Africa*. Cape Town: Struik.

Tolley, K.A., Alexander, G.J., Weeber, J., Maritz, B. & Turner, A.A. 2019. *Bitis schneideri*. *The IUCN Red List of Threatened Species* 2019: e.T2818A147708662. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T2818A147708662.en.

Transnet National Ports Authority, 2024. *Boegoebaai Port and Rail Development Site Selection*.

Uetz, P., Freed, P, Aguilar, R., Reyes, F. & Hošek, J. (Eds). 2024. The Reptile Database, http://www.reptile-database.org.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2019. *South African National Biodiversity Assessment 2018: Technical Report.* Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3. Pretoria: CSIR & SANBI.

Van Rooyen, G., Van Rooyen, N. & Van Wyk, P. 2025. *Chapter 3e: Vegetatio and flora (A)* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Van Wilgen, B.W., Reyers, B., Le Maitre, D.C., Richardson, D.M. & Schonegevel, L. 2008. A biome-scale assessment of the impact of invasive alien plants on ecosystem services in South Africa. *Journal of Environmental Management* 89: 336 –349.

Van Wyk, A.E. & Smith, G.F. 2001. *Regions of Floristic Endemism in southern Africa*. Pretoria: Umdaus Press.

Van Wyk, P. 2025. *Chapter 3f: Vegetation and flora (B)* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Vignali, S., Barras, A.G., Arlettaz, R. & Braunisch, V. 2020. SDMtune: An R package to tune and evaluate species distribution models. *Ecology and Evolution* 10: 11488–11506.

Walker, C., Milton, S.J., O'Connor, T.G., Maguire, J.M. & Dean, W.R.J. 2018. Drivers and trajectories of social and ecological change in the Karoo, South Africa. *African Journal of Range and Forage Science* 35:157–177.

Wallace, B.P., Tiwari, M. & Girondot, M. 2013. *Dermochelys coriacea (Southwest Indian Ocean subpopulation)*. *The IUCN Red List of Threatened Species* 2013: e.T46967863A46967866. https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T46967863A46967866.en.

Young, A.J., Guo, D., Desmet, P.G. & Midgley, G.F. 2016. Biodiversity and climate change: Risks to dwarf succulents in Southern Africa. *Journal of Arid Environments* 129: 16–24.

## 3.9 SUPPLEMENTARY MATERIAL: SPECIALIST REPORTS

### *1. Aquatic report*

Day, L. 2025. *Strategic Environmental Assessment for the proposed Boegoebaai Port and Strategic Economic Zone, Northern Cape, South Africa, Work Package 1: Aquatic Ecosystems Assessment – Inland Aquatic Ecosystems and Estuaries.* Report to CSIR.

### *2. Fauna: Avifauna report*

Froneman, A., Colyn, R. & Loftie-Eaton, M. 2025. *Strategic Environmental Assessment for the proposed Boegoebaai Port and Strategic Economic Zone: Avifaunal Specialist Assessment*. Report to CSIR.

### *3. Fauna: Bat report*

Marais, W. 2025. *Bat Specialist Assessment for the Strategic Environmental Assessment of the Proposed Boegoebaai Port and SEZ* (Special Economic Zone), Northern Cape, South Africa.

### *4. Fauna: Mammal, Reptile and Amphibian report*

Niemandt, C. 2025. *Strategic Environmental Assessment (SEA) for the Proposed Boegoebaai Port and SEZ Fauna Desktop Assessment*. Report to CSIR.

### *5. Vegetation and Flora report*

(A.) Van Rooyen, N., Van Rooyen, G. & Van Wyk, P. 2025. *Boegoebaai Port and Special Economic Zone Strategic Environmental Assessment. Terrestrial Ecology: Vegetation and Flora component.* Report to CSIR.

(B.) Van Wyk, P. 2025. *Boegoebaai Strategic Environmental Assessment; Report 1; exploring the floral richness of the Boegoebaai Port development site and surrounding areas, Richtersveld Municipal Area, Western Gariep Desert, Northern Cape, South Africa.* Report to CSIR.