GEORGE
THE CITY FOR ALL REASONS

# Coastal Erosion Response Guideline

**Directorate**: **Human Settlements, Planning and Development**
**Section: Environmental Management**
**Version: 001**
**Date: September 2024**

The purpose of this guideline is to provide the framework for addressing coastal erosion in Wilderness. It informs affected property owners and stakeholders about the best practices for managing coastal erosion as determined by the George Municipality. Nature-based solutions are identified as the only permissible intervention permitted along the Wilderness coastline. The guideline provides information on erosion drivers, best practice response options, the legislative framework for responding to coastal erosion and the process that affected landowners must follow to engage with the relevant authorities to approve proposed erosion control measures.

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## 1. Purpose of Guideline

This guideline provides information on erosion drivers, best practice response options, the legislative framework for responding to coastal erosion and the process for affected landowners to engage with the relevant authorities.

The guideline is intended to:

- Identify and explain the natural and human-induced factors contributing to coastal erosion along the Wilderness coastline.
- Provide guidance on short-term best practices for managing coastal erosion, ensuring a consistent approach among stakeholders.
- Clarify applicable legislation related to coastal management and erosion control to ensure compliance with national and provincial laws and the George Municipal Spatial Framework
- Facilitate effective communication and coordination between affected landowners, local government and other relevant stakeholders.

## 2. Introduction

Sandy beaches, which line much of the world's coastlines, provide life-sustaining ecosystem services that maintain safe and healthy environments for people. These services include filtering seawater, recycling nutrients, providing habitats, providing valuable recreational spaces and importantly, protecting inland areas by buffering against erosion from sea-level rise and storms[1]. These ecosystem services, however, are being compromised globally by various stressors, which places sandy beaches under significant strain[2,3].

Beaches do not exist in isolation; they are central to the sandy littoral zone, flanked by surf zones seaward and dunes landward and are closely linked with both through the exchange of sand. Therefore, damage to any one of these interconnected compartments affects all three[4]. The ability of beaches to provide ecosystem services is declining due to numerous pressures from both the landward and seaward sides.

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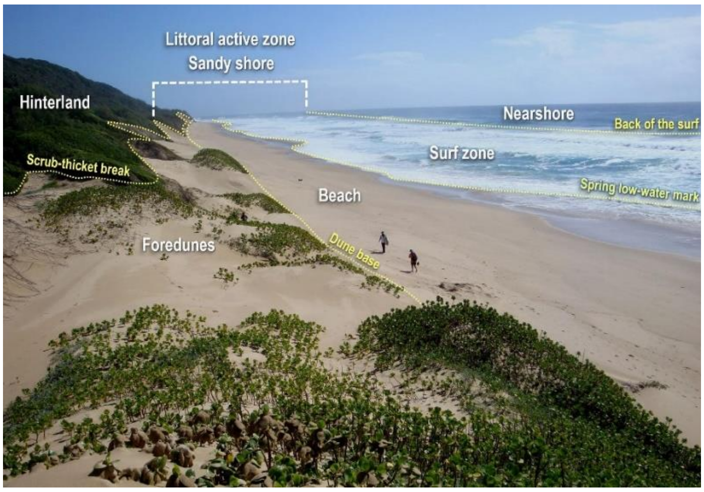
[1] Harris, L.R. and Defeo, O., 2022. Sandy shore ecosystem services, ecological infrastructure, and bundles: New insights and perspectives. *Ecosystem Services*, *57*: 101477.
[2] Vousdoukas, M.I., Ranasinghe, R., Mentaschi, L., Plomaritis, T.A., Athanasiou, P., Luijendijk, A. and Feyen, L., 2020. Sandy coastlines under threat of erosion. *Nature climate change*, *10*(3), pp.260-263.
[3] Harris, L.R. and Defeo, O., 2022. Sandy shore ecosystem services, ecological infrastructure, and bundles: New insights and perspectives. *Ecosystem Services*, *57*: 101477.
[4] McLachlan, A. and Defeo, O., 2017. *The ecology of sandy shores*. Academic press.

Human activities, particularly the rapid expansion of urban development and infrastructure, are impairing beaches' capacity to protect coastlines. Climate change exacerbates this threat through sea-level rise and increased storminess and flooding, which lead to erosion, beach retreat and coastal overtopping[5]. As a result, a situation known as 'coastal squeeze' is created where sandy beaches are trapped between advancing urban and industrial development on one side and rising sea levels on the other[6]. This ongoing pressure, known as 'press-press' compound perturbation, results in substantial long-term losses of sandy beach ecosystem services, such as food, recreation and coastal protection, which have been documented globally[7]. Coastal squeeze also interacts with other disturbances, creating unpredictable effects on the social-ecological system of sandy shores.

Sandy shores can be divided into three connected areas: the foredunes, the beach and the surf zone as shown in Figure 1.




| Zones | Description |
|---|---|
| Foredunes | The foredunes are the wind-controlled, terrestrial area comprising hummocks and shifting sands. The zone extends from the edge if shrub-thicket vegetation to the base of the dunes. |
| Beach | The beach is the non-vegetation area between the dune base and the low-water mark during spring tides. |
| Surf zone | The surf zone is where waves break and lose their energy due to the shallow water depth. |

**Figure 1**. Three zones of the sandy beaches.

These zones constantly exchange nutrients, biota and sand, forming a single geomorphic unit called the littoral active zone (LAZ). The LAZ is the area at the land-sea interface where sand is mobile due to wind and wave transport. Different beach types emerge from the interaction of tides, waves and sand grain size, ranging from tide-dominated, wide, flat ultra-dissipative beaches with wide surf zones and fine-grained sand, to wave-dominated, narrow, steep reflective beaches with narrow surf zones and coarse-grained sand.

During storms, steep, short waves can flatten and lower beaches, eroding the upper beach and cutting

[5] Ibid.
[6] Ibid
[7] Harris, L.R. and Defeo, O., 2022. Sandy shore ecosystem services, ecological infrastructure, and bundles: New insights and perspectives. *Ecosystem Services*, 57: 101477.

into dunes. The sand removed during storms typically accumulates just below the low tide level, creating a wider, flatter beach with a nearshore bar that helps dissipate storm wave energy. When the weather is calm, fair-weather waves gradually return the sand from the bar to the beach, and wind action rebuilds the dunes. These changes often follow a seasonal pattern, resulting in a constantly evolving beach-dune landscape.

## 3. Erosion as a natural process

Coastal erosion along sandy beaches is a natural and dynamic process shaped by complex interactions between physical, geological and environmental factors. While human activities can exacerbate erosion rates through activities such as coastal development, erosion remains an inherent feature of sandy coastal environments and must be managed with an understanding of its underlying natural processes. Coastal erosion is worsened by climate change-related stressors such as sea level rise, increased storm surges and increased coastal flooding. As these stressors intensify, erosion rates may accelerate, leading to more severe and widespread impacts on coastal environments.

One of the most direct effects of coastal erosion is the gradual loss of land along the shoreline. As waves and currents erode coastal sediments, beaches, dunes and cliffs can diminish in size or disappear entirely, leading to the loss of valuable recreational land and private property. As land erodes, buildings and infrastructure may become unstable or collapse, leading to property damage, economic losses and threats to public safety. Vousdoukas et al. (2020) forecast that coastal retreat could result in the loss of almost half of the world’s sandy beaches by the end of the century[8].

Coastal erosion, therefore, poses a significant threat to human infrastructure located along the shoreline and coastal biodiversity. Coastal protection from erosion is essential for preserving the ecological integrity, economic viability and social well-being of coastal areas.

### 3.1. Drivers of erosion

Coastal erosion, defined as a long-term sediment loss that causes a coastline retreat or a dune erosion, is the result of several drivers: anthropic pressure, wind and dynamic action of the waves. The shape and structure of beaches and dunes are influenced by the interaction between available sediment and the energy from waves, tides and wind. During storms, steep, short waves can flatten and lower beaches, eroding the upper beach and cutting into dunes. The sand removed during storms

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[8] Vousdoukas, M.I., Ranasinghe, R., Mentaschi, L., Plomaritis, T.A., Athanasiou, P., Luijendijk, A. and Feyen, L., 2020. Sandy coastlines under threat of erosion. *Nature climate change*, *10*(3): 260-263.

typically accumulates just below the low tide level, creating a wider, flatter beach with a nearshore bar that helps dissipate storm wave energy[9]. When the weather is calm, fair-weather waves gradually return the sand from the bar to the beach, and wind action rebuilds the dunes. However, with coastal squeeze[10], the natural ability of beaches and dunes to recover is restricted.

Urban development and infrastructure can restrict the inland movement of dunes and the deposition of wind-blown sediment. Rising sea levels, on the other hand, can permanently submerge parts of the beach, reducing the available area for sediment deposition. This results in a net loss of beach and dune volume over time, leading to narrower and more vulnerable beaches.

Climate change is increasing the frequency and intensity of storms, accelerating sea-level rise and altering wind and wave patterns. These changes exacerbate the erosion of beaches and dunes, making recovery even more difficult. The increased storm activity leads to more frequent and severe erosion events, while higher sea levels and altered wave dynamics make it harder for beaches to retain and restore sand.

The lack of space for natural beach and dune dynamics under coastal squeeze conditions prevents the full recovery of these systems after storm events. This means that the protective functions of beaches and dunes—such as buffering against erosion and storm impacts—are diminished. Consequently, coastal areas become more susceptible to flooding, erosion and other detrimental effects of climate change and human development.

### *3.1.1. Urban development*

While erosion is a natural part of coastal dynamics, human activities have significantly intensified it. Currently, only 15% of the world's coastal areas remain undisturbed by human activities[11] (Williams et al., 2021). The expansion of infrastructure towards the sea and the suppression of dunes and coastal vegetation have played major roles in this intensification. The rapid rates of urban development and supporting infrastructure impair the ability of sandy beaches to provide coastal protection.

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[9] National Academies of Sciences, Engineering, and Medicine. 2007. Mitigating Shore Erosion Along Sheltered Coasts. Washington, DC: The National Academies Press. https://doi.org/10.17226/11764

[10] Coastal squeeze refers to the pressure exerted on dune ecosystems when they are trapped between rising sea levels and fixed human-made structures like seawalls, buildings, or roads. This situation prevents dunes from naturally migrating inland in response to environmental changes, leading to their degradation and loss. Coastal squeeze reduces the space available for dunes to maintain their natural processes and functions.

[11] Williams, B.A., Watson, J.E., Beyer, H.L., Klein, C.J., Montgomery, J., Runting, R.K., Roberson, L.A., Halpern, B.S., Grantham, H.S., Kuempel, C.D. and Frazier, M., 2022. Global rarity of intact coastal regions. *Conservation Biology*, *36*(4), p.e13874.

Coastal infrastructure, such as seawalls and buildings, prevents the natural landward migration of beaches, especially in the face of sea-level rise, storms and flooding events (Almar et al., 2021). This restriction means that beaches cannot adjust and move as they would naturally, leading to increased erosion and loss of beach area.

This widespread phenomenon, known as coastal squeeze, is leading to significant habitat loss for beach-dependent species[12]. Coastal squeeze culminates in the loss of essential habitats and the natural dynamics that support the resilience and protective functions of beaches and dunes.

### *3.1.2. Climate Change Impacts*

Climate change exacerbates coastal erosion and the recession of sandy beaches primarily through sea level rise and increased storm intensity and frequency. Both natural and human-induced changes in the climate system are driving significant shifts in sea levels, posing a threat to coastal communities, cities and low-lying islands. These sea-level changes occur over various time periods (temporal scales) and different geographic locations (spatial scales). The term 'sea level' in this context refers to the long-term average height of the sea surface and excludes short-term variations like waves, surges and tides.

Over the past century, the rate of global mean sea level (GMSL) has increased significantly, from 1.4 mm per year between 1901 and 1990, to 2.1 mm per year between 1970 and 2015 and a further 3.6 mm per year between 2006 and 2015[13]. This acceleration is largely due to human activities, such as emission of greenhouse gas emission since the industrial revolution around the 1970s. While the exact rates and magnitudes of past sea level changes are still uncertain, historical trends show the potential for substantial sea level rise in response to ongoing global warming.

[12] Mazaris, A.D., Matsinos, G. and Pantis, J.D., 2009. Evaluating the impacts of coastal squeeze on sea turtle nesting. Ocean & Coastal Management, 52(2), pp.139-145.
[13] Oppenheimer, M., B.C. Glavovic , J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari, 2019: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 321-445. https://doi.org/10.1017/9781009157964.006

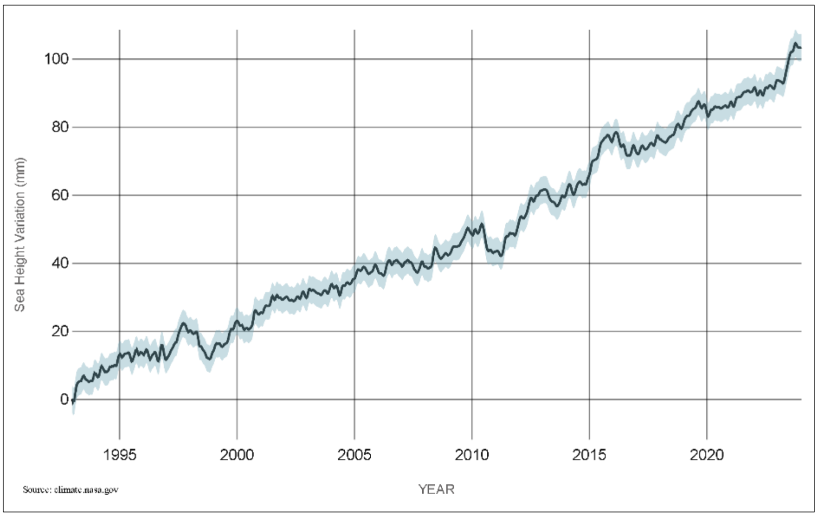


**Figure 2**. Satellite sea level observations from 1993–Present
(Source: NASA's Goddard Space Flight Center).

In South Africa, sea level has increased at a rate of around 3 mm year−1 in recent decades, which is consistent with estimates of GSLR over the same period[14]. A recent study provides projections of mean sea level change for the 21st century (2007–2100) for tide gauges at eight locations along South Africa's coastline. Trends and projections for Wilderness is not available; however, data from the gauge stations in Mossel Bay and Knysna can provide indicative measurements for Wilderness, which projects sea level rise (relative to 1986–2005) of approximately 0.65 m (0.25–0.8 m) for RCP2.6[15] or approximately 0.85 m (0.5–1.25 m) for RCP8.5[16]. These increases are approximately 7%–14% higher than projections of GMSL.

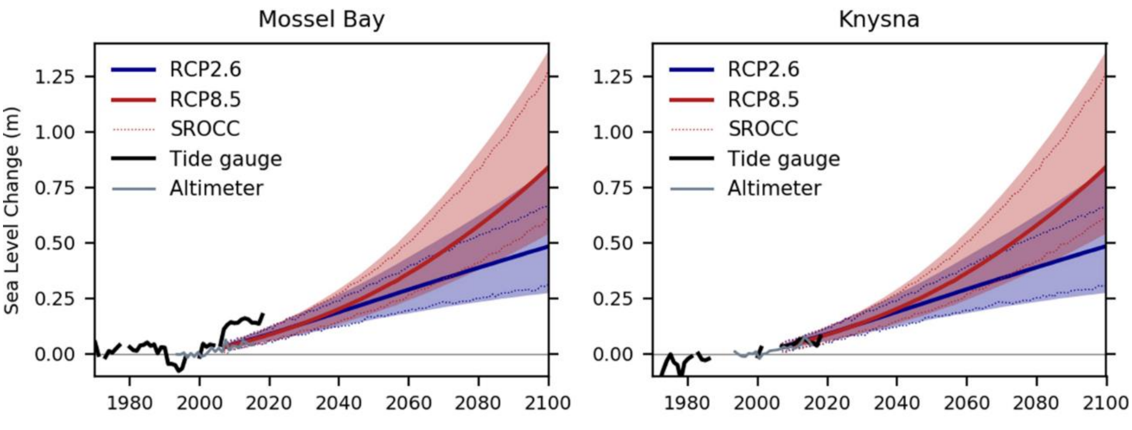


**Figure 3**. Projections of mean sea level change for the 21st century (2007–2100) for tide gauges in Mossel Bay and Knysna.

[14] Allison, L.C., Palmer, M.D. and Haigh, I.D., 2022. Projections of 21st century sea level rise for the coast of South Africa. Environmental Research Communications, 4(2), p.025001.
[15] RCP 2.6 is a scenario that assumes we take significant and immediate action to reduce greenhouse gas emissions.
[16] RCP 8.5 represents a future where greenhouse gas emissions continue to increase rapidly with little or no effort to curb them.

(Source: Allison et al. 2022).

Sea level rise causes shoreline retreat through coastal erosion and dune migration and coastal inundation and flooding through the increased frequency of storm surges.

Extreme weather events such as coastal storms, storm surge and flooding accelerate coastal erosion. A storm surge refers to an abnormally high sea level, which is often accompanied by severe meteorological conditions and high tides. The southern African coastline is intermittently impacted by extreme swells associated with tropical cyclones and cut-off low-pressure systems[17]. When these weather systems coincide with spring high tides they create the conditions for significant erosion events. During these events, coastal erosion can occur rapidly, causing damage and potential danger to buildings, infrastructure and people. The South African coastline is expected to face increased coastal erosion due to rising sea levels, more frequent and intense sea storms, higher wave heights and the associated risks of storm surges, flooding and destruction of coastal property and infrastructure.

In September 2023, a severe coastal storm surge along Western Cape's coastline, including George/Wilderness coastline resulted in substantial infrastructure damage. This event, described as the worst storm surge in 20 years, resulted from a combination of high tides and powerful storm conditions, creating what has been termed a "perfect storm". The storm caused extensive damage to infrastructure and private property, with estimates of the damage running into millions of rand. Herolds Bay was among the worst affected areas, where residents had to be evacuated due to the dangerous conditions. The high waves not only damaged homes and businesses but also washed away critical infrastructure like roads and transformers. The Garden Route District Municipality developed a Public Storm Surge Damage Assessment Dashboard to document the impacts of the storm and shows the extent of erosion that occurred in Wilderness (see Figure 4).

[17] Kovács, Z.P.; du Plessis, D.B.; Bracher, P.R.; Dunn, P.J.; Mallory, G.C.L. Documentation of the 1984 Domoina Floods; Technical Report TR 122. Department of Water Affairs: Pretoria, South Africa, 1985.

**Figure 4**. Photographic evidence coastal erosion resulting from the September 2023 storm surge.

The map in Figure 5 shows the modelled extent of coastal erosion caused by coastal storms. Areas shaded in darkest orange are those which are at the highest risk of erosion, as even relatively “minor” 1:10 years storm events, in combination with 0.35 m sea level rise, may cause erosion in these areas. The areas shaded in lighter orange indicate additional areas that might be affected by erosion under increasingly severe (but less likely) storm events. The map shows that the entire Wilderness coastline has a medium to very high risk of erosion.

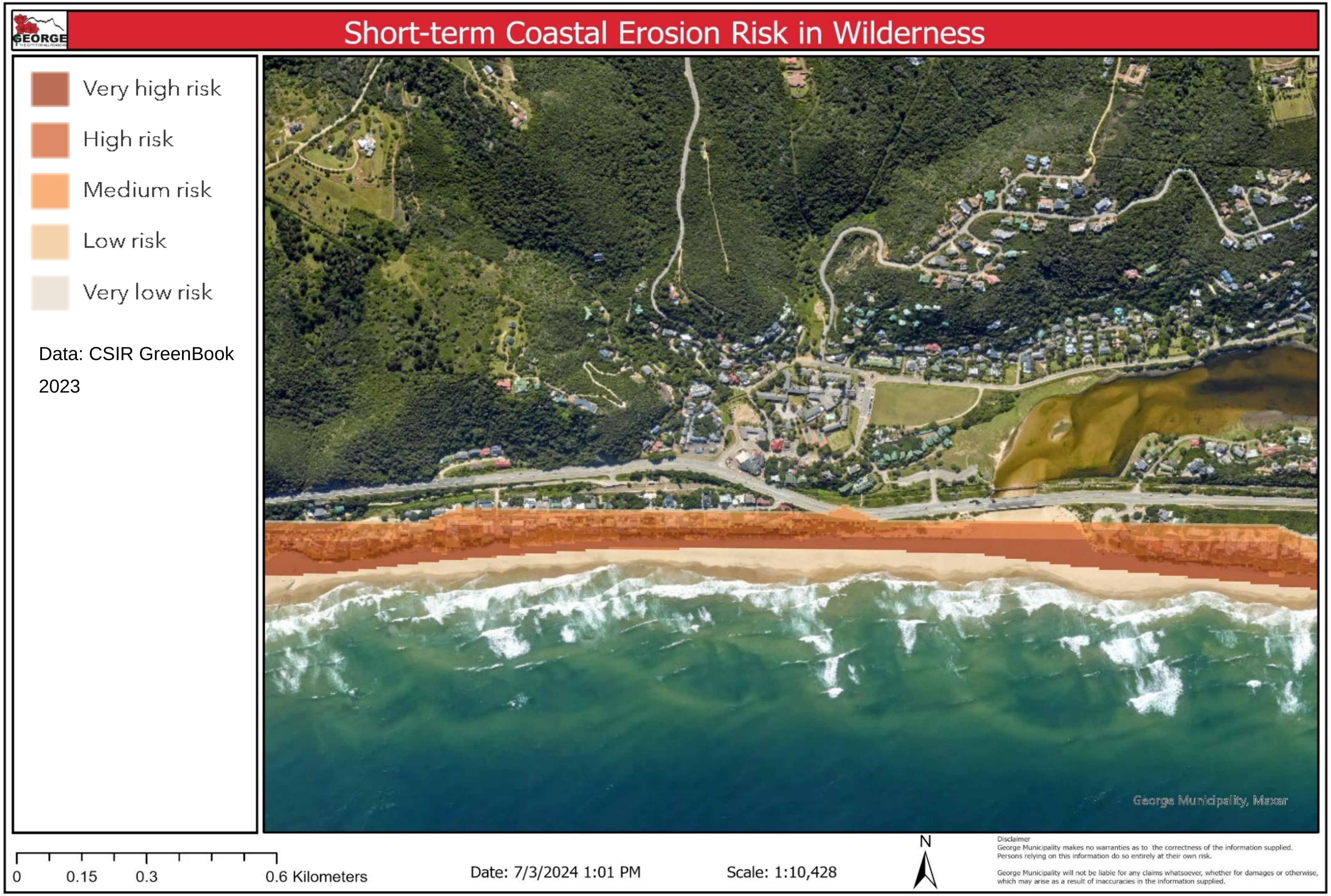


**Figure 5.** Map showing the areas at risk of erosion.

## 4. The Wilderness coastline

The coastline from Glentana to Sedgefield exhibits basement metasediments of the Kaaimans Group and granites from the Cape Granite Suite, resulting in a rocky shoreline similar in relief and geomorphology to the Cape Town Atlantic Coast from Camps Bay to Hout Bay. However, between Wilderness and Buffelsbaai, the landscape is characterized by a low relief wave cut platform that formed during the Pleistocene high stand approximately 125,000 years ago[18]. This area is now characterized by Quaternary sand and dune systems.

Quaternary sand and dune systems are inherently unstable over short timescales due to ongoing wind action and occasional storm events. Wind continuously shapes and reshapes dunes, redistributing sand within the system. These systems are sensitive to climate variations. Changes in precipitation patterns and wind strength can significantly impact dune stability. Dunes can expand during periods of increased sand supply and stabilizing vegetation or erode during drier, windy periods.

The coastline of Wilderness is largely built up with large single residential homes, guesthouses and hotels on the foredune. Currently, the most remaining vacant erven adjacent to the coast are in Kleinkrantz. The terrain of the coastline is relatively flat from Lueentjies Klip, gradually increasing in steepness towards the east, where the topography transforms from hummock dunes to dune rock

In recent years, the shoreline of Wilderness has experienced significant changes due to sea level rise and increased storm surges. These factors have contributed to a noticeable shoreline retreat, with some storm events causing rapid loss of coastal land. The combination of rising sea levels and the intensity of storm surges has accelerated erosion, threatening both the natural landscape and the built environment along the coast. A substantial portion of the bult-up area is found along the low-lying coastline and therefore is subject to ongoing coastal erosion.

Vegetated dunes provide a natural defence against the sea, helping to absorb the impact of waves and reduce coastal erosion. However, in Wilderness, many property owners have encroached into the coastal dune beyond their property boundaries with gardens, structures, walkways, decks and

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[18] Umvoto Africa. (2010). Sea Level Rise and Flood Risk Assessment for a Select Disaster-Prone Area Along the Western Cape Coast. Phase 1 Report: Eden District Municipality Sea Level Rise and Flood Risk Literature Review. Prepared by Umvoto Africa (Pty) Ltd for the Provincial Government of the Western Cape Department of Environmental Affairs and Development Planning: Strategic Environmental Management (May 2010).

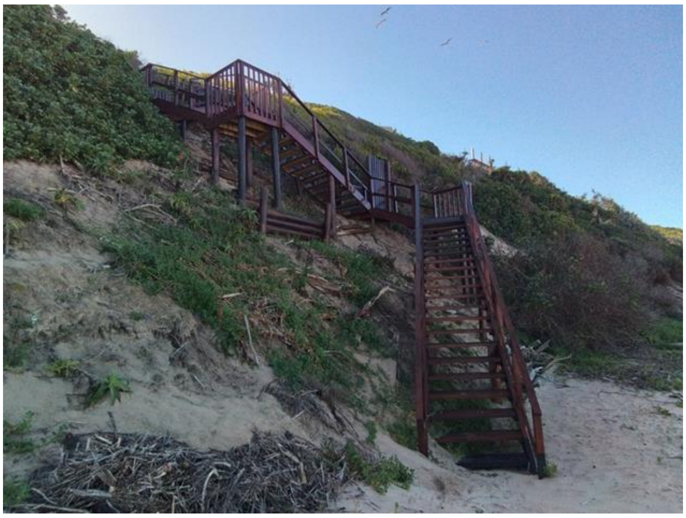
pools. This encroachment has resulted in dune flattening, vegetation removal and in some cases, the washing away of sand due to stormwater or pool water backwash from the properties. These activities have compromised the integrity of the dunes. It is very evident that the dunes along Wilderness beach have been substantially transformed by both natural processes and human activity.

### 4.1. Contributors of erosion in Wilderness

The Wilderness is characterised as a sandy beach, with a modified foredune which serves as the only coastal defence between the sea and built up environment. Foredunes are shore-parallel sand ridges that comprise the first vegetated dune behind the beach. The fore dune in Wilderness has been compromised by the following:

- Coastal vegetation has been removed to provide better sea views.
- The dune has been flattened and vegetation removed for the creation of domestic gardens.
- Both informal paths and formal structures, such as boardwalks, have been cut through the dune to provide beach access from private properties.
- Seawalls constructed using gabions and sandbags have been installed as engineered structures for protection against erosion.

| Activity | Photograph |
| --- | --- |
| Flattened dune where indigenous vegetation was replaced with grass for a domestic garden and viewing area.<br><br>Dunes provide habitat for various species of plants and animals. Flattening or removing dunes destroys these habitats, leading to a loss of biodiversity. |  |
| Garden extension with boardwalk to access the beach. Dune vegetation has been replaced with grass.<br><br>Replacing dunes with domestic gardens can negatively impact the natural beauty and scenic value of coastal areas for beachgoers, affecting tourism and the overall appeal of the region. |  |

| | |
|---|---|
| Staircase from a private property leading to the beach.<br><br>Staircases cut through the dunes, interrupting the natural movement of sand and vegetation. This disruption can interfere with the natural growth and replenishment of the dune.<br><br>The presence of staircases can accelerate erosion by creating pathways for water flow during storms and high tides, which can wash away sand and destabilize the dune structure. |  |
| A sandbag sea wall in Wilderness (13 June 2024). Photograph shows the structural integrity of the wall is compromised.<br><br>Sandbags can interfere with the natural processes of sand movement and dune formation, preventing the natural recovery and maintenance of coastal dunes.<br><br>Sandbags are also visually unappealing, which impacts the recreational appeal of the beach. |  |

In most cases, these activities have occurred outside property boundaries, encroaching into the coastal protection zone. In addition, most of these activities do not have the required environmental authorisation.

The coastal protection zone is established to manage, regulate and restrict the use of land adjacent to coastal public property or land that plays a significant role in the coastal ecosystem. This zone is also designed to protect people, property and economic activities from risks associated with dynamic coastal processes, including the risk of sea-level rise.

The removal of vegetation and modification of the foredune weaken the natural coastal defence, increasing vulnerability to erosion, storm surges and sea-level rise. In addition, encroachment can lead to habitat destruction and disturbance of local ecosystems, affecting biodiversity and the natural landscape. Furthermore, by compromising the natural defences, encroachment increases the risk of damage to property and endangers people living in the area.

The George Municipality recognizes the adverse impacts that erosion and human activity have on the foredune of Wilderness. There is an urgent need to take action to restore functioning coastal ecosystems, preserve recreational value and protect private property. All dune management initiatives must positively impact the environment. Therefore, in consideration of the literature provided in this guideline, **only nature-based foredune restoration projects are permitted**. These interventions must replicate natural processes to re-establish the degraded foredune in Wilderness.

In the absence of a coastal morphological study of the Wilderness coastline and expert reports on how different coastal protection measures, specifically engineered techniques, will impact coastal systems, the George Municipality cannot support such types of intervention. As set out in the National Environmental Management Act 107 of 1998 S2(4)(viii), the municipality must apply a "risk-averse and cautious approach, which takes into account the limits of current knowledge about the consequences of decisions and actions".

## 5. Legislative framework in South Africa for authorising erosion control measures

In South Africa, the legislative framework for coastal management is guided by key laws such as the National Environmental Management Act (NEMA), the Environmental Conservation Act (ECA) and the Integrated Coastal Management Act (ICMA). These laws aim to protect coastal environments, regulate development activities and promote integrated approaches to coastal planning and management. This section describes these laws and the requirements for Environmental Authorization (EA) under NEMA, the ECA and the collaborative governance principles outlined in ICMA. Understanding these legal mechanisms is necessary to implement any erosion control measures along the Wilderness coastline.

The National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008) ("NEM: ICMA"), aims to facilitate the integrated management of the coastal environment and maintain the natural attributes of coastal landscapes and seascapes and ensure that development and use of natural resources in the coastal zone is socially and economically justifiable and ecologically sustainable. It also seeks to define the rights and duties of stakeholders in relation to coastal areas and determine roles and responsibilities of organs of state as well as give guidance when it comes to inappropriate development and other adverse effects on the coastal environment.
The NEM: ICMA requires that where environmental authorisation in terms of the Chapter 5 of the National Environmental Management Act ("NEMA") is required for coastal activities (i.e. where an Environmental Impact Assessment ("EIA") listed activity is triggered) and competent authorities need to consider the following

- Whether coastal public property, coastal access land or the coastal protection zone will be affected by the proposed activity or action;
- Whether the proposed activity is consistent with the purpose or objective(s) of the various zones as prescribed in the NEM: ICMA;
- The likely effect of dynamic coastal processes (such as wave, current and wind action, erosion, accretion, sea-level rise, storm surges and flooding) on the activity;
- The socio-economic impact of that activity or action is authorised or not;
- Coastal Management Programmes, Coastal Management Lines, Estuarine Management Plans and Coastal Management Objectives;
- Whether the development of an activity is likely to cause irreversible or long-lasting adverse effects on the coastal environment that cannot be properly mitigated; will prejudice the achievement of any coastal management objective; or will not be in the interest of the whole community; and

- Whether the proposed activity or development will provide important services to the public and / or whether the very nature of the proposed activity or development requires it to be located within coastal public property, the coastal protection zone or coastal access land.

A big lesson the Western Cape has learned is that, in the past, the spatial extent to which coastal processes can take place, were drastically underestimated. Consequently, there is infrastructure located along the Western Cape coastline that is now exposed to coastal processes which are *'burdens'* to coastal municipalities. It is therefore vital that a conservative stance is taken in the consideration of coastal processes and the extent to which they may occur against appropriate time horizons.

**SECTION 15 OF THE NEM: ICMA**

Any acts or physical responses to erosion or accretion on coastal public property is prohibited by Section 15 of the NEM: ICMA.

***(1) 'No person, owner or occupier of land adjacent to the seashore or other coastal public property capable of erosion or accretion may require any organ of state or any other person to take measures to prevent the erosion or accretion of the seashore or such other coastal public property, or of land adjacent to coastal public property, unless the erosion is caused by an intentional act or omission of that organ of state or other person;***

***(2) No person may construct, maintain or extend any structure, or take other measures on coastal public property to prevent or promote erosion or accretion of the seashore except as provided for in this Act.'***

It must be noted that any erosion response methods may only occur within the ambit of legislation as the NEM: ICMA specifically prohibits the erection of erosion protections measures within coastal public property. The erection of erosion protection measures may only be considered under certain circumstances. This guideline must be used as a reference or guiding document by authorities, as a last resort option for erosion protection measures within the coastal zone; while taking cognisance of all relevant and applicable legislation.

When intervention and erosion protection measures become necessary, the competent authority(ies) need to consider the following in a given scenario:

- The physical character of the site;
- Cause of coastal erosion;
- The severity of the erosive forces;
- Frequency of events;

- Potential recurring nature of the erosive forces;
- Potential and nature of extreme events;
- Future climatic conditions and weather patterns;
- Nature of present or future human activities in the sea;
- The degree of maintenance that is practical for a particular method;
- Direct and indirect impacts of proposed intervention on coastal processes and adjacent coastline
- Whether the provisions of NEM: ICMA provides for development within such zone, e.g. coastal public property.

An Environmental Authorisation may be required for any such activity and the relevant authority(ies) must always be consulted for clarity and verification of applicability and interpretation of EIA listed activities. It should also be noted it is important that changes in the coastal environment must be considered in order to correctly determine the applicability of activities.

The following listed activities contained in the National Environmental Management Act (NEMA) Environmental Impact Assessment (EIA) Regulations, 2014 defined in Government Notice (GN) No. R. 983, R. 984 and R. 985 (as amended) are identified as falling within the ambit rehabilitation and managements and maintenance of dunes and beaches.

If property owners intend to undertake in any of the listed activities or are unsure whether their proposed intervention might involve any of these activities, they must consult with the Western Cape Government Department of Environmental Affairs and Development Planning (DEA&DP) to ascertain whether an environmental authorization is required. A checklist for the determination of the applicability of NEMA EIA Regulations can be found using this link.

Given that the rehabilitation will extend into the coastal adjacent erven, some of which the ownership is vested to the George Municipality, an application must be made to the Goege Municipality for a letter of support to undertake rehabilitation work within these erven. Furthermore, given that the rehabilitation will extend into the coastal adjacent erven, some of which are owned by the George Municipality, an application must be made to the George Municipality for a letter of support to undertake rehabilitation work within these erven. A method statement for the planned rehabilitation intervention must accompany the application. George Municipality will only support applications that use nature-based solutions as described in this guideline.

| Listing Notice and Activity Number | Description |
|---|---|
| **Listing notice 1: Activity 15** | The development of structures in the coastal public property where the development footprint is bigger than 50 square metres, excluding—<br>(i) the development of structures within existing ports or harbours that will not increase the development footprint of the port or harbour;<br>(ii) the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies;<br>(iii) the development of temporary structures within the beach zone where such structures will be removed within 6 weeks of the commencement of development and where coral or indigenous vegetation will not be cleared; or<br>(iv) activities listed in activity 14 in Listing Notice 2 of 2014, in which case that activity applies. |
| **Listing notice 1: Activity 17** | Development—<br>*i) in the sea;*<br>*ii) in an estuary;*<br>*iii) within the littoral active zone;*<br>*iv) in front of a development setback; or*<br>*v) if no development setback exists, within a distance of 100 metres inland of the*<br><br>high-water mark of the sea or an estuary, whichever is the greater;<br>in respect of—<br>(a) fixed or floating jetties and slipways;<br>(b) tidal pools;<br>(c) embankments;<br>(d) rock revetments or stabilising structures including stabilising walls; or<br>(e) infrastructure or structures with a development footprint of 50 square metres or more —<br><br>but excluding<br>(aa) the development of infrastructure and structures within existing ports or harbours that will not increase the development footprint of the port or harbour; |

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| | (bb) where such development is related to the port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies.<br>(cc) the development of temporary infrastructure or structures where such structures will be removed within 6 weeks of the commencement of development and where coral or indigenous vegetation will not be cleared.<br>(dd) where such development occurs within an urban area. |
| **Listing notice 1: Activity 18** | The planting of vegetation or placing of any material on dunes or exposed sand surfaces of more than 10 square meters, within the littoral active zone4, for the purpose of preventing the free movement of sand, erosion or accretion, excluding where –<br>(i) the planting of vegetation or placement of material relates to restoration and maintenance of indigenous coastal vegetation undertaken in accordance with a maintenance management plan; or<br>(ii) (ii) such planting of vegetation or placing of material will occur behind a development setback. |
| **Listing notice 1: Activity 19** | The infilling or depositing of any material more than 10 cubic meters into, or the dredging, excavation removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic meters from a watercourse;<br>But excluding where such infilling, depositing, dredging, excavation, removal or moving-<br>(a) will occur behind a development setback<br>(b) is for maintenance purposes undertaken in accordance with a maintenance management plan<br>(c) falls within the ambit of activity 21 in this Notice, in which case that activity applies;<br>(d) occurs within exiting ports or harbours that will not increase the development footprint of the port or harbour; or<br>(e) where such development is related to the development of a port or harbour, in which case activity 26 of Listing Notice 2 of 2014 applies. |
| **Listing notice 1: Activity 19A** | The infilling or depositing of any material of more than 5 cubic meters into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from a watercourse —<br>but excluding where such infilling, depositing, dredging, excavation, removal |

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| | or moving—<br>(a) will occur behind a development setback;<br>(b) is for maintenance purposes undertaken in accordance with a maintenance management plan;<br>(c) falls within the ambit of activity 21 in this Notice, in which case that activity applies;<br>(d) occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies.” |
| **Listing notice 1: Activity 52** | The expansion of structures in the coastal public property where the development footprint will be increased by more than 50 square metres, excluding such expansions within existing ports or harbours where there will be no increase in the development footprint of the port or harbour and excluding activities listed in activity 23 in Listing Notice 3 of 2014, in which case that activity applies. |
| **Listing notice 1: Activity 54** | The expansion of facilities-<br>(i) in the sea<br>(ii) in an estuary<br>(iii) within the littoral active zone<br>(iv) in front of a development setback; or<br>(v) if no development setback exists, within a distance of 100 meters inland of the high-water mark of the sea or an estuary, whichever is the greater;<br><br>In respect of-<br>(a) fixed or floating jetties and slipways;<br>(b) tidal pools;<br>(c) embankments;<br>(d) rock revetment or stabilizing structures including stabilizing walls; or<br>(e) infrastructure or structures where the development footprint is expanded by 50 square meters or more;<br><br>but excluding-<br>(aa) the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port |

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| | or harbour; or<br>(bb) where such expansion takes place within an urban area |
| **Listing notice 1: Activity 55** | Expansion-<br>(i) in the sea<br>(ii) in an estuary<br>(iii) within the littoral active zone<br>(iv) in front of a development setback; or<br>(v) if no development setback exists, within a distance of 100 meters inland of the high-water mark of the sea or an estuary, whichever is the greater<br><br>in respect of —<br>(a) facilities associated with the arrival and departure of vessels and the handling of cargo;<br>(b) piers;<br>(c) inter- and sub-tidal structures for entrapment of sand;<br>(d) breakwater structures;<br>(e) coastal marinas;<br>(f) coastal harbours or ports;<br>(g) tunnels; or<br>(h) underwater channels;<br>but excluding the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour. |
| **Listing notice 2: Activity 14** | The development and related operation of<br>(i) an anchored platform; or<br>(iii) any other structure or infrastructure-<br><br>on, below or along the seabed.<br><br>Excluding<br>(a) development of facilities, infrastructure or structures for aquaculture purposes; or<br>(b) the development of temporary structures or infrastructure where such structures will be removed within 6 weeks of the commencement of development and where coral or indigenous |

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| | vegetation will not be cleared. |
| **Listing notice 2: Activity 26** | Development—<br>(i) in the sea;<br>(ii) in an estuary;<br>(iii) within the littoral active zone;<br>(iv) in front of a development setback; or<br>(v) if no development setback exists, within a distance of 100 metres inland of the highwater mark of the sea or an estuary, whichever is the greater;<br><br>in respect of —<br>(a) facilities associated with the arrival and departure of vessels and the handling of cargo;<br>(b) piers;<br>(c) inter- and sub-tidal structures for entrapment of sand;<br>(d) breakwater structures;<br>(e) coastal marinas;<br>(f) coastal harbours or ports;<br>(g) tunnels; or<br>(h) underwater channels;<br><br>but excluding the development of structures within existing ports or harbours that will not increase the development footprint of the port or harbour. |

## 6. Long-term erosion control

Managing coastal erosion in Wilderness beyond the next decade is challenging. The large expense associated with effective management strategies is the main barrier to long term protection. Whether opting to defend against erosion or strategically retreat from affected areas, both approaches involve significant costs that often exceed the financial capabilities of property owners. Moreover, achieving a delicate balance in response to coastal erosion is crucial. This balance necessitates not only safeguarding private property interests but also ensuring perpetual protection of the public's access to and enjoyment of Wilderness's Coastal Protection Zone.

Long-term responses to coastal erosion demand a re-evaluation of existing financial models to support adaptive interventions, given the current inadequacies in dealing with the scale and costliness of the issue. Furthermore, improving sea-level and coastal process models is critical to refine predictions in vulnerable areas. Given scientific uncertainties surrounding future sea-level rise rates and associated coastal risks, continuous improvement of these models based on the latest scientific findings is imperative.

Lastly, any proposed coastal protection measures for Wilderness must undergo comprehensive studies to assess their potential impacts on the beach and adjoining shoreline. These assessments should consider environmental and social factors, such as aesthetics, construction impacts and long-term maintenance costs, to develop feasible, sustainable solutions that uphold both ecological integrity and community well-being.

## RESPONDING TO COASTAL EROSION IN WILDERNESS

Use this checklist to determine if you have a successful rehabilitation approach

### APPLICANT'S CHECKLIST

#### REHABILITATION PRIORITIES

- [ ] Restoration of Foredune
- [ ] Coastal Protection & Resilience
- [ ] Biodiversity Enhancement
- [ ] Encroachment Rectification
- [ ] Compliance with Legislation
- [ ] Compliance with Guideline

#### NATURE-BASED DESIGN

- [ ] Integration with Natural Processes
- [ ] Minimal Intervention

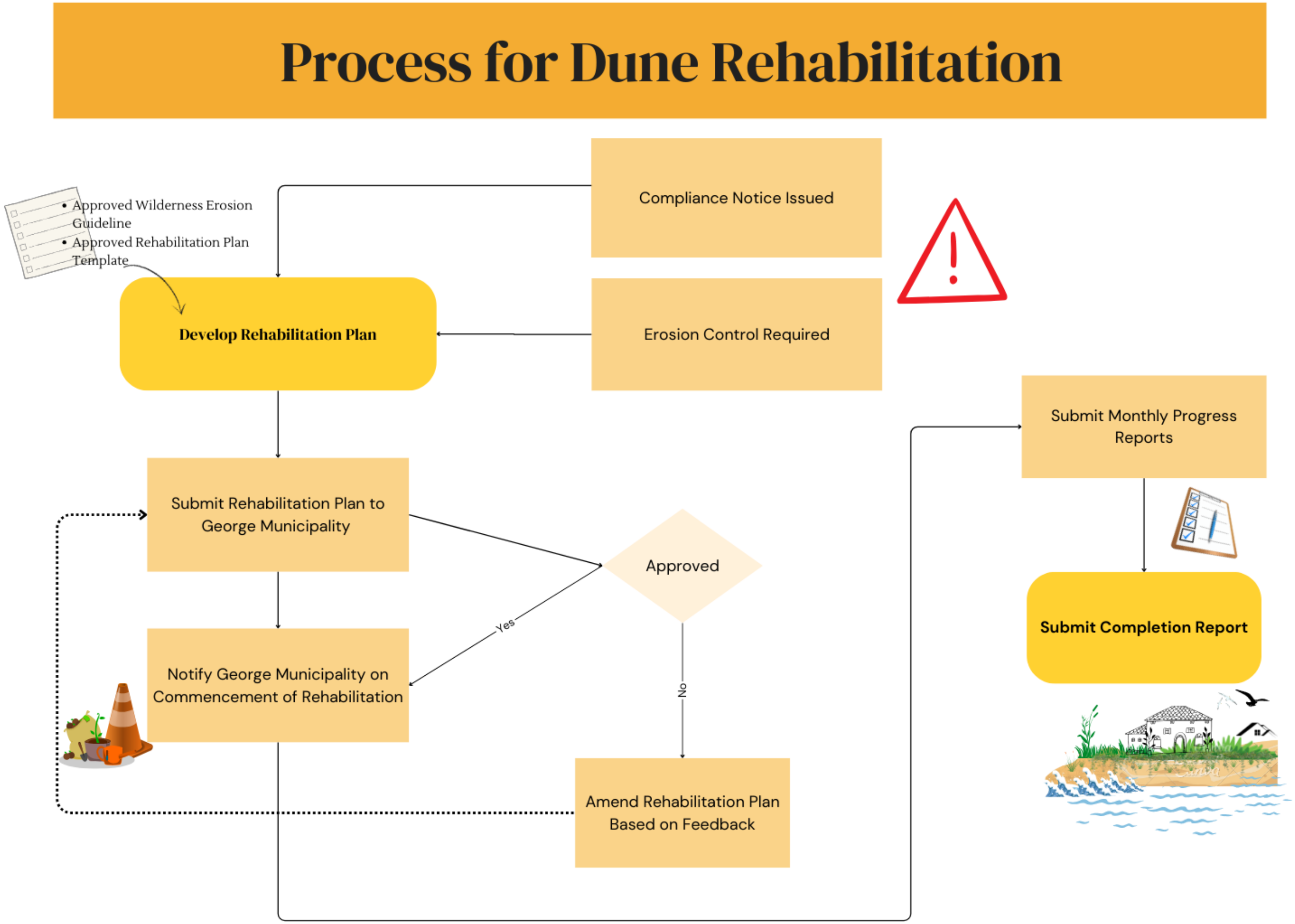


**Figure 6**. Workflow for authority engagement.

## 7. Responding to coastal erosion

Numerous techniques, technologies and planning measures are available to address shoreline erosion, with most methods primarily intended to protect property from shore erosion caused by wave attack[19]. In this context, "techniques" refers to broad categories of approaches used to address erosion, "technologies" refers to specifically designed or engineered methods used to address erosion and "measures" refers to regulatory and planning actions used to address erosion.

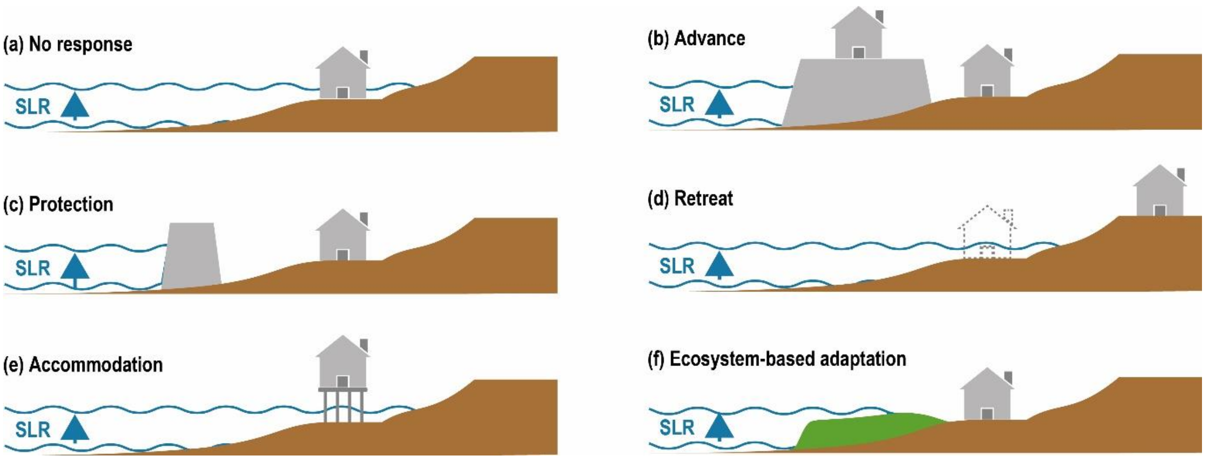


**Figure 7**. Different types of responses to coastal risk and sea level rise[20].

Natural shorelines typically undergo seasonal fluctuations and natural cycles. For example, vegetated shorelines experience changes in plant biomass, while sandy beaches are continually shaped by wave action. These cycles allow ecosystems to maintain equilibrium, recovering from disturbances over time. However, when coastal erosion is intensified and shoreline protection measures are implemented, natural shorelines are disrupted. Instead of undergoing natural recovery cycles, these ecosystems are prevented from returning to their original states.

Shoreline protection structures alter coastal dynamics by stabilizing shorelines and preventing natural

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[19] National Academies of Sciences, Engineering, and Medicine. 2007. Mitigating Shore Erosion Along Sheltered Coasts. Washington, DC: The National Academies Press. https://doi.org/10.17226/11764

[20] Oppenheimer, M., B.C. Glavovic , J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari, 2019: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 321-445. https://doi.org/10.1017/9781009157964.006.

processes of sediment movement and vegetation growth. This disruption creates a new equilibrium that may not support the same range of ecosystem services as the original natural state. For example, habitats may be altered, affecting the availability of food and shelter for coastal species and reducing the natural ability of shorelines to absorb nutrients and pollutants.

Guidance for shoreline protection is crucial as it ensures that measures are implemented in a way that minimizes ecological impacts while still protecting coastal communities and infrastructure. The selection and implementation of coastal protection measures should be based on careful consideration of site-specific conditions, environmental impacts, cost-effectiveness and long-term sustainability.

## 7.1. Techniques for responding to coastal erosion

Techniques for responding to erosion are broadly categorized into two main types: hard-engineered ad nature-based techniques. In some cases, a combination of both approaches may be necessary to effectively manage coastal erosion and protect coastal communities and ecosystems.

### *7.1.1. Hard-engineered solutions*

Hard engineering is a coastal management technique used to protect coasts by absorbing the energy of waves, preventing erosion and flooding. They are highly visible man-made structures used to stop or disrupt natural processes. These structures are expensive, short-term solutions and often they can have a negative impact on the environment. Installing hard engineering structures in one coastal location can have detrimental effects further down the coast. Seawalls, revetments and gabions are examples of hard-engineered techniques commonly used for coastal protection.

| Intervention | Description | Example |
|---|---|---|
| Seawalls | Seawalls are vertical or sloping structures built along the shoreline to protect coastal properties from wave action and erosion. Made of concrete, steel, or other durable materials, seawalls provide a hard barrier against erosion, with greater protection for coastal homes but can also alter coastal processes and aesthetics and may lead to |  |

| | | |
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| | increased erosion in adjacent areas. | |
| Revetments | Revetments are sloping structures made of riprap (large rocks), concrete, or other materials placed along the shoreline to absorb wave energy and protect against erosion. Revetments help stabilise coastal slopes, prevent undercutting and reduce erosion rates but may be visually unappealing and can impede beach access. |  |
| Gabions | Gabions are wire mesh baskets filled with rocks or other durable materials used to stabilise coastal slopes and protect against erosion. Gabion structures are relatively inexpensive and flexible but may require regular maintenance and can be susceptible to corrosion and failure over time. |  |

## Geotextile bags

Geotextile bags are a form of hard engineering used to mitigate erosion and protect shorelines. These bags are typically made from synthetic materials like polypropylene or polyester and are filled with sand or other sediments. When strategically placed along the coastline, they function as barriers to absorb wave energy, reduce the impact of storm surges and stabilise the shoreline. Geotextile bags are used to create temporary or semi-permanent barriers that prevent coastal erosion by stabilizing sand dunes and beaches. By absorbing and dissipating wave energy, these bags help to reduce the erosive power of incoming waves, thus protecting the coast from further degradation.


**Figure 8.** A bag seawall in Umhlanga Rocks (29/08/2011) showing (a) the movement of the seawall relative to its original position and (b) the steepening of the seawall toe and the flattening of the seawall crest[21].

Geotextile sand filled containers (GSC) have rapidly become the preferred coastal defence on South Africa's coastline. This is evident in Wilderness where increasingly property owners have resorted to the use of GSC for erosion control.

The application of geosynthetics in coastal protection has several economic benefits, including savings via substitutions of or reductions in selected soil materials, ease of installation, increased speed of construction, life cycle cost savings through improved performance (by increased longevity or reduction in maintenance) and improved sustainability in terms of conserving natural environments as compared to alternative designs[22].

However, while they are practical, sandbags can be unsightly and detract from the natural beauty of coastal areas One of the primary disadvantages of using sandbags for coastal protection is their impact on the visual appeal of the beach. This can negatively affect tourism and the overall attractiveness of these regions, which often depend on their scenic value.

Sandbags are not a long-term solution and will degrade over time. Exposure to water, sunlight and varying weather conditions causes them to break down, necessitating regular maintenance and replacement. This ongoing upkeep can be both time-consuming and costly, particularly in areas with high rates of erosion.

Using sandbags can also pose environmental issues. The sand used to fill these bags is often sourced

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[21] Corbella, S. and Stretch, D.D., 2012. Geotextile sand filled containers as coastal defence: South African experience. Geotextiles and Geomembranes, 35, pp.120-130.

[22] Scholz, P., Putna-Nimane, I., Barda, I., Liepina-Leimane, I., Strode, E., Kileso, A., Esiukova, E., Chubarenko, B., Purina, I. and Simon, F.G., 2021. Environmental impact of geosynthetics in coastal protection. *Materials*, *14*(3): 634.

from nearby beaches or dredged from offshore areas, which can lead to habitat destruction and the disturbance of coastal ecosystems. Additionally, the bags are typically made from non-biodegradable materials, contributing to plastic waste pollution.

While sandbags can effectively prevent erosion under moderate conditions, they may not hold up against severe storms or high-energy wave events. In such situations, sandbags can be easily breached or washed away, leaving the coastline exposed to further erosion. Sandbags must therefore be used judiciously and as part of a broader erosion control strategy.

#### *7.1.2. Nature-based solutions (NbS)*

Nature-based solutions (NbS) refer to strategies that protect, manage and restore natural or modified ecosystems to effectively tackle societal challenges. Ecosystem-based adaptation, a subset of NbS, specifically uses biodiversity and ecosystem services within broader adaptation strategies to aid in mitigating the adverse impacts of climate change. These solutions leverage existing natural systems by actively managing or restoring these ecosystems (dune rehabilitation and reshaping).

NbS solutions increase coastal resilience and reduce risks by using natural processes and landforms to protect both ecosystems and built environments[23]. NbS provides a coastal defence against sea-level rise and storm events while providing co-benefits such as climate change mitigation through carbon sequestration, providing recreational opportunities and creating habitats for endemic species[24].

Implementing NbS in urban settings is challenging due to biophysical constraints interacting with built environments. Urban areas typically contend with limited space or coastal squeeze, where coastal processes are prevented from migrating landward as sea levels rise.

Governance structures, regulations and funding further complicate NbS implementation in urban contexts. Fragmented property ownership along shorelines complicates coordinated action, while complex and overlapping governmental competencies necessitate integrated efforts and extensive stakeholder engagement to achieve shared objectives and feasible solutions.

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[23] Bridges, T. S. et al. *Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience*. https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/3442/ (2015).
[24] Arkema, et al. In *Living Shorelines; The Science and Management of Nature-Based Coastal Protection* (eds. Bilkovic, D. M. et al.) 11–30 (Taylor and Francis, 2017).

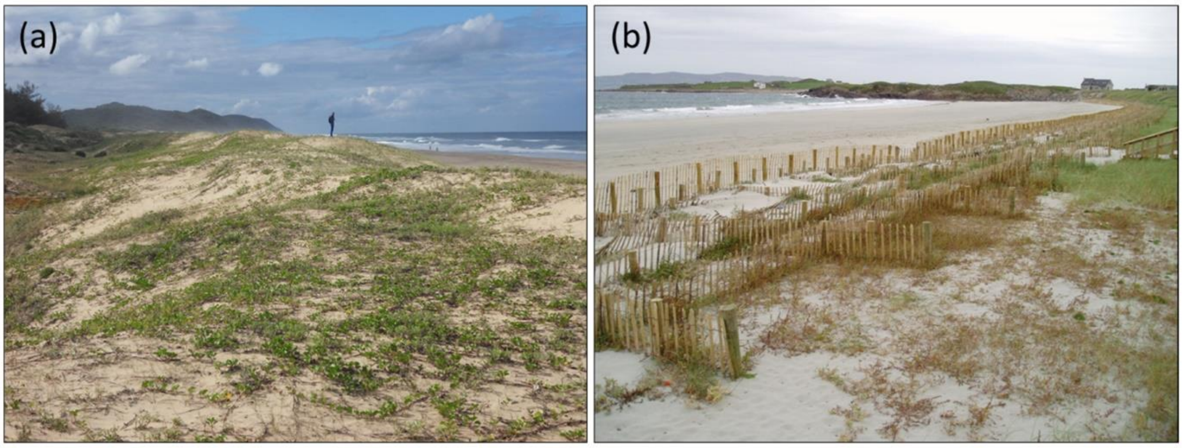


**Figure 9.** Examples of sandy coastal landforms that represent ‘green infrastructure’ that increases coastal resilience to climate forcing. (a) A natural beach berm in northeast South Africa, partly vegetated by Scaevola plumieri (gullfeed), (b) embryo dunes in northwest Ireland with sand fences and planted with Ammophila arenaria (European marram grass)[25].

[25] Knight J. The Green Infrastructure of Sandy Coastlines: A Nature-Based Solution for Mitigation of Climate Change Risks. *Sustainability*. 2024; 16(3):1056. https://doi.org/10.3390/su16031056 .


**Figure 10.** Stages of dune restoration using a Nature-based Solution from sand accumulation (2006–2010) to revegetation

and full regeneration (2011)[26].


**Figure 11.** Soil bioengineering technique for coastal dune restoration in the Mediterranean using autochthonous vegetation species. Stages of intervention: (a) pole drilling; (b) wattle; (c) trench excavation; (d) wood chips spreading; e bio-mesh; (f) intervention accomplished[27].

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[26] Lawlor, P. and Jackson, D.W., 2022. A nature-based solution for coastal foredune restoration: the case study of maghery, county Donegal, Ireland. *Ieva Misiune Daniel Depellegrin*, p.417.
[27] Romano, G., Ricci, G.F., Leronni, V., Venerito, P. and Gentile, F., 2022. Soil bioengineering techniques for Mediterranean coastal dune restoration using autochthonous vegetation species. *Journal of Coastal*

## 8. Technical specifications for rehabilitation

The following section describes the standards that affected property owners must use to design dune restoration projects for coastal erosion protection:

*Conservation*, *26*(6), p.71.

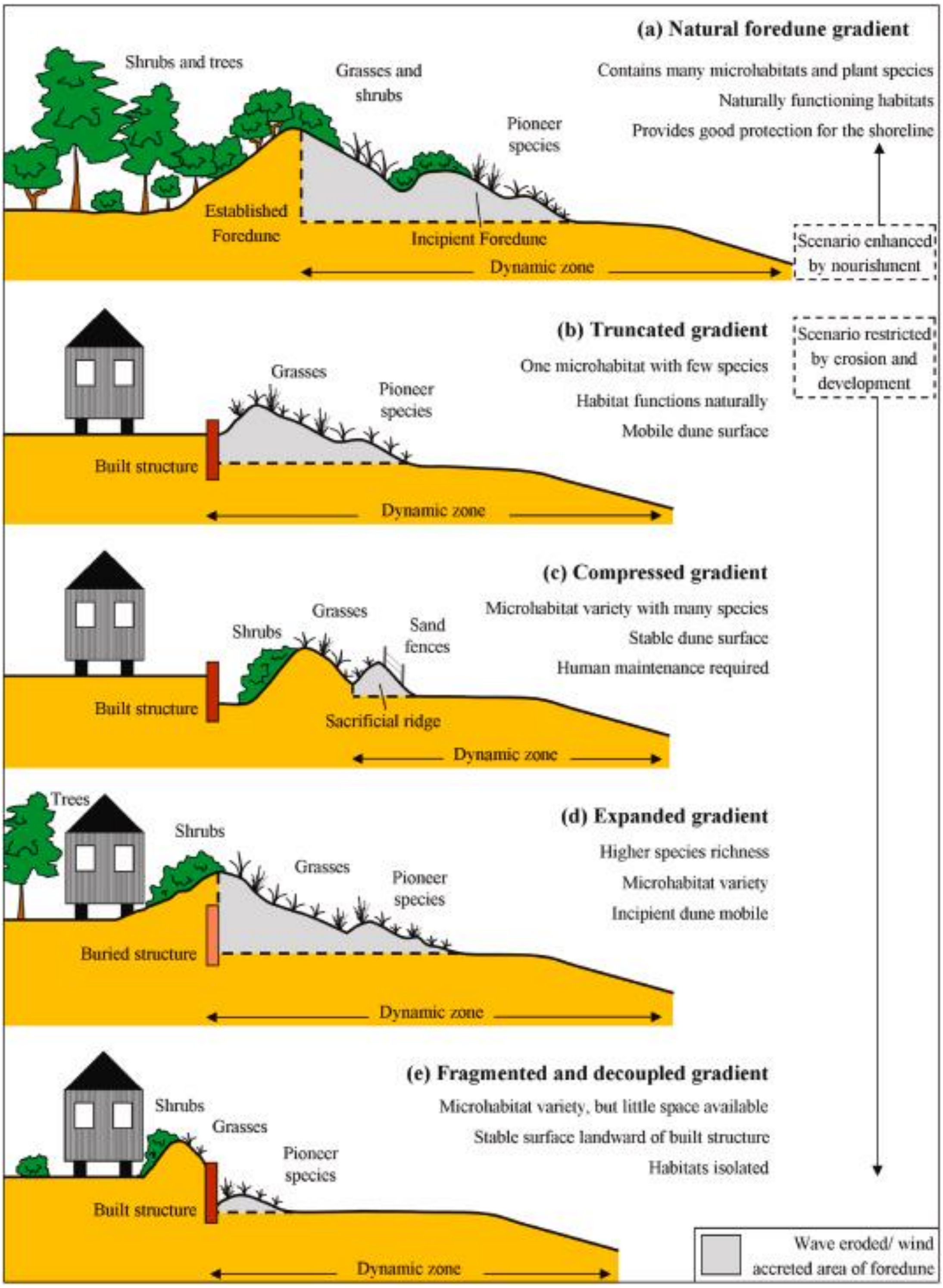


**Figure 12**. The impact of limited space on the eco-morpho dynamics of foredunes, particularly regarding vegetation zonation and distribution, can be observed as follows (adapted from Nordstrom, 2013): (a) Natural foredune with a full environmental gradient; (b) Foredune with a truncated gradient; (c) Foredune with a compressed gradient; (d) Foredune with an expanded gradient due to management; and (e) Foredune with a fragmented and decoupled gradient. The grey areas indicate the mobile component of the foredune, where natural processes such as sand movement are active[28].

[28] Doyle, T.B. and Woodroffe, C.D., 2023. Modified foredune eco-morphology in southeast Australia. *Ocean & Coastal Management*, 240: 106640.

The natural progression of environmental gradients across foredune ecosystems is crucial for biodiversity and ecosystem resilience. However, in modified foredune environments, these gradients are often truncated or compressed (see Fig. 13). This compression limits the space for natural dune processes and inhibits the formation of hind dunes, which are essential for ecosystem stability and biodiversity[29]. In spatially restricted environments, such as Wilderness, dunes can be managed to provide the seaward portion of a dynamic and naturally functioning incipient dune (truncated environmental gradient) or a spatially restricted sampler of a wider natural dune (compressed environmental gradient) that must be maintained using sand fences and vegetation plantings[30].

Dune restoration efforts for coastal protection in Wilderness must focus on maintaining a single, naturally functioning incipient dune zone[31]. This approach involves:

- Truncated environmental gradients: Managing the foredune to support a truncated but dynamic gradient that allows for the natural movement of sand and supports pioneer vegetation close to the shoreline (Fig. 13b).
- Compressed native species cohort: Using spatially restricted and compressed cohorts of native plant species that can tolerate harsh coastal conditions (Fig. 13c). Techniques like sand fences can protect these species from sand and salt spray, promoting their establishment and growth (Freestone and Nordstrom, 2001).
- Expanded Environmental Gradient: Where feasible, expanding the environmental gradient to allow for a more natural transition from pioneer species to mature vegetation (Fig. 13d). This approach supports biodiversity and ecosystem services by creating varied habitats and microclimates within the foredune area, while also enhancing the dune's ability to resist erosion.

In some cases, buried structures may be permitted within the property boundary to protect against slippage and increase stabilization. These structures may provide the structural support needed for dune stability without compromising the natural aesthetic and functionality of the foredune ecosystem.

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[29] Nordstrom KF, Jackson NL. Options in Spatially Restricted Environments. In: *Beach and Dune Restoration*. Cambridge University Press; 2021:pp.146–158.
[30] Nordstrom KF, Jackson NL. Options in Spatially Restricted Environments. In: *Beach and Dune Restoration*. Cambridge University Press; 2021:pp146–158
[31] Doyle, T.B. and Woodroffe, C.D., 2023. Modified foredune eco-morphology in southeast Australia. *Ocean & Coastal Management*, *240*, pp 106640.

The following aspects must be explored and reported on in dune rehabilitation plans:

| Activity | Description |
|---|---|
| Reshaping and reforming dunes | Any revegetation program proposed for degraded coastal dunes requires a landform that encourages the establishment and survival of grasses or shrubs and trees. In badly degraded areas, preparing a suitable landform may involve rebuilding or reshaping the dunes. This may involve filling of small blowouts<br><br>**Material:** The sand used in dune reconstruction should match the grain size of the sand in the adjacent remaining dune. Finer material will be more mobile and the new dune may be eroded more rapidly than the existing dunes.<br><br>**Position:** The position of a reconstructed dune is governed by that of existing dunes in the area and by the location of any structures it may be designed to protect. An adequate beach berm width must be maintained to permit normal coastal processes, especially at elevated high water levels during storms. A reconstructed dune should be integrated with any remnant dunes and should run approximately parallel with the beach berm.<br><br>**Slope and shape:** Natural dune gradients range from zero to 1 in 1.5 (1 Vertical :1.5 Horizontal) and vary considerably at any site. The primary objective in reforming degraded dunes should be to re-establish the diversity of landform that existed before initial disturbance. This should also assist reestablishment of an appropriate dune ecosystem.<br><br>**Height and width:** The height and width of a reconstructed dune depends on several factors including the height and width of existing dune remnants, availability of sand, available space and degree of landward protection required. |
| Dune-forming fences | The principal function of a dune-forming fence is to reduce the wind velocity, thereby causing drift sand to be deposited in the vicinity of the fence<br>(Figure 13). This technique can be used for small blowouts, for larger scale dune formation and at sites where it is not feasible to import new material.<br>Dune-forming fences can be installed during the non-planting season to allow for a gradual buildup of sand (although in some cases the fences may fill in a matter of hours). Planting can commence when the fences have filled with sand. Dune-forming fences are most commonly made of a porous material such as a woven synthetic cloth with approximately 40% porosity. Figure 10 shows the design elements of a dune-forming fence[32]. |

[32] Kidd, R., 2001. Coastal dune management: a manual of coastal dune management and rehabilitation techniques. *NSW Government publication ISBN 0.7347. 5202.4*.

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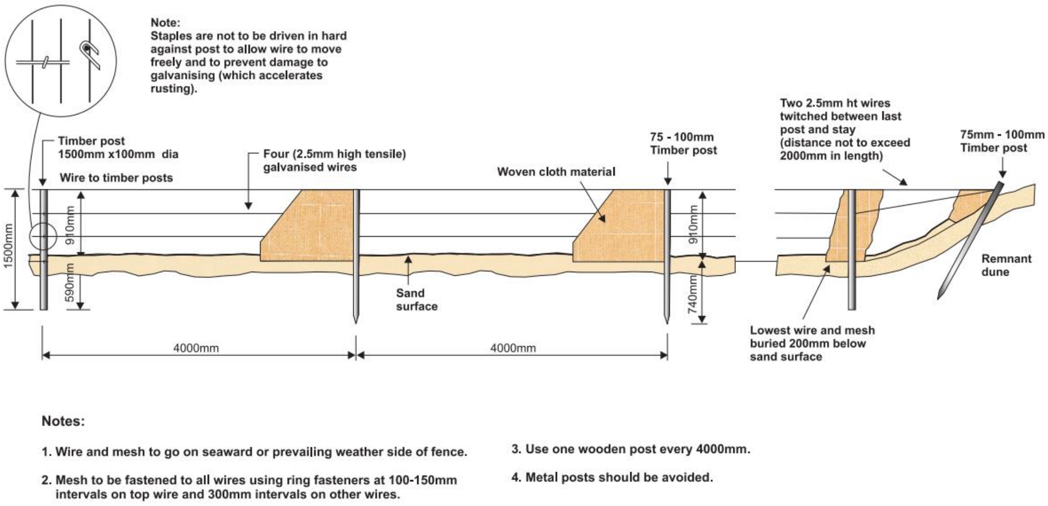
| | <br>**Figure 13**. Desing of a dune forming fence. |
| Dune rebuilding with earthmoving equipment | This should be avoided, however, in some circumstances earthmoving equipment can be used to rebuild dunes. A survey of the dune must be done together with information of reconstruction methods, sand movement and the type of earthmoving machinery that is needed. |
| Temporary dune stabilisers | In many situations an immediate stabilising cover is required on bare sand to prevent drift. Examples may vary from small blowouts starting where dunal vegetation has been damaged, to larger areas of bare sand resulting from the reforming or repairing of a dunal system by earthmoving machinery.<br><br>Temporary stabilisers can be used to establish a cover in an emergency situation or to provide a surface cover until more permanent vegetation<br>becomes established. They protect the sand surface and can encourage sand trapping. In broad terms, there are four main types of<br>temporary stabilisers:<br>• brushes and mulches<br>• liquid sprays<br>• cover crops |
| Revegetation | Dune vegetation has the ability to:<br>• prevent wind erosion by decreasing wind speed at ground level and by providing a protective cover over the dune<br>• build up sand dunes and thereby increase the sand reserve for storm waves n reduce but not prevent damage from wave erosion |

| | |
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| | • regenerate naturally after storm damage and facilitate natural dune recovery<br>• tolerate gradual movements of the dunes both vertically and horizontally<br>• provide habitat for native fauna<br><br>Most plants found on coastal dunes come from a limited number of species, particularly those located on or near the foredune. Despite this, the biodiversity of these ecosystems depends on many other species, even if they are represented by few individual plants. Effective efforts to restore vegetation in these areas must replicate this diversity as closely as possible<br><br>The vegetation type for coastal dunes between Mossel Bay and Sedgefield has been mapped as Goukamma Strandveld[33]. Southern Cape hummock dunes have a rich flora incorporating elements of both the temperate southwestern coast and the subtropical east coast. Common species are *Ipomoea brasiliensis*, *Scaevola thunbergii*, *Arctotheca populifolia*, *Tetragonia decumbens, Hebenstreitia cordata*, *Zalusianskya maritima*, *Gladiolus gueinzii*, *Chrysanthemoides monolifera*, *Metalasia muricata* and *Sporobolus virginicus*[34].<br><br>Hummock dune plants are adapted to withstand erosion: many are ephemerals, others have rhizomatous stem s (which aid in d u n e stabilization) and thick fleshy leaves. Propagules are typically dispersed by ocean currents. Figure 14 shows the three overlapping dune zones inhabited by plants suited to their specific conditions:<br>• An unstable initial foredune area with pioneering herbs and grasses.<br>• A partially stable foredune area with shrubs and accompanying ground vegetation.<br>• A stable hind-dune area where trees predominate, supported by an undergrowth of shrubs and ground plants. |

[33] Cowling, R.M., Cawthra, H., Privett, S. and Grobler, B.A., 2023. The vegetation of Holocene coastal dunes of the Cape south coast, South Africa. *Peer Journal*, 11: 16427.
[34] Cowling, RM and Pierce, S.M., 1985. Southern Cape coastal dunes-an ecosystem lost? *Veld & Flora*, *71*(4): 99.

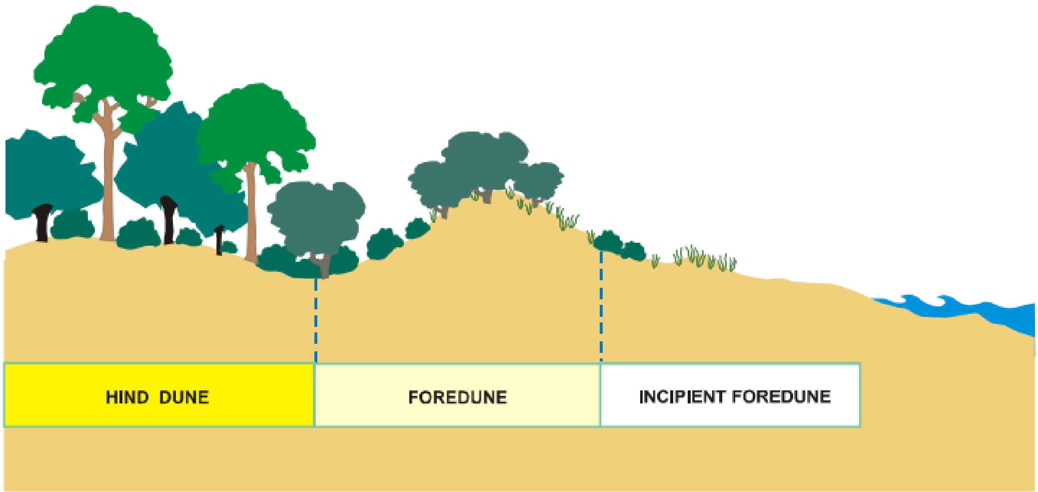


**Figure 14.** Zones that must be considered in species selection[35].

In Wilderness, the hind dune is mostly urbanized. Figure 11 shows, the stages of natural plant success. Stage 3, which describes long-lived trees (tertiary species), was omitted due to its hind dune being urbanised.

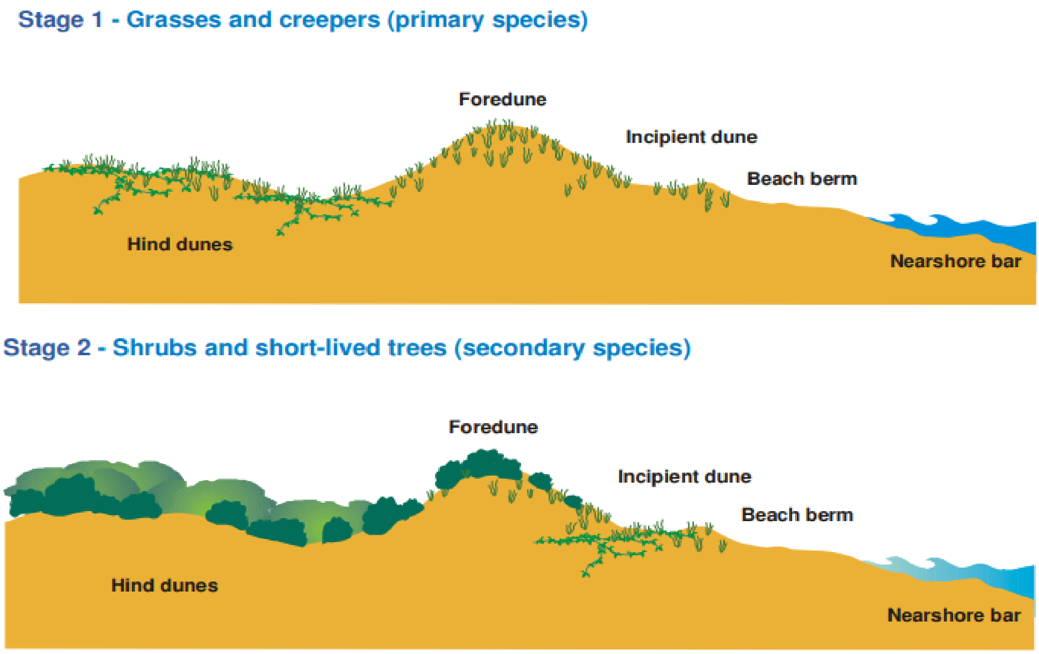


**Figure 15.** Idealised vegetation succession on coastal dunes.

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[35] Kidd, R., 2001. Coastal dune management: a manual of coastal dune management and rehabilitation techniques. NSW Government publication ISBN 0.7347. 5202.4.

## Appendix 1: Requirements for the rehabilitation plan

| Section | Subsection | Description |
|---|---|---|
| **Property and encroachment details** | Property owner information | Include the name, contact details, property address and legal description of the property owner. |
| | Detailed property description | Provide a comprehensive description of the property, including its general characteristics, current land use, size and boundaries. |
| | Description of encroachment areas | Describe the areas of encroachment with detailed maps and photographs. Include the legal status of any structures and their impact on the foredune. |
| **Objectives and compliance** | State the goals of the rehabilitation plan | Outline the primary goals of the rehabilitation plan, such as rectifying encroachments, mitigating coastal erosion and/or increasing coastal protection. |
| | Compliance with legislation | Reference the applicable legislation and how the rehabilitation plan complies to it. |
| **Site assessment** | Site analysis | Conduct a detailed assessment of the affected site's physical characteristics, including vegetation and topography. Evaluate the environmental impact of current conditions, such as erosion and aesthetics. |
| | Detailed environmental impact analysis | Analyse potential impacts of the rehabilitation project |
| | Plan for removal or modification of encroaching structures | List the encroaching structures and outline the methodology and timeline for their removal or modification. |
| **Rehabilitation plan/method statement** | Rehabilitation approach | Detail the nature-based solutions to be implemented, such as dune reshaping, installing sand fencing, revegetation method for shoreline stabilisation such as coir logs. |
| | Erosion control methods | Describe the installation of erosion control structures like sand fences and coir logs. Include sediment management practices and plans for monitoring and maintenance. |
| | Detailed revegetation plans | Specify and justify the selection of endemic plant species to be used, planting techniques and maintenance plan. |
| **Site management** | Detail how site will be managed | Specify the methods to control access to the rehabilitation area, including the use of barrier shade cloth and signage. |

| | | |
|---|---|---|
| **Monitoring and evaluation** | Regular monitoring schedule | Describe the frequency for monitoring activities, specifying the parameters to be monitored, such as vegetation growth and erosion rates. Detail the data collection methods. |
| | Performance indicators | Define success criteria, including baseline data and target values, to measure the effectiveness of the rehabilitation efforts. Performance indicators provide a clear framework for evaluating progress. |

## Appendix 2: Non-exhaustive list of suitable plant species for revegetation

| Name | Description | Image |
|---|---|---|
| ***Ipomoea pes-caprae* (L.) R.Br. subsp. *Brasilien sis*** **(L.**<br><br>beach morning glory, goat's foot (Eng.); strandpatat (Afr.) | This plant occurs in tropical and subtropical beaches around the world. In South Africa, it is found it in the following provinces: Western Cape; Eastern Cape and KwaZulu-Natal. It occurs from Mossel Bay in the Western Cape to tropical Africa. It grows on beaches just above the high tide mark and it is also found in beach forests and other vegetation types close to sea level. |  |
| ***Arctotheca populifolia* (Berg ius) Norlindh**<br><br>beach pumpkin (Eng.); seepampoen, tonteldoek (blom), strandgousblom (Afr.) | This plant is common along the southern African coastline, from Hondeklipbaai along the West Coast right up to the southern Mozambique coast. It grows in deep sand on coastal dunes and around estuaries. |  |

| | | |
|---|---|---|
| ***Tetragonia decumbens*** **Mill.**<br><br>dune spinach (Eng.); duinespinasie (Afr.) | Found on coastal sand dunes from southern Namibia to the Eastern Cape An early colonizer of moist sand dunes, this plant is extremely valuable for stabilizing moving sand. It acts as a seed trap and provides organic matter that supports the growth of other species. The accumulation of plant matter enables dunes to develop from fore dunes to stabilized rear dunes. Its four-angled fruits are easily dispersed by the wind, further aiding in dune stabilization. |  |
| ***Hebenstretia cordata***<br><br>beach slugwort (Eng.) | |  |

| | | |
|---|---|---|
| ***Zalusianskya maritima***<br><br>Coastal Drumsticks (Eng.) | The native range of this species is the Western Cape. It is an annual or subshrub and grows primarily in the subtropical biome. |  |