MARINE ECOLOGY IMPACT ASSESSMENT FOR EXPANSION OF SEA WATER INTAKE INFRASTRUCTURE AT TRONOX MINERAL SANDS (PTY) LTD

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EXECUTIVE SUMMARY

Namakwa Sands is a Heavy Mineral Sands operation operated by Tronox Mineral Sands (Pty) Ltd (Tronox). Namakwa Sands comprises the mine at Brand-se-Baai (385 km north of Cape Town), a Mineral Separation Plant near Koekenaap and a Smelter in Saldanha. The Brand-se-Baai mine is split into a West Mine and an East Mine. The East Mine is currently a shallow mine, where mining of only the top Red Aeolian Sand layer occurs. However, Tronox is authorised to mine and process the deeper Orange Feldspathic Sand resource underlying the Red Aeolian Sand material at the East Mine. This project is called the Namakwa Sands East Mine Orange Feldspathic Sands (East OFS) Project.

Tronox has appointed SRK Consulting (South Africa) (Pty) Ltd (SRK) to undertake an Environmental Impact Assessment (EIA) in support of applications for the proposed construction and operation of a new Residue Storage Facility (RSF), amending the approved backfilling plan and upgrading the seawater intake for the East OFS Project. SRK has in turn appointed Anchor Environmental Consultants (Anchor) to assess the potential impacts on the marine environment of the expansion of the sea water intake, which is the only component of the project that has the potential to impact on the marine environment.

Currently, seawater is abstracted at the seawater intake and pumped to the seawater dam located at the Secondary Concentration Plant (SCP). This dam supplies seawater to reservoirs servicing processing plants. Although Tronox is authorised in terms of NEMA to upgrade seawater intake infrastructure and increase the seawater abstraction volume to 57.6 Ml/day for the East OFS project, further upgrades are required and proposed as part of this application. This includes a new de-sanding sump with a footprint of ~40 m^2 and new foundation for high-lift pumps with a footprint of ~40 m^2.

This marine impact assessment report includes a description of the marine environment that may be affected by the proposed seawater intake expansion, an assessment of the significance of any potential impacts associated with the proposed expansion, and identification of mitigation measures that need to be implemented.

Affected environment

The broader oceanography of the Brand-se-Baai area is influenced by the cold, highly productive Benguela upwelling system of the West Coast. The study site is subject to semi-diurnal tides, with each successive high (and low) tide separated by 12 hours. Spring tides occur once a fortnight during full and new moons. Tidal activity greatly influences the biological cycles (feeding, breeding and movement) of intertidal marine organisms, and has an influence on when people visit the coastline to partake in various activities such as bathing and, harvesting of marine resources.

Another factor which greatly influences marine ecology and human activities along the coastline is wave energy. Wave size is determined by wind strength and fetch (distance over which it blows) and determines the degree to which breaking waves at the shore will shift sand and erode rock. The west coast of South Africa typically experiences high wave energy and is dominated by south-westerly swells. Southerly and south westerly waves off Brand-se-Baai frequently exceed 2 m.

Intertidal rocky shore community structure and species composition observed at Brand-se-Baai is typical of the west coast region, and all the taxa recorded in the intertidal zone on the rocky shore are ubiquitous throughout the Namaqua Inshore Ecozone and are not restricted to this particular area. None of the intertidal rocky shore species are considered to be rare or endangered. Of the intertidal bird species observed at Brand-se-Baai, the African Black Oystercatcher can be highlighted as an important species in terms of its conservation status.

Impact Assessment

Potential impacts associated with the expansion of sea water intake for the Namakwa Sands mine at Brand-se-Baai range from habitat loss to impaired water quality effects. Based on the results of the baseline study, it is apparent that the seawater intake site has benthic biota that is not of great significance in terms of conservation status. This suggests that impacts of the construction and operational phases of the expansion of the sea water intake are likely to be fairly low at the Brand-se-Baai site.

A total of three potential environmental impacts were assessed for this report. After mitigation, no impact was rated as of above 'low' significance

Cumulative marine environmental impacts emanating from the proposed project are primarily related to periodic intake infrastructure upgrades, maintenance and repair — this is an infrequent but ongoing impact considered to be of 'low' significance, provided that the specified mitigation measures are implemented.

Summary of impacts identified, and significance before and after mitigation

Phase	Impact identified	Significance before mitigation	Significance after mitigation
Construction	Impact 1: Direct losses of Littorina habitat in development footprint.	INSIGNIFICANT	n/a
	Impact 2: Waste generation and disposal during construction.	MEDIUM	LOW
	Impact 3: Impaired water quality impacts to marine systems.	VERY LOW	INSIGNIFICANT

Based on the impacts assessed in this report, it is recommended that the proposed development proceed with the implementation of strict environmentally responsible practices as outlined in the mitigation measures below.

Mitigation

Proposed mitigation measures for impacts are well known and have been effectively applied in similar circumstances. If followed, the overall effect of the perceived impacts will be significantly reduced and will be of low to very low significance. Recommendations to mitigate impacts associated with the proposed expansion of the Namakwa Sands seawater intake infrastructure at Brand-se-Baai are listed below:

- Minimise the spatial extent of the developmental footprint as much as possible.
- Minimise the duration of construction as far as possible.
- Inform & empower all staff about sensitive marine species & suitable disposal of construction waste.
- Suitable handling and disposal protocols must be clearly explained, and sign boarded.
- Reduce, reuse, recycle.
- All fuel and oil is to be stored with spill protection, no leaking vehicles permitted on site, spillages to be cleaned up as quickly as possible.

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GLOSSARY

Alien species	Species that become established in areas outside their natural, native range.
Amphipod/a	Crustaceans with no carapace and a laterally compressed body
Anaerobic (conditions)	An environment that lacks free oxygen but may contain atomic oxygen bound in compounds such as nitrate (NO_3), nitrite (NO_2), and sulfites (SO_3).
Anthropogenic	Environmental pollution originating from human activity
Baseline	Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured.
Benthic	Pertaining to the environment inhabited by organisms living on or in the ocean bottom
Biodiversity	The variety of plant and animal life in a particular habitat.
Biomass	The mass of living biological organisms in a given area or ecosystem.
Bioregion	A region defined by characteristics of the natural environment rather than by man-made divisions.
Biota	Living organisms within a habitat or region
Chart datum	Chart Datum is level on the shore corresponding with the Lowest Astronomical Tide (LAT) as from 1 January 2003.
Construction phase	The stage of project development comprising site preparation as well as all construction activities associated with the development.
Copepod	A group of small crustaceans found in the sea and nearly every freshwater habitat. Some species are planktonic (drifting in the water column), while some are benthic (living on the ocean floor).
Coralline	Corallines are red algae in the order Corallinales. They are characterized by a thallus that is hardened by calcareous deposits contained within the cell walls.
Crinoid/ea	Feather stars belong to the phylum Echinodermata. As juveniles, they are attached to the sea bottom by a stalk with root-like branches. In the adult stage, they break away from the stalk and move about freely.
Crustacea/n	Generally differ from other arthropods in having two pairs of appendages (antennules and antennae) in front of the mouth and paired appendages near the mouth that function as jaws.
Cumulative impacts	Direct and indirect impacts that act together with current or future potential impacts of other activities or proposed activities in the area/region that affect the same resources and/or receptors.
Diatom	A major group of algae that makes up the most common type of phytoplankton. Most are unicellular but they can group together to form colonies.
Dinoflagellate	A large and diverse group of unicellular protists, most of which are marine, and that can either be free-living in the plankton, or benthic.
Echinoderm/ata	Marine invertebrates with fivefold radial symmetry, a calcareous skeleton and tube feet (e.g. starfishes, sea urchins, sea cucumbers)
Ecoregions	Geographical regions that are characterised by specific ecological patterns, including flora and fauna, climatic conditions, among other factors.
Encrusting algae	A type of coralline algae that grows in low carpets on rocky shores.
Endemicity /endemism	A species unique to a defined geographic location. Organisms that are indigenous to an area are not endemic if they are found elsewhere.

Environment	The external circumstances, conditions and objects that affect the existence of an individual, organism or group. These circumstances include biophysical, social, economic, historical and cultural aspects.
Environmental Impact Assessment	A process of evaluating the environmental and socio-economic consequences of a proposed course of action or project.
Epiphyte	An organism that grows on the surface of a plant.
Faunal community	A naturally occurring group of native animals that interact in a unique habitat.
Gastropod/a	Molluscs (e.g. snails and slugs)
High shore	The section of the intertidal zone reaching from the extreme high water spring tide to the mean high water neap tide.
Holoplanktonic (organisms)	Permanent members of the plankton, such as copepods, diatoms and bacteria
Impact	A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.
Infauna	The assemblage of organisms inhabiting the seafloor.
Infratidal zone	The section of the marine environment that falls below the low tide line.
Intertidal zone	The section of the marine environment that lies exposed at low tide and submerged at high tide.
Invasive species	Alien species capable of spreading beyond the initial introduction area and have the potential to cause significant harm to the environment, economy or society.
Invertebrate	An animal without a backbone (e.g. a starfish, crab, or worm)
Low shore	The section of the intertidal zone reaching from the mean low water neap tide to the extreme low water spring tide.
Macrofauna	Animals larger than 0.5 mm.
Meiofauna (meiobenthos)	Small benthic invertebrates that are larger than microfauna but smaller than macrofauna.
Meroplanktonic (organisms)	Temporary members of the plankton, such as juvenile shrimps and the planktonic eggs and larvae of invertebrates and fish
Mitigation measures	Design or management measures that are intended to minimise or enhance an impact, depending on the desired effect. These measures are ideally incorporated into a design at an early stage.
Mollusc/a	Invertebrate with a soft unsegmented body and often a shell, secreted by the mantle.
Offshore	The area seaward of the nearshore environment boundary.
Operational phase	The stage of the works following the Construction Phase, during which the development will function or be used as anticipated in the Environmental Authorisation.
Ophiuroid/ea	An order of echinoderms known as the brittle stars.
Pelagic	Within the water column.
Phytoplankton	Ocean dwelling microalgae that contain chlorophyll and require sunlight in order to live and grow.
Polychaete/a	Segmented worms with many bristles (i.e. bristle worms).
Semi-diurnal tides	When there are two high tides and two low tides within a day that are about the same height,
Species	A category of biological classification ranking immediately below the genus, grouping related organisms. A species is identified by a two part name; the name of the genus followed by a Latin or Latinised un-capitalised noun.

Species richness	The number of different species represented in an ecological community. It is simply a count of species and does not take into account the abundance of species.
Subtidal	The marine habitat that lies below the level of mean low water for spring tides.
Supratidal	The area above the spring high tide mark that is not submerged by seawater. Seawater penetrates these elevated areas only at high tide during storms.
Surf zone	Zone extending seawards of the high water mark to a point where the largest waves begin to break, off any section of coast defined as “sandy coast” or “mixed coast” on the National Coastline Layer, available from the South African National Biodiversity Institute’s BGIS website (http://bgis.sanbi.org).
Total Suspended Solids	A measure of the mass per unit volume of TSS in the water column.
Turbidity	A measure of light conditions in the water column.
Upwelling	A process in which deep, cold water rises toward the surface; surface waters moved offshore by the wind, for example, are replaced by cold, nutrient-rich water that “wells up” from below.
Wind forcing	The movement of surface waters and the resulting transfer of energy to deeper waters by the predominant wind (i.e. a strong easterly wind will result in an eastward flowing surface current).

LIST OF ABBREVIATIONS

Anchor	Anchor Environnemental Consultants (Pty) Ltd
DMRE	Department of Mineral Resources and Energy
DO	Dissolved Oxygen
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
GA	General Authorisation
ICMA	Integrated Coastal Management Act (No. 24 of 2008)
IEM	Integrated Environmental Management
IUCN	International Union for Conservation of Nature
MSL	Mean Sea Level
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act (No. 107 of 1998, as amended)
OFS	Orange Feldspathic Sands
PCP	Primary Concentration Plants
PSU	Practical Salinity Unit
RSF	Residue Storage Facility
SCP	Secondary Concentration Plant
SRK	SRK Consulting (South Africa) (Pty) Ltd
TOC	Total Organic Carbon
TON	Total Organic Nitrogen
Tronox	Tronox Mineral Sands (Pty) Ltd
TSS	Total Suspended Solids
WQG	Water Quality Guidelines
Ml	Megalitres

1 INTRODUCTION

1.1 Background

Namakwa Sands is a Heavy Mineral Sands operation operated by Tronox Mineral Sands (Pty) Ltd (Tronox). Namakwa Sands comprises the mine at Brand-se-Baai (385 km north of Cape Town, see Figure 1.1), a Mineral Separation Plant near Koekenaap and a Smelter in Saldanha. The division of Tronox that operates the business is referred to as Tronox Namakwa Sands.

The Brand-se-Baai mine is split into a West Mine and an East Mine (Figure 1.2). Material from both mines is processed at Primary Concentration Plants (PCP West and PCP East) to produce a heavy mineral concentrate, which is pumped to the Secondary Concentration Plant (SCP) which is also located at the mine. Waste products from primary processing at the PCP East include tailings (coarser material) and residue (fines). No chemicals are used in processing, but seawater is used resulting in a high saline content of tailings and fines. Tailings are partially backfilled in the mining void, while fines are deposited in Residue Storage Facilities (RSF). The East Mine is currently a shallow mine, where mining of only the top Red Aeolian Sand layer occurs. However, Tronox is authorised to mine and process the deeper Orange Feldspathic Sand resource underlying the Red Aeolian Sand material at the East Mine. This project is called the Namakwa Sands East Mine Orange Feldspathic Sands (East OFS) Project.

For the East OFS Project to proceed, the following need to be authorised:

- an additional ~200 ha Residue Storage Facility (RSF) with a (storage) capacity of between 34 and 40 million m^3 (Mm^3) for residue (fines) disposal;
- new sand tailings disposal deposition strategy entailing single stacking sand tailings in the East OFS pit by truck and construction of two large Sand Tailings Facilities in the East Mine pit;
- expansion of sea water intake, including new de-aeration sump and high-lift pump foundation;
- fines and return water transfer pipelines;
- overhead powerlines;
- overburden stockpile; and,
- the demolition of two farmhouses.

Tronox has appointed SRK Consulting (South Africa) (Pty) Ltd (SRK) to undertake an Environmental Impact Assessment (EIA) and associated processes in support of applications for the proposed construction and operation of an In-Pit Residue Storage Facility for the East OFS Project. SRK has in turn appointed Anchor Environmental Consultants (Anchor) to assess the impacts on the marine environment of the above listed developments. Here, the impacts directly applicable to the marine environment are related to the expansion of sea water intake (including new de-aeration sump and high-lift pump foundation).

This marine impact assessment includes a description of the environment that may be affected by the proposed expansion of the seawater intake infrastructure, an assessment of the significance of any potential impacts associated with the upgrading of the seawater intake, and identification of mitigation measures that need to be implemented.

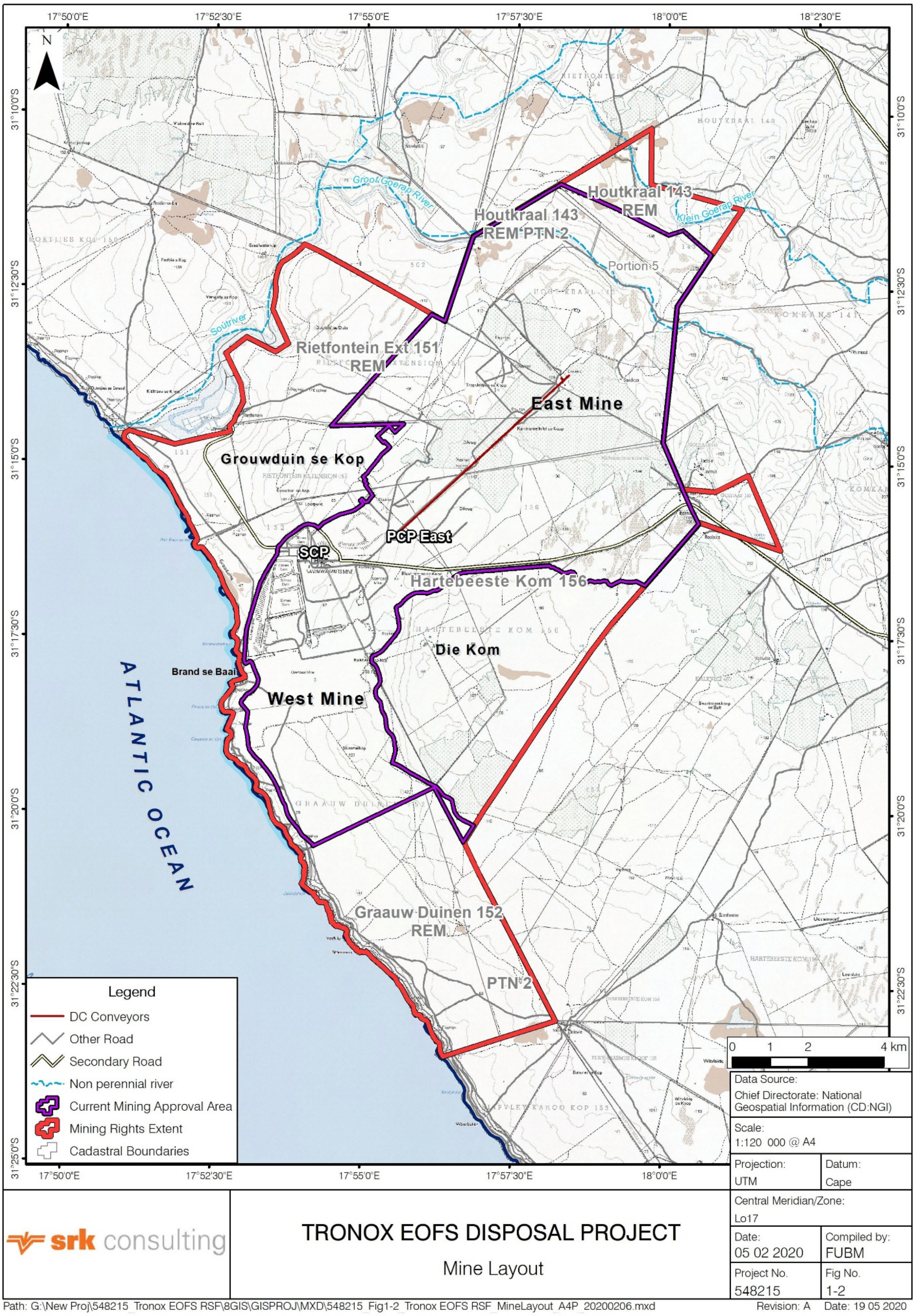


Figure 1.1 Site locality – prepared by SRK Consulting (2020).

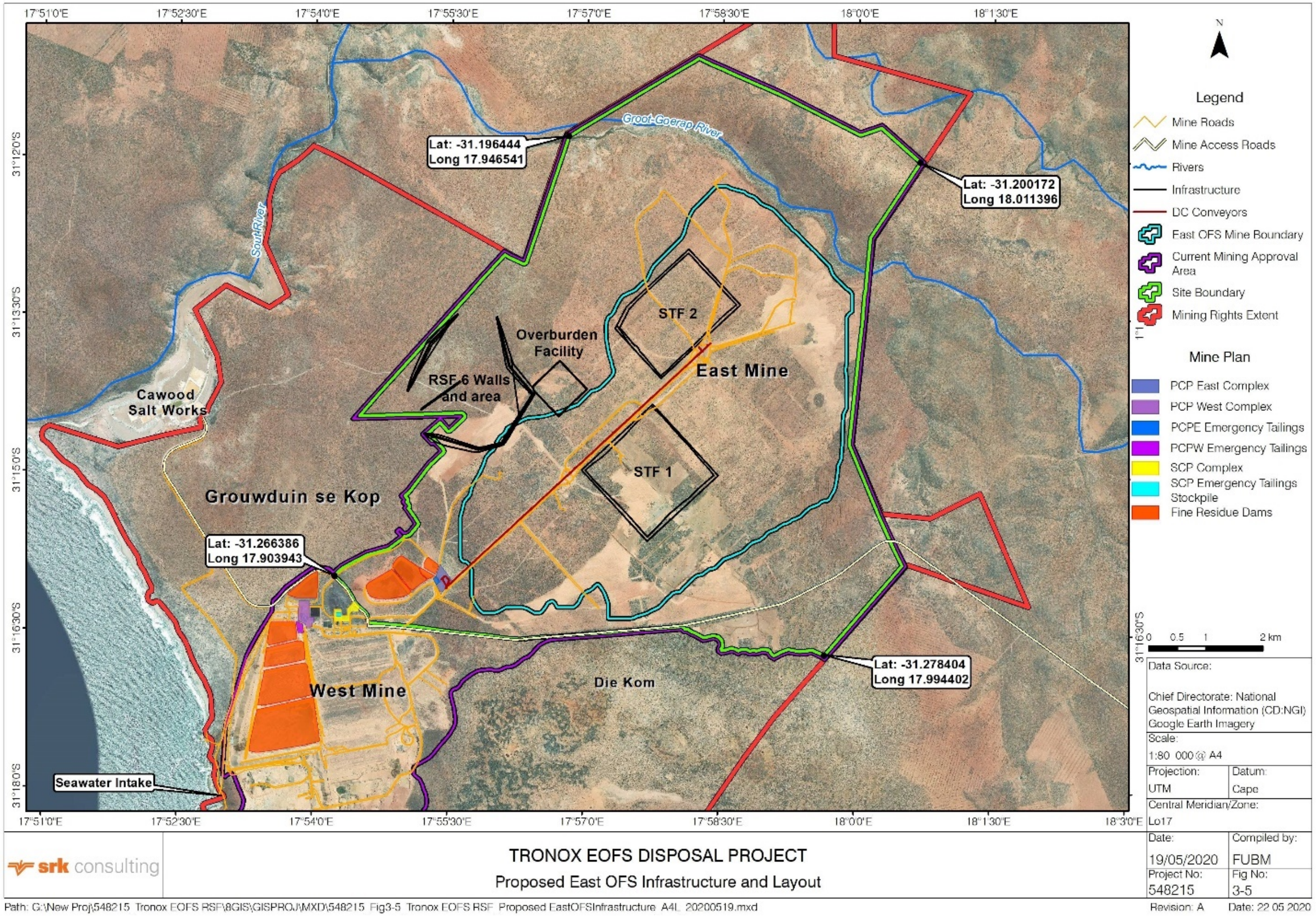


Figure 1.2 Proposed East OFS infrastructure and layout – prepared by SRK Consulting (2020).

1.2 Terms of Reference

The marine study will consider all potential risks and impacts on the marine environment that may arise during the construction, operation and decommissioning phases of the project. Impacts will be assessed in respect of their extent, magnitude, timing, and significance. Using available literature on the nature of the marine environment at the site and informed by the results of a past site visit, a marine specialist study report must be prepared that covers the following aspects:

- Review sea water intake infrastructure expansion plans;
- Draw on previous studies undertaken at this location (by Anchor Environmental) to describe the local baseline;
- Assess the impacts of the infrastructure on the marine environment; and,
- Recommend practicable mitigation measures to avoid and/or minimise impacts and/or optimise benefits.

1.3 Details of Proposed Upgrades and Alternatives

The following is taken from the Project Description provided by SRK Consulting (2020).

Currently seawater is abstracted at the seawater intake and pumped to the seawater dam located at the Secondary Concentration Plant (SCP). This dam supplies seawater to reservoirs servicing the processing plants. Tronox is authorised in terms of NEMA to upgrade seawater intake infrastructure and increase the seawater abstraction volume to 57.6 Ml/day for the East OFS project to supply the upgraded PCP East with enough water. Upgrades to the seawater intake and infrastructure that were the subject of previous assessment by Anchor, and have already been authorised by Department of Mineral Resources and Energy (DMRE) for the East OFS project (and therefore excluded from the current scope) is listed below:

- Installation of more effective pumps (including a <50 m^2 expansion of the existing pump station);
- Enlarging the gully and suction cage;
- Excavation (by blasting) of the intake gully;
- An additional below ground pipeline from the sea water intake to the proposed sea water buffer dam, in the existing pipeline corridor (4.9 km);
- A new booster pump station mid-way between existing booster station and proposed buffer dam;
- Additional lined sea water buffer dam with a capacity of up to 40 000 m^3 at a location in the vicinity of the existing sea water dam;
- New pipeline from the sea water dam to the PCPE in the existing pipeline corridor within the Mine footprint;
- Raw water dam for PCPE with a capacity of 20 000m^3; and
- Associated pumping infrastructure at the proposed new PCPE raw water dam.

However, to allow the full use of the authorised 57.6 Ml/day, further intake infrastructure upgrades are proposed (and which are assessed here) include:

- A new de-sanding sump with a footprint of ~40 m^2; and
- New foundation for high-lift pumps with a footprint of ~40 m^2.

Conceptual designs and an indication of the footprints of the new de-sanding sump and foundation for high-lift pumps are shown in Figure 1.3.

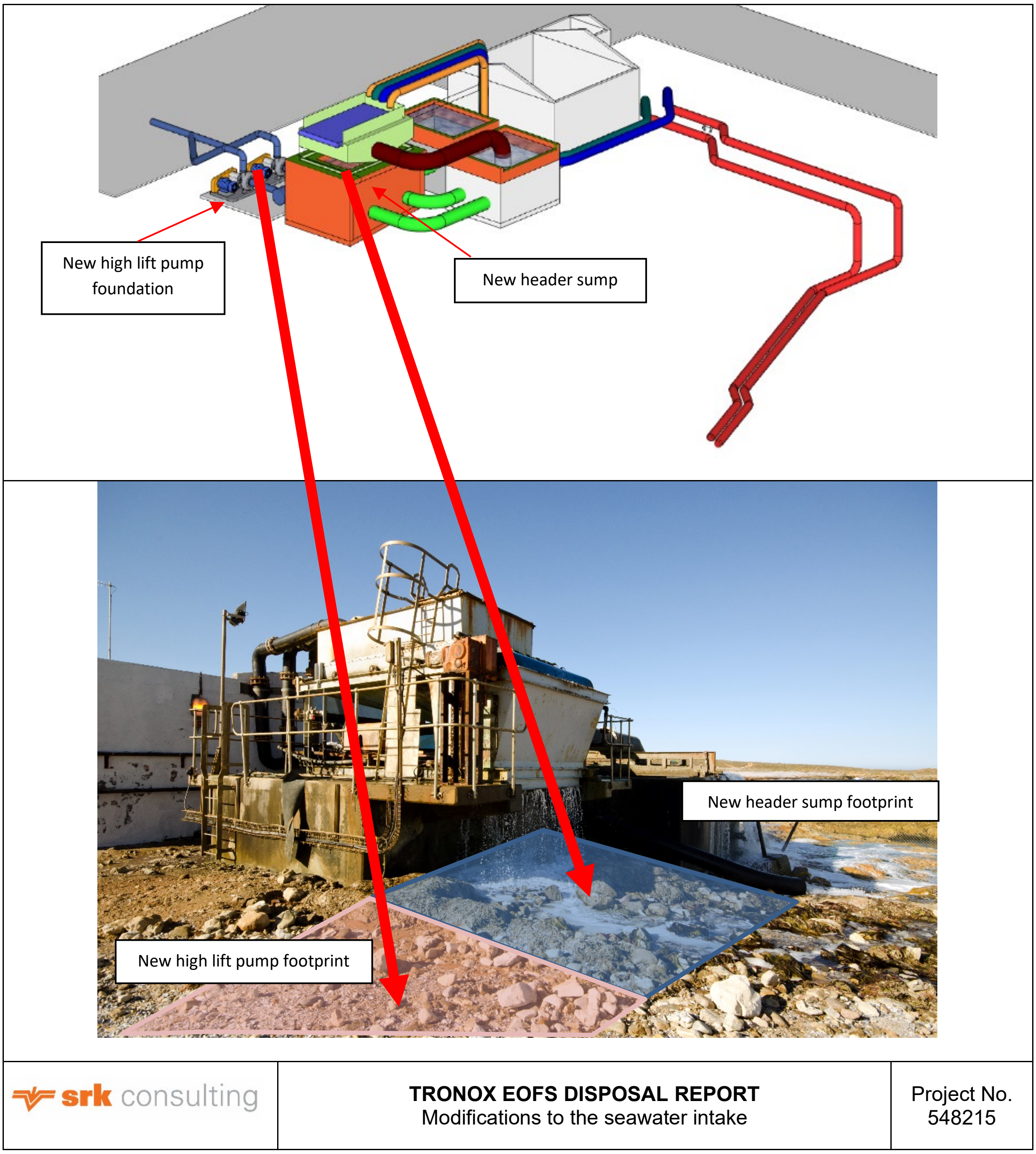


Figure 1.3 Upgrades to the seawater intake – prepared by SRK Consulting (2020).

As this is an upgrade to existing intake infrastructure, there are no alternatives for this development, save for the no-go alternative.

1.4 Assumptions and Limitations

The study is based on a number of assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report. The validity of the findings of the study is not expected to be affected by these assumptions and limitations:

- *This study is based on two existing marine specialist studies undertaken by Anchor for Tronox and SRK, namely Biccard & Clark (2014) and Clark (2016)*

Other assumptions made in the report are explicitly stated in the relevant sections.

2 OVERVIEW OF THE RECEIVING ENVIRONMENT

2.1 Oceanography

The physical oceanography of an area (particularly water temperature, nutrient and oxygen levels, and wave exposure) is the principal driving force that shape marine communities. The broader oceanography of the region is influenced by the cold Benguela upwelling system of the West Coast (Figure 2.1). The Benguela Current originates from the South Atlantic Circulation, which circulates just north of the Arctic Circumpolar Current.

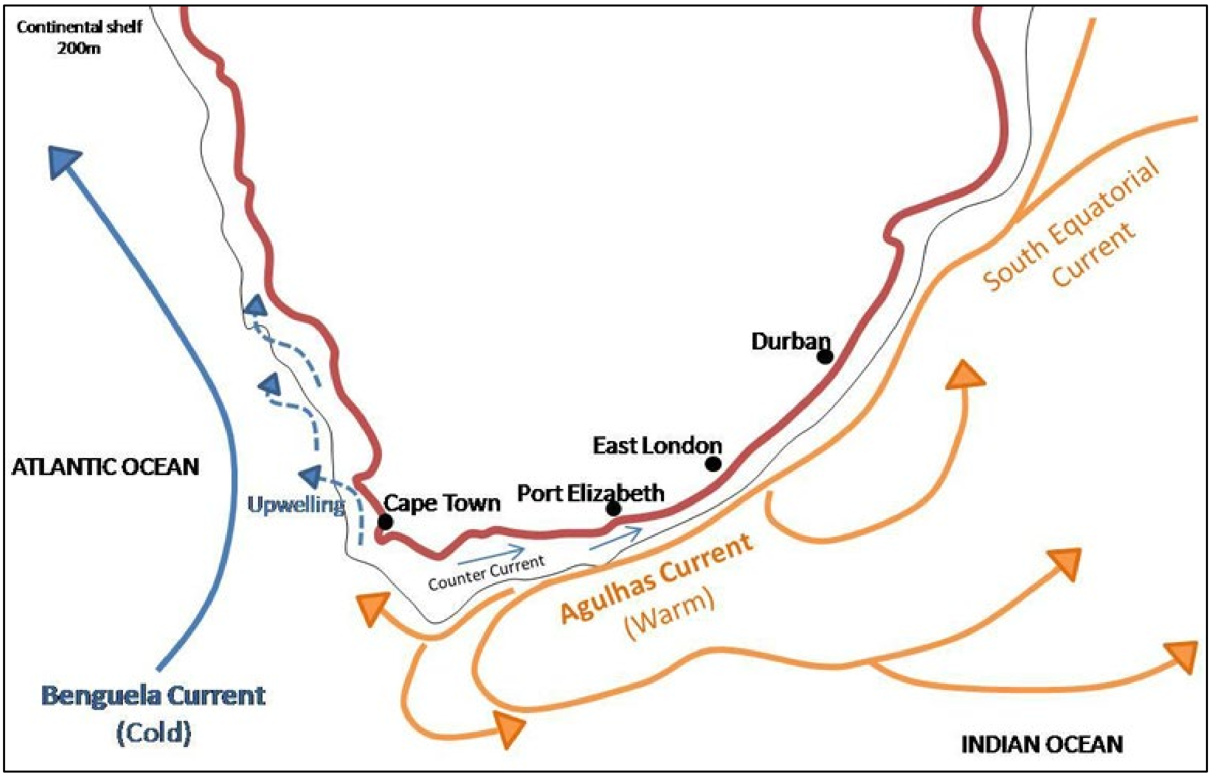


Figure 2.1. Major current streams around South Africa (Biccard & Clark, 2014)

The cool average temperature of the Benguela current (10-14^{o}C) is enhanced by the upwelling of colder nutrient-rich deep water (Branch & Branch, 1981). The area experiences strong southerly and south-easterly winds which are deflected by the Coriolis force (rotational force of the earth which causes objects in the southern hemisphere to spin anticlockwise). These prevailing conditions deflect the surface waters offshore and draw cold, nutrient rich water to the surface (Figure 2.1). Phytoplankton bloom when the nutrients reach the surface waters where plenty of light is available for photosynthesis. The phytoplankton is then preyed upon by zooplankton, which is in turn eaten by filter feeding fish such as anchovy or sardine. This makes the west coast one of the richest fishing grounds in the world and also attracts large colonies of birds and seals (Branch & Branch, 1981). The water temperature and nutrient levels are strongly influenced by wind with minimum temperatures and maximum nutrient levels occurring in conjunction with upwelling events (Branch & Griffiths, 1988).

The areas that experience the most intense upwelling activity in the southern Benguela are situated off Cape Columbine (approximately 150 km South of Brand-se-Baai) and the Cape Peninsula.

Occasionally phytoplankton blooms contain species (frequently dinoflagellates) that are toxic to marine life and people who consume shellfish. Under certain oceanographic conditions (a calm period following intense upwelling), extremely dense phytoplankton blooms can sink and decay in coastal water, leading to oxygen depletion of water and the production of hydrogen sulphide, which is toxic to marine life. Both toxic phytoplankton blooms (often referred to as red tides) and low oxygen events (colloquially called black tides) are known to occasionally occur along the entire west coast. These events are, however, more common in retentive bays downstream of intensive upwelling cells (e.g. St Helena Bay, Elands Bay). The exposed linear coastline around Brand-se-Baai is probably too exposed for low oxygen events to affect the near shore in this area.

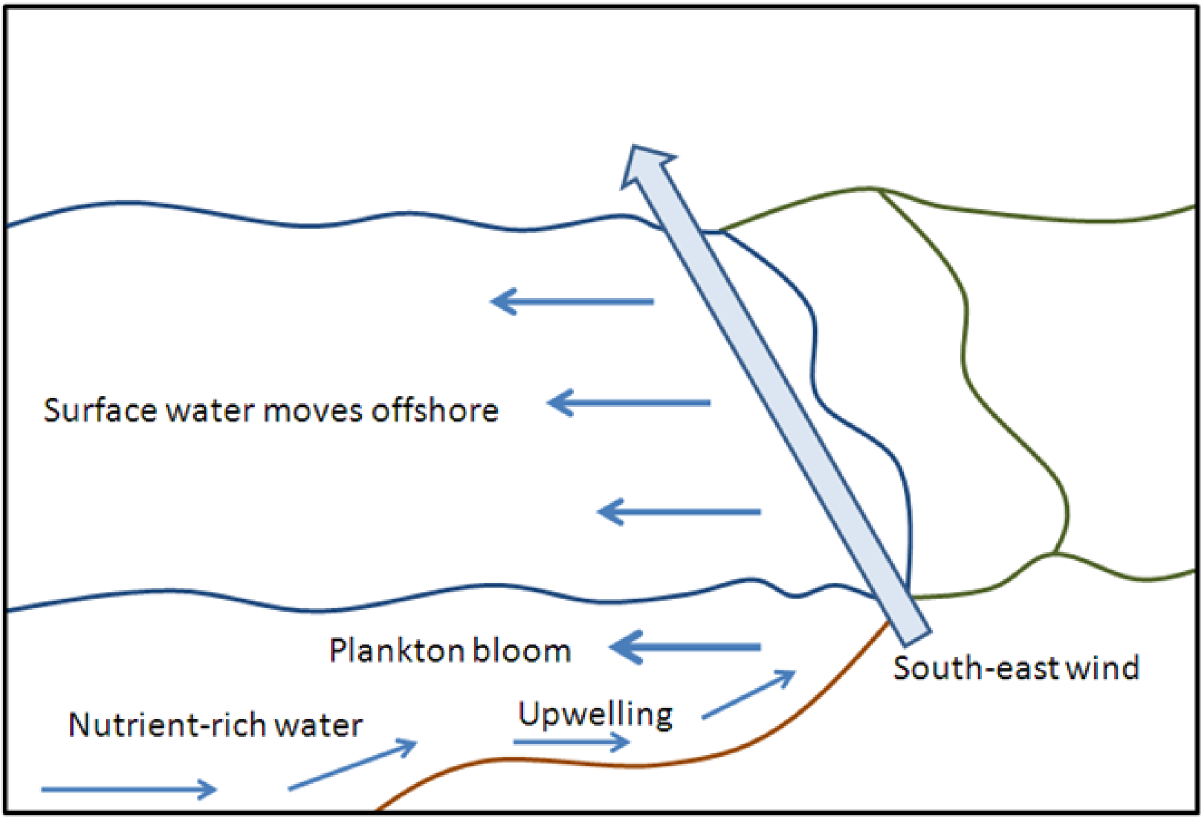


Figure 2.2 Wind-driven upwelling that occurs on the west and south west coasts of South Africa (Biccard & Clark, 2014).

The study site is subject to semi-diurnal tides, with each successive high (and low) tide separated by 12 hours. Each high tide occurs approximately 25 minutes later every day, which is due to the 28-day rotational cycle of the moon around the earth. Spring tides occur once a fortnight during full and new moons. Tidal activity greatly influences the biological cycles (feeding, breeding and movement) of intertidal marine organisms, and has an influence on when people visit the coastline to partake in various activities such as bathing and, harvesting of marine resources. The tidal variation in the vicinity of Brand-se-Baai usually ranges between 0.28 m (relative to the chart datum) at mean low water springs and 1.91 m at mean high water springs, with the highest and lowest astronomical tide being 2.25 m and 0.056 m respectively.

Another factor which greatly influences marine ecology and human activities along the coastline is wave energy. Wave size is determined by wind strength and fetch (distance over which it blows) and determines the degree to which breaking waves at the shore will shift sand and erode rock. The west coast of South Africa typically experiences high wave energy and is dominated by south-westerly swells with a long fetch and a period of 10 to 15+ seconds (Branch & Griffiths, 1988). Southerly and south westerly waves off Brand-se-Baai frequently exceed 2 m (Figure 2.3).

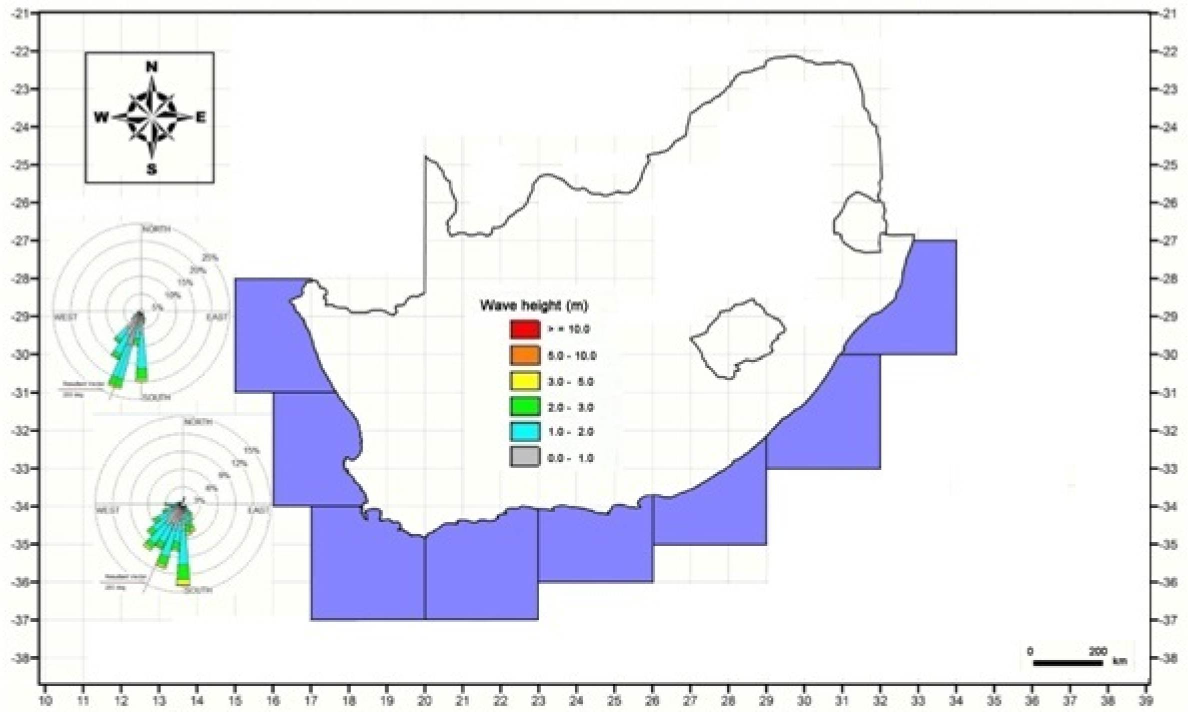


Figure 2.3. Wave roses showing the frequency of significant wave heights and direction in the vicinity of Brand-se-Baai (Source: SADCO Voluntary Observing Ships data).

2.2 Biogeography

Numerous attempts have been made to understand and map marine biogeographic patterns around the coast of South Africa with the most recent being Sink *et al*. (2012). Most of the studies recognised three coastal bioregions; a cool temperate west coast, a warm temperate south coast and a subtropical east coast region; however, Sink et al. (2012) defined several new ecoregions that are now in use. According to these divisions, Brand-se-Baai and the study site described in this report, fall in the Namaqua inshore ecozone, which is nested within the Southern Benguela Ecoregion (Figure 2.4) (Sink, et al., 2012).

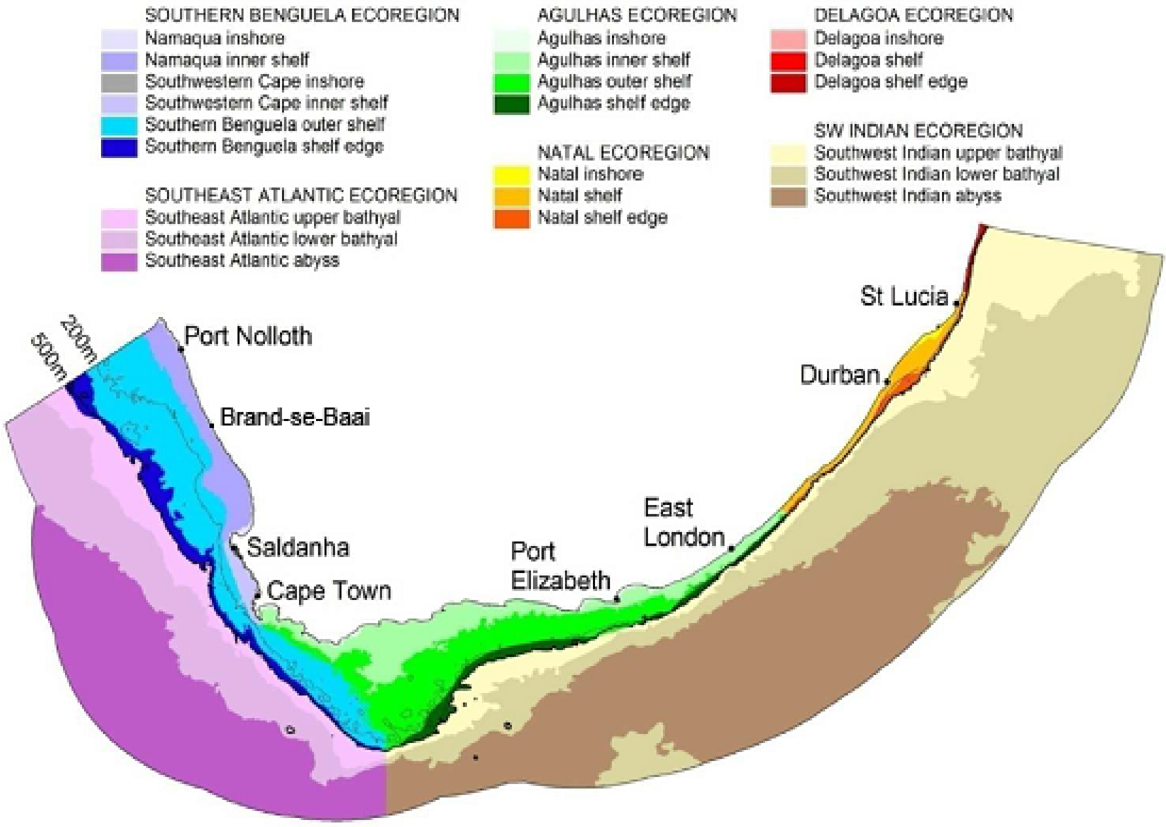


Figure 2.4. **Six marine ecoregions with 22 ecozones incorporating biogeographic and depth divisions in the South African marine environment as defined by Sink *et al.* (2012).**

2.3 Ecology

2.3.1 Sandy beaches

Intertidal sandy beaches are very dynamic environments. The faunal community composition is largely dependent on the interaction of wave energy, beach slope and sand particle size (beach morphodynamics). Three morphodynamic beach types are described: dissipative, reflective and intermediate beaches (McLachlan, et al., 1993). Dissipative beaches are wide and flat with fine sands and high wave energy. Waves start to break far from the shore in a series of spilling breakers that 'dissipate' their energy along a broad surf zone. This generates slow swashes with long periods, resulting in less turbulent conditions on the gently sloping beach face. These beaches usually harbour the richest intertidal faunal communities. Reflective beaches have low wave energy, and are coarse grained (>500 µm sand) with narrow and steep intertidal beach faces. The relative absence of a surf-zone causes the waves to break directly on the shore causing a high turnover of sand. The result is depauperate faunal communities. Intermediate beach conditions exist between these extremes and have a very variable species composition (McLachlan, et al., 1993). This variability is mainly attributable to the amount and quality of food available. Beaches with a high input of e.g. kelp wrack have a rich and diverse drift-line fauna, which is sparse or absent on beaches lacking a drift-line[1] (Field & Griffiths, 1991).

The sandy beaches of the Southern Benguela Ecoregion are exposed to high energy waves with the exception of a few small sheltered bays (Bally, 1987). The main inputs of food to the sandy beaches in this system are upwelling-related coastal phytoplankton and kelp detritus (Bally 1987). The biomass values reported for beaches along the southern Benguela coast are some of the highest in the world (Bally, 1987).

Sandy beaches have no hard substratum onto which animals and plants can attach. Organisms living here rely on a nutrient source in the form of seaweed detritus which is constantly deposited on the beach together with organic rich froth, or spume (Branch & Branch, 1981). Sandy beaches are highly dynamic; strong waves scour and erode beaches while gentle waves deposit sand. Sand is typically deposited with offshore winds, and eroded with onshore winds. Relatively few species occur on sandy beaches due to their unstable and harsh nature, but those that do occur are hardy, and well adapted to life in these environments (Branch & Branch, 1981). Animals living here are, however, offered some degree of protection by being able to burrow into the layers of sand to escape desiccation, overheating and strong waves (Branch & Branch, 1981). Five groups of organisms are typically found on sandy beaches: aquatic scavengers, aquatic particle feeders, air breathing scavengers, meiofauna (smaller than 1 mm in size), and higher predators (Branch & Branch, 1981).

Aquatic scavengers feed on dead or dying animals that wash up on the beach and their activity is largely regulated by tides. This group includes species such as Bullia (the plough snail), that emerge from the sand as the tide rises and are deposited in the same area in which the waves drop debris and decaying matter. Later they follow the tide down the shore as it recedes to avoid being eaten by terrestrial predators. Aquatic particle feeders, such as the sand hopper, occur mostly on the low-shore and feed on small organic particles. The majority of these species migrate up and down the beach with each tidal cycle, such that they remain in the surf zone and can escape avian and terrestrial predators. Sand hoppers are important for the breakdown of washed up seaweed, and are also a major food source for sanderlings and other birds. Air breathing scavengers live high on the shore and feed on kelp and other seaweeds that have been washed up, as well as dead and decaying animal matter. These species complete their life cycles out of water, emerge from the sand during low tide when there is less risk of being washed away, and are almost strictly nocturnal to avoid desiccation and predation. Meiofauna (organisms < 1mm in size) are by far the most abundant of the animals found on sandy beaches, as their small size enables them to live between sand grains. The two most common groups are nematode worms and harpacticoid copepods. Meiofauna play an important role in breaking down organic matter which is then colonised by bacteria. Higher predators which feed on sandy beach organisms include birds, such as African black oystercatchers (*Haematopus moquini*), White fronted plovers (*Charadrius marginatus*) and sanderlings (*Calidris alba*), and fish such as galjoen (*Dichistius capensis*) and white steenbras (*Lithognathus lithognathus*) (Branch & Branch, 1981).

[1] The drift line is a line on the upper part of the beach corresponding to the highest point reached by the tide on the preceding days or weeks where debris from the sea has been deposited.

Beaches typically comprise three functional zones, namely the surf zone, the beach (intertidal and backshore zones) and the dunes. The diversity and abundance of species has been shown to increase with depth in the surf zone of beaches along the Benguela system. A rich outer turbulent zone (10-33m from the shore) supports delicate cnidarians (anemones), tube building polychaetes and amphipods, while the less diverse offshore turbulent zone (3-5 m from the shore) is typified by deep burrowing polychaetes and crustaceans. Poor species diversity and abundance, as well as the presence of the cumacean *Cumopsis robusta* (a small crustacean), characterise the inner turbulent zone (0-1 m from the shore) of the surf zone. Fish such as galjoen and white steenbras frequent turbulent surf zone waters off the west coast where they swim over submerged beaches at high tide and feed on small crustaceans (Branch & Branch, 1981). Surf zone habitats, particularly medium to low energy beaches, are in fact widely recognised as important nursery areas for fish, and are even thought to rival that of estuaries in some areas (Clark, et al., 1996). The intertidal zone of sandy beaches along the coast of the Benguela system can be divided into three zones; the zone of saturation (or the sublittoral fringe), the midshore and the upper drift line (or supralittoral zone). The sublittoral fringe is typified by mysids (*Gastrosaccus* spp.) and scavenging gastropods (*Bullia* spp.), while the midshore region is characterised by isopods (*Eurydice longicornis* and *Pontogeloides latipes*) and a polychaete (*Scolelepis squamata*). The upper drift line is typified by air-breathing amphipods (*Talorchestia*) and giant isopods (*Tylos* spp.), as well as a rich diversity of insects (mostly Coleoptera and Diptera) where large quantities of kelp have been deposited on the drift line.

Sandy beaches are important for the filtering and decomposition of organic matter in sea water. As water percolates down through the sand the organic particles are trapped and decomposed by bacteria, which in turn release nitrates and phosphates that are returned to the sea. Continual flow of water through the sand maintains oxygen levels and aids bacterial decomposition, and thus sandy beaches act as water purifiers (Branch & Branch, 1981).

2.3.2 Sandy benthic habitat

The primary food source in near-shore sediments is plankton and detritus, brought in by currents from rocky shores and reefs, and other more productive coastal communities. Faeces, dead individuals and debris from plankton and nekton in the water column as well as detritus, generated by the bottom dwellers themselves as they die, is also present. Bacteria play a major role in decomposition and are an important source of protein on soft-bottom habitats.

Fauna and flora that inhabit the surfaces of subtidal sand are called benthic epifauna, while those that burrow or dig into the soft sediments are called benthic infauna. Soft-bottom subtidal communities are dominated by benthic infauna, with some epifauna present, however sessile or attached forms are virtually absent as there is nothing to attach to (Castro & Huber, 1997). The distribution of infauna and the depth at which organisms can live in the substrate is largely dependent on sediment particle size. More porous, larger grained substrates allow greater water circulation through the sediment thereby replenishing the oxygen which is used up during decomposition processes.

Much of the benthic infauna are deposit feeders which either ingest sediments and extract organic matter trapped between the grains or actively collect organic matter and detritus (Castro & Huber, 1997). Many species of polychaetes and worms are deposit feeders. Peanut worms (Sipunculida) gather detritus using tentacles at the mouth of an elongate, tubular anterior process that can be squeezed out by muscular contraction and then retracted (Branch, et al., 2010).

Suspension feeders eat drifting detritus and plankton from the water column (Castro & Huber, 1997). Some suspension feeders are filter feeders which actively pump and filter water to obtain suspended particles. These include clams as well as species of amphipods and polychaetes. Other suspension feeders lift arms, tubes, branches or polyps vertically into the water column to catch suspended particles.

Predators in soft bottom habitats may burrow through sediments to get to their prey or catch it on the surface (Castro & Huber, 1997). Predators such as crabs, hermit crabs, lobsters and octopuses, which inhabit rocky areas, may move to sandy benthos to feed (Castro & Huber, 1997). Most bottom-dwelling fish in soft bottom habitats are predators. Rays and skates scoop up clams, crabs and other infauna and epifauna, while flat fishes, such as flounders and soles, lie camouflaged or covered on the bottom and forage for a wide variety of prey.

2.3.3 Rocky reefs and kelp forests

Temperate rocky reefs are found below the low water mark (i.e. are always completely submerged) and are known to support diverse assemblages of life. Disturbance from wave action and sedimentation result in a high turnover of competitors in these habitats. Many large predators such as fish and sharks are attracted to rocky reefs, and thus form an important component of these ecosystems (Barros, et al., 2001). Rocky reef communities also influence the abundance and distribution of benthic macrofauna in adjacent soft bottom habitats, and it has been found that more benthic species occur close to rocky reefs (Barros, et al., 2001). Thus many reef-associated fish and crustaceans not only forage directly on the reef but also on the adjacent sandy bottom areas.

The following generic description of subtidal, west coast rocky reef is largely based on information provided by Branch *et al*. (2010) and Meyer & Clark (1999). Rocky reefs provide substratum to which kelp (*Ecklonia and Laminaria*) can attach, and these large kelp forests provide food and shelter for many organisms. Light is the limiting factor for plant growth, and thus kelp beds only extend down to approximately 10 m depth. Many other algal species live underneath the floating canopy of kelp, especially inshore where the light is abundant and the water shallow. A sub-canopy of *Lamanaria* grows beneath the *Ecklonia* in deeper waters (Figure 2.5), and dense communities of mussels, sea urchins, and rock lobster live between the *Lamanaria*. Growing epiphytically on these kelps are the algae *Carradoria virgata*, *Suhria vittata* and *Carpoblepharis flaccida*. Representative under-storey algae include *Botyrocarpa prolifera*, *Neuroglossum binderianum*, *Botryoglossum platycarpum*, *Hymena venosa* and *Epymenia obtusa*, various coralline algae. The dominant grazer is the sea urchin *Parechinus angulosus*, with lesser grazing pressure from limpets, the isopod *Paridotea reticulata* and the amphipod *Ampithoe humeralis* (Meyer & Clark, 1999). Herbivores occurring in the kelp forests include the kelp limpet *Patella compressa* which lives on the stipes of the kelp (Branch & Branch, 1981). West coast rock lobster *Jasus lalandi* and octopus *Octopus vulgaris* are two of the most important carnivores that occur within kelp forests in the Brand-se-Baai area. Other kelp forest predators include the starfish *Henricia ornata*, various feather and brittle stars (Crinoidea & Ophiuroidea), and whelks *Nucella* and *Burnupena* spp. Fish species likely to be found in these kelp beds include hottentot *Pachymetopon blochii,* two-tone fingerfin *Chirodactylus brachydactylus*, red fingers *Cheilodactylus fasciatus*, galjoen *Dichistius capensis,* milk fish *Parascorpis typus*, rock suckers *Chorisochismus dentex* and the catshark *Haploblepharus pictus*(Figure 2.5) (Branch *et al*. 2010).

Figure 2.5. Left – *E. maxima* kelp forest with *L. pallida* sub-canopy and Hottentot (*Pachymetopon blochii*). Right – sandy anemones (*Bunodactis reynaudii*), a typical west coast shallow reef species.

Kelp washed ashore forms an important food source for scavengers and provides shelter for numerous isopods (sea lice), which are in turn preyed upon by birds (Figure 2.6). Filter feeders such as mussels, red bait and sea cucumbers comprise 70-90% of the faunal community on rocky shores and their principal food source is kelp (Branch *et al*. 2010). Kelp thus forms an integral part of the rocky shore and sandy beach ecosystems. Kelp also produces large quantities of mucus, which encourages bacterial growth upon which protozoa feed.

Figure 2.6 Horned isopods, *Deto echinata*, feeding on drift cast kelp Ecklonia *maxima* (Clark & BM, 2016)

2.3.4 Rocky shore

Rocky shores can be divided into distinct bands according to the amount of time each is exposed to the air, which in turn influences the organisms that inhabit each section of the shore. Species that are more tolerant to desiccation (drying out) are found near the high-water mark, while those that cannot tolerate long periods of water recession are found near the low-water mark. There are five distinct zones that are typically found on rocky shores. These zones (moving in a landward direction) are named the Infratidal zone, the Cochlear zone, the Lower Balanoid zone, the Upper Balanoid zone and the Littorina zone. The upgrades under consideration in this report are located in the Littorina zone.

A further influencing factor on the distribution of organisms on the rocky shore is the degree of exposure to wave action, with significant differences noted between sheltered and exposed areas (Bustamante *et al*. 1997).

The Infratidal zone is inhabited by species which cannot withstand long periods of exposure and includes thick algal beds of kelp, *Gigartina, Champia lumbricalis* and articulated corallines interspersed with sea urchins (*Parechinus*) and the invasive black mussel, *Mytilis galloprovincialis*. The large limpets, *Scutellastra argenvillei* and *Cymbula granatina*, form dense stands which extend up into the cochlear zone effectively replacing *S. cochlear* which are somewhat rare in the region. *Octopus vulgaris*, and various species of fish, known as “klipvis” in South Africa, are found in subtidal rock pools where they prey upon bivalves and other invertebrates.

Above the Cochlear zone is the Lower Balanoid, where the limpet *S. granularis*, winkles (*Oxystele tigrina* and *O. variegata*) and whelks (*Burnupena spp.*) are found. The black mussel, *M. galloprovincialis*, also extends into this zone and competes for space with *Gunnarea gaimardi*, the Cape reef worm. Little seaweed occurs within this zone, however some sea lettuce (*Ulva*) is present and there are scattered patches of the encrusting brown alga, *Ralfsia verrucosa*. The upper Balanoid zone is dominated by animals, in particular limpets and barnacles. The harshest of all is the Littorina zone, which is dominated by the snail *Afrolittorina knysnaensis* and the flat-bladed alga *Porphyra capensis* (Branch & Branch, 1981; Barros, et al., 2001).

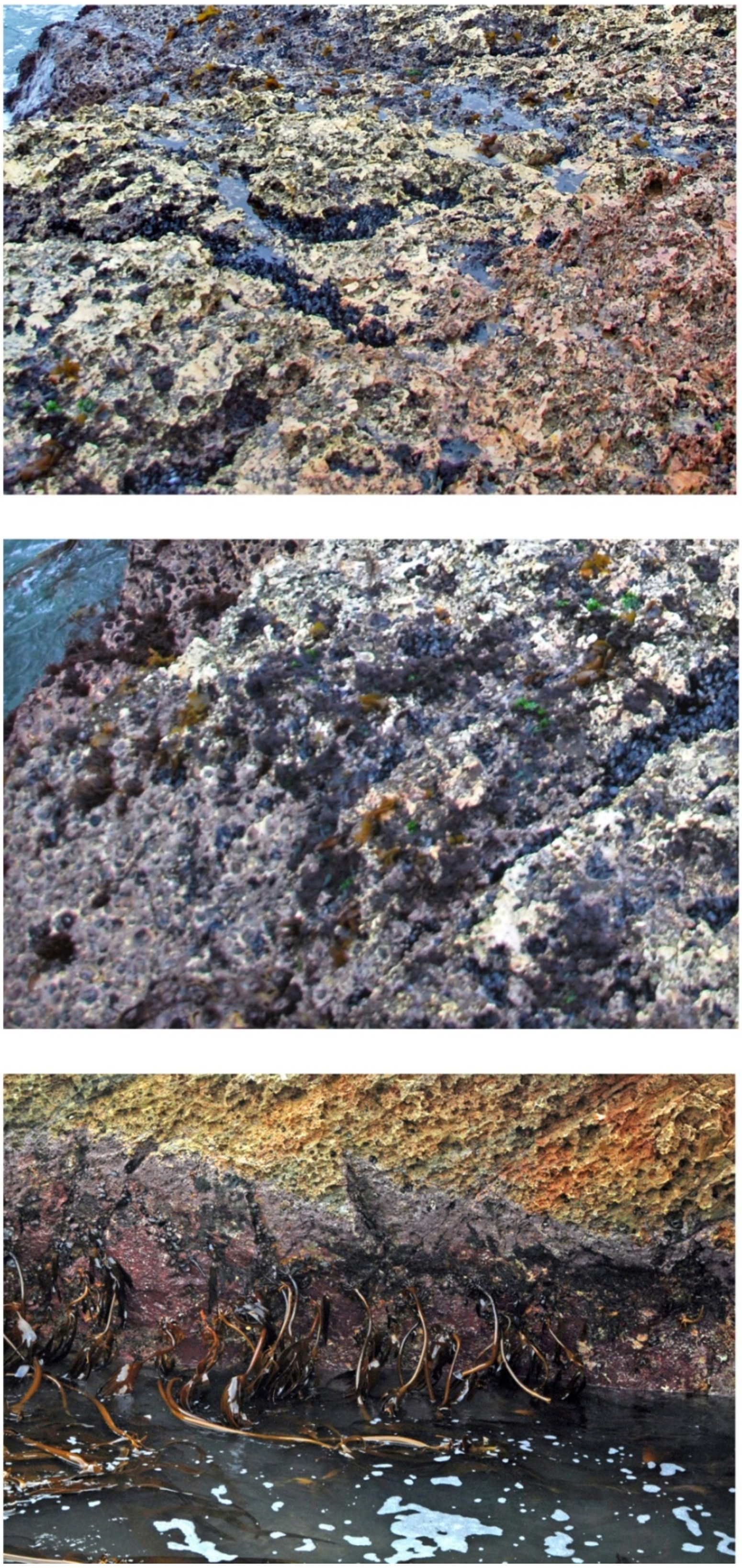
The diversity of intertidal macroalgal species is relatively low in the region (Bustamnante, et al., 1997). Filter feeders such as mussels and the Cape reef worm comprise ~70% of the faunal community on rocky shores and their principal food source is kelp particulates together with various microorganisms, kelp spores, phytoplankton and other fragments of organic matter (duToit & Attwood, 2008).

A site visit in 2014 noted that the intertidal rocky shore community structure and species composition agrees well with previous findings by Bustamante *et al.* (1997) (Biccard & Clark, 2014). A large proportion of the biomass present on the low shore was contributed by the kelps *E. maxima* and *L. pallida* and the limpet *C. granatina* (Figure 2.7) (Biccard & Clark, 2014). Large colonies of the polychaete *G. gaimardi* and the alien invasive European black mussel, *M. galloprovincialis*, were also present low down on the shore and extended up into the mid-shore zones (Biccard & Clark, 2014). High on the shore *P. capensis* formed dense patches. *B. reynaudii* and *Burnupena spp.* were most frequently encountered in the crevices and gullies (Biccard & Clark, 2014) The species most frequently encountered throughout all the zones was *S. granularis* (Biccard & Clark, 2014). All the taxa recorded in the intertidal zone on the rocky shore are ubiquitous throughout the Namaqua Inshore Ecozone and are not restricted to this particular area (Biccard & Clark 2014, Branch *et al*. 2010). None of the intertidal rocky shore species observed are considered to be rare or endangered (Biccard & Clark, 2014).

Photographs of common intertidal macrofauna and algae recorded on the shore in the vicinity of Brand-se-Baai during the site visit are included in Figure 2.8 and Figure 2.9.

Two intertidal bird species were recorded at Brand-se-Baai – the kelp gull, *Larus dominicanu* and the African Black Oystercatcher, *Haematopus moquini* (Figure 2.10). Of these two species, the African Black Oystercatcher can be highlighted as an important species in terms of its conservation status. It is endemic to southern Africa and is listed as near threatened on the IUCN Red list (Birdlife International 2011). Their range extends from the coastal areas of Namibia to the Wild Coast (Branch, et al., 2010). This species forages exclusively in the intertidal zone and they can be found on both rocky and sandy shores throughout the year (BirdLifeInternational, 2011). Breeding occurs from September to April, with a peak from November to February. The favoured breeding habitats are offshore islands and sandy beaches; however they do occasionally breed on mainland rocky shores (BirdLifeInternational, 2011). Oystercatcher nests are simple scrapes in the sand where possible, but on rocky substrata shells are built up to form a lip or eggs are laid on bare rock. The birds build their nests just above the high water mark (usually within 30 m) and sometimes even below it. Besides being susceptible to high storm or spring tides the nests are situated in the path of vehicles travelling on or just above the HWM (Branch *et al*. 2010). Many breeding pairs are known to occur on this stretch of coastline (Biccard & Clark, 2014), which would suggest that it is an important stronghold for this species.

Species **Shore level**



High

Mytilus galloprovincialis
Porphyra capensis
Ulva sp.
Affrolittorina knynaensis
Oxystele variegata
Scutellastra granularis

Mid

Mytilus galloprovincialis
Cymbula granatina
Scullastra granularis
Burnupena sp.
Champia lumbricalis
Pachymenia orbitosa
Mazaella capensis
Encrusting coralline
Porphyra capensis
Ulva sp.
Oxystele variegata

Low

Mytilus galloprovincialis
Scutellastra cochlear
Scutellastra granularis
Cymbula granatina
Burnupena sp.
Oxystele variegata
Hymeniacidon perleve
Bunodactis reynaudii
Gunnarea gaimardi
Ecklonia maxima
Laminaria pallida
Cladophora spp.
Encursting coralline
Ralfsia sp.
Champia lumbricalis
Ulva sp. & Red turf

Figure 2.7 **Photographic survey results for high, mid and low shore – showing species diversity within each intertidal zone. The photographs shown are a representative of one of the five replicates which were taken. Note the increase in species diversity from the high-shore zone to the low-shore zone (Clark & BM, 2016)**

Figure 2.8 Common intertidal animals on the shore at Brand-se-Baai (Clark & BM, 2016).

Figure 2.9 Common species of intertidal seaweed collected during the site visit (Clark & BM, 2016).

Figure 2.10 Birdlife observed at Brand-se-Baai. Left: kelp gull, *Larus dominicanus*. Right: breeding pair of oystercatchers, *Haematopus moquini* (near-threatened conservation status). Note the beds of the alien invasive black mussel, *Mytilus galloprovincialis* in the foreground (Clark & BM, 2016).

During the site visit (Clark & BM, 2016), an existing impact on the marine environment from the operation of the Brand-se-Baai gully seawater intake facility was observed (Figure 2.11). Nutrients from decomposing seaweed, which accumulates next to the pump station whilst operating (A), had resulted in eutrophication of the outfall stream – evident from the green algal bloom photographed at this site (B and C).

It has been shown that enhanced nutrient supply can stimulate macroalgal blooms in disturbed environments despite the normally strong top-down control by intertidal grazers (Masterson, et al., 2008). This is precisely what has occurred here at Brand-se-Baai, and Clark (2016) recommended that every effort should be made to restore the balance of the intertidal ecosystem from an artificially changed bottom-up control (by nutrient supply) back to a top-down control by the intertidal grazers.

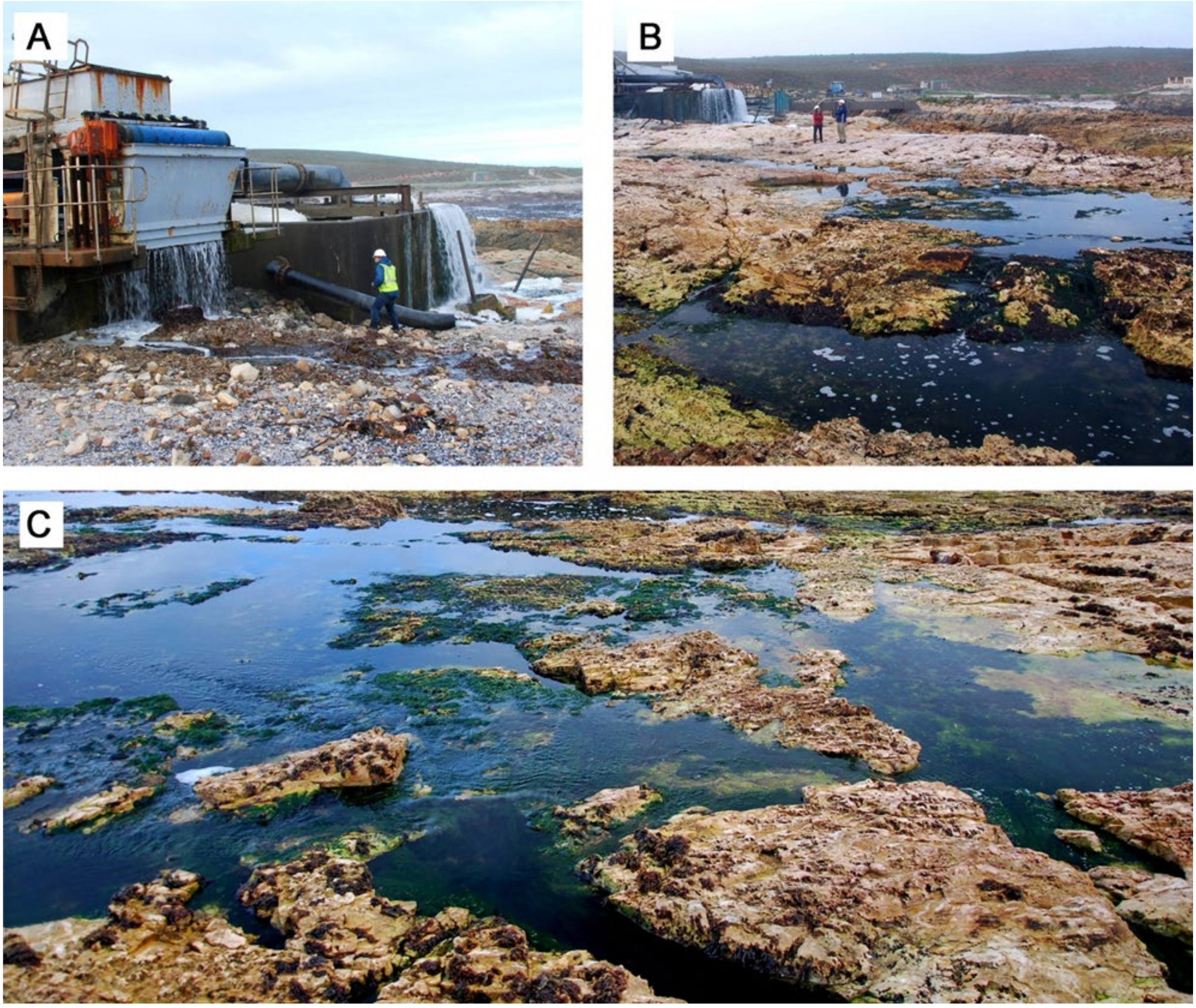


Figure 2.11 **A – accumulation of decomposing seaweed material next to pump station outfall. B – Outfall stream running back towards the sea over intertidal rock platform, carrying nutrients from decomposing algae. C –eutrophication in the form of an algal bloom in outfall stream on intertidal rock platform (Clark & BM, 2016).**

3 IMPACT ASSESSMENT

In the marine environment a disturbance can be relatively short-lived (e.g. accidental spill which is diluted in the water column below threshold limits within hours) but the effect of such a disturbance may have a much longer lifetime (e.g. attachment of pollutants to sediment which may be disturbed frequently). The assessment and rating procedure set by SRK and outlined in Appendix 1 addresses the effects and consequences (i.e. the impact) on the environment rather than the cause or initial disturbance alone. To reduce negative impacts, precautions referred to as 'mitigation measures' are set, and attainable mitigation actions are recommended. In this report, the 'construction footprint' is defined as the total area of new infrastructure as determined by design engineers.

In assessing potential impacts on the marine biota in the vicinity of proposed construction and maintenance operations, consideration was given to the fact that the proposed development is an expansion of existing infrastructure i.e. the area is already subject to some level of anthropogenic disturbance. Each of the identified impacts is likely to affect the associated biota in different ways and at varying intensities depending on the nature of the affected habitat and the sensitivity of the biota. Results of each assessment are presented in Table 3-1 to Table 3-3 and are summarised in Table 3-4.

All potential impacts of the proposed expansion of sea water intake, including new de-aeration sump and high-lift pump foundation were assessed as part of this study. Construction phase impacts are expected to be localised and of temporary duration, while operating phase impacts are of a longer duration.

3.1 Construction Phase

Currently seawater is abstracted at the seawater intake and pumped to the seawater dam located at the Secondary Concentration Plant (SCP). This dam supplies seawater to reservoirs servicing the processing plants. Although Tronox is authorised in terms of NEMA to upgrade seawater intake infrastructure and increase the seawater abstraction volume to 57.6 Ml/day for the East OFS project the existing intake does not have the capacity to supply the upgraded PCP East with enough water, and therefore further upgrades are proposed as part of this application, including a new de-sanding sump with a footprint of ~40 m^2 and a new foundation for high-lift pumps with a footprint of ~40 m^2.

As such, construction phase impacts are likely to include:

- Direct losses of Littorina habitat in the development footprint;
- Waste generation and disposal during construction; and
- Impacts of impaired water quality on marine systems as it relates to the sump and foundation only.

3.1.1 Direct losses of Littorina habitat in the development footprint

The proposed expansion of the intake water infrastructure includes the loss of ~40 m^2 of habitat each for the new de-sanding sump and the new foundation for high-lift pumps (Section 1.3, see Figure 1.3). The proposed area of expansion appears to be within the Littorina (splash zone) directly adjacent to existing seawater intake and on habitat that is already disturbed (Figure 1.3). Given the natural low diversity an biomass of the Littorina zone on the West Coast, and as there does not appear to be any developed sessile Littorina marine communities in the proposed footprint, the significance of this impact is rated as 'insignificant' (Table 3-1). However, best practise mitigation should still be applied. This includes limiting both the spatial extent of the construction footprint and time spent in the area (Table 3-1).

Table 3-1 **Impact 1: Direct losses of intertidal and infratidal habitat in development footprint.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short term 1	Very Low 3	Possible	**INSIGNIFICANT**	-ve	High

Best practise mitigation:

- Minimise the duration of operations in the area.
- Minimise the spatial extent of the developmental footprint as much as possible.

3.1.2 Waste generation and disposal

During the construction and initiation phase of the new pumps and other infrastructure, offcuts and fragments of piping and other materials used or bought to site during construction, may enter the sea. The problem of litter entering the marine environment has escalated dramatically in recent decades, with an ever-increasing proportion of litter consisting of non-biodegradable plastic materials. South Africa has laws against littering, both on land and in the coastal zone, but these laws are seldom rigorously enforced. Objects which are particularly detrimental to aquatic fauna include plastic bags and bottles, pieces of rope and small plastic particles. Large numbers of aquatic organisms are killed or injured daily by becoming entangled in debris or as a result of the ingestion of small plastic particles (Wright, et al., 2013). These materials, being largely plastics, may be transported by currents for long distances out to sea or around the coast. Thus, unlike fuel or sewage contamination, the extent of the damage is in theory limitless. The impact on certain forms of marine life by floating or submerged solid materials can hardly be overstressed. Most at risk are seabirds and fish, including possibly rare or even endangered species.

In order to reduce this, all domestic and general waste generated must be disposed of responsibly. All reasonable measures must be implemented to ensure there is no littering and that construction waste is adequately managed. Staff must be regularly reminded about the detrimental impacts of pollution on aquatic species and suitable handling and disposal protocols must be clearly explained and sign boarded. The 'reduce, reuse, recycle' policy must be implemented. This impact is rated as 'medium' without mitigation and is reduced to 'low' by implementing the actions outlined in Table 3-2.

Table 3-2 **Impact 3: Waste generation and disposal during construction.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	International 3	Low 1	Long term 3	High 7	Possible	**MEDIUM**	-ve	High
Essential mitigation: • Inform & empower all staff about sensitive marine species & suitable disposal of construction waste. • Suitable handling and disposal protocols must be clearly explained, and sign boarded. • Reduce, reuse, recycle.								
With mitigation	International 3	Low 1	Medium term 2	Medium 6	Improbable	**LOW**	-ve	High

3.1.3 Impaired water quality impacts to marine systems

In the event of exposure of cement directly into the marine environment, any chemical pollution is expected to be readily dispersed and as such, impacts are expected to be of extremely short duration and hence 'very low' significance to the marine biota in the area (Table 3-3).

Construction activities will involve the use of heavy vehicles and machinery in the coastal zone and there is also a potential for hydrocarbon spills. Suitable management mechanisms must be implemented to mitigate this risk and contingency plans in the event of accidental spills must be prepared. This should include measures required to ensure that no storm water from the site be allowed to enter the sea.

Further mitigation includes that all fuel and oil is to be stored with adequate spill protection and no leaking vehicles are to be permitted on site. Contingency plans in the event of an accident must be prepared. The mitigation measures render the significance of this impact as 'insignificant' (Table 3-3).

Table 3-3 Impact 4: Impaired water quality impacts to marine systems.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Short-term 1	Very Low 4	Probable	**VERY LOW**	– ve	High
Essential mitigation: • All fuel and oil is to be stored with spill protection, no leaking vehicles permitted on site, spillages to be cleaned up as quickly as possible.								
With mitigation	Local 1	Low 1	Short-term 1	Very Low 3	Possible	**INSIGNIFICANT**	– ve	High

3.2 Operation Phase

Operational phase impacts for this project have already been assessed in Biccard & Clark (2014) and Clark (2016), and are therefore not repeated here.

3.3 Decommissioning Phase

No decommissioning procedures or restoration plans have been compiled at this stage, although impacts are expected to be similar (if not less) to those assessed during the construction phase. The potential impacts during the de-commissioning phase are expected to be minimal in comparison to those occurring during the operational phase, and no key issues related to the marine environment have been identified at this stage. The same mitigation procedures as those explained in the construction phase should be adhered to in the decommissioning phase in order to mitigate for any of the impacts listed above.

3.4 Cumulative Impacts

Anthropogenic activities can result in numerous and complex effects on the natural environment. While many of these are direct and immediate, the environmental effects of individual activities or projects can interact with each other in time and space to cause incremental or aggregate effects. Impacts from unrelated activities may accumulate or interact to cause additional effects that may not be apparent when assessing the activities individually. Cumulative effects are defined as the total impact that a series of developments, either present, past or future, will have on the environment within a specific region over a particular period of time (DEAT IEM Guideline 7, Cumulative effects assessment 2004).

Cumulative marine environmental impacts emanating from the proposed project are primarily related to intake infrastructure upgrades, maintenance and repair — associated impacts will occur over the lifespan of the development, but will only be relevant during sporadic upgrades and infrequent periods of maintenance. Therefore, cumulative marine ecology impacts are likely to be of 'low' significance, provided that the specified mitigation measures are implemented during upgrades and maintenance.

3.5 No-go alternative

The No-Go alternative (i.e. no expansion of the seawater intake) is considered here in accordance with the requirements of the EIA Regulations, 2014.

Tronox utilises water from two sources, namely freshwater from Koekenaap and saline water from the seawater intake located on the coast. As such, the expansion of the seawater intake infrastructure is crucial to the Tronox operations. Tronox is already authorised in terms of NEMA to upgrade seawater intake infrastructure and increase the seawater abstraction volume to 57.6 Ml/day — this assessment is for further intake infrastructure upgrades necessary to allow this full 57.6 Ml/day to be utilised.

No impacts on the marine environment are anticipated as a result of no-go alternative. However, should the application be refused, the efficiency of the East OFS project will be reduced.

3.6 Summary of potential impacts

The impacts that may be experienced during construction and operation before and after mitigation are summarised in Table 3-4. A total of three impacts were identified and, after mitigation, none of the identified impacts were assessed as being above 'low' significance.

Table 3-4 Summary of potential impacts as a result of construction and operation of the proposed facilities.

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Construction	Impact 1: Direct losses of Littorina habitat in development footprint.	Low	Definite	**INSIGNIFICANT**	-ve	High
	Impact 2: Waste generation and disposal during construction.	High	Possible	**MEDIUM**	-ve	High
	With mitigation	Medium	Improbable	**LOW**	-ve	High
	Impact 3: Impaired water quality impacts to marine systems.	Very Low	Probable	**VERY LOW**	– ve	High
	With mitigation	Very Low	Possible	**INSIGNIFICANT**	– ve	High

4 CONCLUSIONS AND RECOMMENDATIONS

The expansion of sea water intake for the Namakwa Sands mine at Brand-se-Baai will have minimal of impacts on the marine environment. Based on the results of the baseline study, it is apparent that the seawater intake site has benthic biota that is not of great significance in terms of conservation status. This would suggest that impacts of the construction and operation of the new sump and booster pump foundation would be fairly low at the Brand-se-Baai site.

A total of three potential environmental impacts were assessed for this report (see Table 3-4). Of these, one was rated 'insignificant and one was rated as 'very low' (rated 'insignificant' after mitigation). One impact was rated as 'medium', and implementation of mitigation measures is expected to reduce this rating to 'low' significance (Table 3-4). No impact was rated as 'high' (Table 3-4).

Cumulative marine environmental impacts emanating from the proposed project are primarily related to periodic intake infrastructure upgrades, maintenance and repair — this is an infrequent but ongoing impact considered to be of 'low' significance, provided that the specified mitigation measures are implemented.

Based on this, it is recommended that the proposed development proceed with the implementation of strict environmentally responsible practices as outlined in the mitigation measures below.

Mitigation

Proposed mitigation measures for impacts are well known and have been effectively applied in similar circumstances. If followed, the overall effect of the perceived impacts will be significantly reduced and will be of low to very low significance. Recommendations to mitigate impacts associated with the proposed expansion of the Namakwa Sands seawater intake infrastructure at Brand-se-Baai are listed below:

- Minimise the spatial extent of the developmental footprint as much as possible.
- Minimise the duration of construction as far as possible.
- Inform & empower all staff about sensitive marine species & suitable disposal of construction waste.
- Suitable handling and disposal protocols must be clearly explained, and sign boarded.
- Reduce, reuse, recycle.
- All fuel and oil is to be stored with spill protection, no leaking vehicles permitted on site, spillages to be cleaned up as quickly as possible.

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6 APPENDIX 1

Impact Assessment Methodology

The significance of all potential impacts that would result from the proposed project is determined in order to assist decision-makers. The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. The significance of each identified impact was thus rated according to the methodology set out below:

Step 1 – Determine the consequence rating for the impact by determining the score for each of the three criteria (A-C) listed below and then adding them. The rationale for assigning a specific rating, and comments on the degree to which the impact may cause irreplaceable loss of resources and be irreversible, must be included in the narrative accompanying the impact rating:

Rating	Definition of Rating	Score
A. ***Extent – the area over which the impact will be experienced.***		
Local	Confined to project or study area or part thereof (e.g. limits of the concession area)	1
Regional	The region (e.g. the whole of Namaqualand coast)	2
(Inter) national	Significantly beyond Saldanha Bay and adjacent land areas	3
B. ***Intensity – the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources.***		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. ***Duration – the time frame for which the impact will be experienced and its reversibility.***		
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years (state whether impact is irreversible)	3

The combined score of these three criteria corresponds to a Consequence Rating, as follows:

Combined Score (A+B+C)	3 – 4	5	6	7	8 – 9
Consequence Rating	Very low	Low	Medium	High	Very high

Example 1:

Extent	Intensity	Duration	Consequence
Regional	Medium	Long-term	High
2	2	3	7

Step 2 – Assess the probability of the impact occurring according to the following definitions:

Probability – the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

Example 2:

Extent	**Intensity**	**Duration**	**Consequence**	**Probability**
Regional 2	Medium 2	Long-term 3	High 7	Probable

Step 3 – Determine the overall significance of the impact as a combination of the consequence and probability ratings, as set out below:

		Probability			
		Improbable	Possible	Probable	Definite
Consequence	Very Low	**INSIGNIFICANT**	**INSIGNIFICANT**	**VERY LOW**	**VERY LOW**
	Low	**VERY LOW**	**VERY LOW**	**LOW**	**LOW**
	Medium	**LOW**	**LOW**	**MEDIUM**	**MEDIUM**
	High	**MEDIUM**	**MEDIUM**	**HIGH**	**HIGH**
	Very High	**HIGH**	**HIGH**	**VERY HIGH**	**VERY HIGH**

Example 3:

Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH

Step 4 – Note the status of the impact (i.e. will the effect of the impact be negative or positive?)

Example 4:

Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	– ve

Step 5 – State the level of confidence in the assessment of the impact (high, medium or low).

Impacts are also considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in the table below. Depending on the data available, a higher level of confidence may be attached to the assessment of some impacts than others. For example, if the assessment is based on extrapolated data, this may reduce the confidence level to low, noting that further ground-truthing is required to improve this.

Confidence rating	
Status of impact	+ ve (beneficial) or – ve (cost)
Confidence of assessment	Low, Medium or High

Example 5:

Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	– ve	High

The significance rating of impacts is considered by decision-makers, as shown below. Note, this method does not apply to minor impacts which can be logically grouped into a single assessment.

1. INSIGNIFICANT: the potential impact is negligible and will not have an influence on the decision regarding the proposed activity.
2. VERY LOW: the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity.
3. LOW: the potential impact may not have any meaningful influence on the decision regarding the proposed activity.
4. MEDIUM: the potential impact should influence the decision regarding the proposed activity.
5. HIGH: the potential impact will affect a decision regarding the proposed activity.
6. VERY HIGH: The proposed activity should only be approved under special circumstances.

Step 6 – Identify and describe practical mitigation and optimisation measures that can be implemented effectively to reduce or enhance the significance of the impact. Mitigation and optimisation measures must be described as either:

1. Essential: must be implemented and are non-negotiable; and
2. Best Practice: must be shown to have been considered and sound reasons provided by the proponent if not implemented.

Essential mitigation and optimisation measures must be inserted into the completed impact assessment table. The impact should be re-assessed with mitigation, by following Steps 1-5 again to demonstrate how the extent, intensity, duration and/or probability change after implementation of the proposed mitigation measures.

Example 6:

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Regional **2**	Medium **2**	Long-term **3**	High **7**	Probable	HIGH	– ve	High
Essential mitigation measures: xxxxx xxxxx								
With mitigation	Local **1**	Low **1**	Long-term **3**	Low **5**	Improbable	VERY LOW	– ve	High

Step 7 – Prepare a summary table of all impact significance ratings as follows:

Impact	Consequence	Probability	Significance	Status	Confidence
Impact 1: XXXX	Medium	Improbable	LOW	–ve	High
With Mitigation	Low	Improbable	VERY LOW		High
Impact 2: XXXX	Very Low	Definite	VERY LOW	–ve	Medium
With Mitigation:	Not applicable				

Indicate whether the proposed development alternatives are environmentally suitable or unsuitable in terms of the respective impacts assessed by the relevant specialist and the environmentally preferred alternative.

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