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Review of the Environmental Impacts and Risks associated with Kelp Farming in Saldanha Bay ADZ as detailed in the Pre-Feasibility Plan



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Executive Summary

BSASA is involved in the development of aquaculture in South Africa. As part of an ongoing investigation into the commercial feasibility of farming kelp, they now wish to initiate experimental farms in the Saldanha Bay ADZ utilising un-used space in the West Coast Oyster Growers (WCOG) lease areas in Small and Big Bays respectively.

While the cultivation of *Gracilaria gracilis* was authorized in the Environmental Authorisation (EA) issued in 2018, the three species which now form the focus of BSASA investigations (*Macrocystis pyrifera*, *Laminaria pallida* & *Ecklonia maxima*) were not. Thus, a Change of Scope to the EA is required.

This desktop risk assessment was commissioned to:

- Determine whether there is sufficient information available on the cultivation of the three new species to apply for a Change of Scope without further specialist studies;
- Document Changes required to the existing Saldanha Bay ADZ EMPr to accommodate cultivation of the three new species; and,
- To assess whether the Change of Scope would require a Part 1 or 2 application.

Based on a literature search, 25 possible impacts were identified. Of these 13 had already been assessed in a generic sense in the Basic Assess Report of 2017. The remainder, with the use of international literature, had sufficient information available to permit a risk assessment of their cultivation in Saldanha Bay.

Recommendations for changes to the existing EMPr were made for each impact identified.

-ve, neutral, +ve		Probability		Severity	
uncertain	3	N/A	2	N/A	2
-ve	14	Low	16	Low	11
neutral	2	Medium	7	Medium	11
+ve	6	High	0	High	1
Total	25	Total	25	Total	25

Of the risks identified, none were assessed to have a high probability of occurrence and only one had a high severity of impact. This related to the potential entanglement of marine animals in the cultivation infrastructure.

The high severity results from the extreme negative response from public and conservation bodies to such events. It was not possible to determine whether the infrastructure to be used would pose such a risk since the final designs have yet to be formulated.

For this reason, it is recommended that final designs be approved by the AMC, marine specialists and the South African Whale Disentanglement Network prior to installation. A number of recommendations for designs to prevent entanglement and response in the unlikely event of an entanglement occurring are detailed.

Finally, it was noted that none of the impacts identified constituted a change to the environmental outcomes of the EA. While a change of scope is required, the exact mechanism of application will need to be determined by the DFFE case officer.

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1. Introduction

The Bivalve Shellfish Association of South Africa (BSASA) seeks to assess the environmental risks and/or benefits associated with the commercial farming of kelp within the Saldanha Bay Aquaculture Development Zone (ADZ) and identify any additional mitigations which would need to be included in the existing ADZ Environmental Management Program (EMPr) and the Environmental Authorisation (EA).

This document, details investigations into the potential impacts and risks associated with such commercial farming specifically in Saldanha Bay Aquaculture Development Zone (ADZ) in which commercial aquaculture is currently taking place.

1.1 Background to the study

The now Department of Forestry, Fisheries and the Environment (DFFE) undertook an Environmental Impact Assessment (EIA) for the establishment of an Aquaculture Development Zone in Saldanha Bay in 2016/2017. Approval was granted on the 8th January 2018. Appeals against the authorisation were lodged to the then Minister of Environmental Affairs and the authorisation was upheld as per the letter dated 7th June 2018.

Aquaculture in the Saldanha ADZ has, since then focussed on mussels and oysters with a pilot study utilising finfish. To date, although this is authorised in the EA, no seaweed cultures have been initiated.

Members of BSASA have been involved in the farming of bivalves in the Saldanha Bay ADZ for a number of years. BSASA has been actively involved in monitoring the success of various farming and monitoring techniques employed in the ADZ, which has resulted in the specifications in the ADZ EMPr being refined and modified to become increasingly more focused on local conditions.

Initially, the basis for farming techniques and monitoring of the outcomes was detailed in the Basic Assessment (BA) compiled for the ADZ and the improvements to farming techniques and especially monitoring resulted from implementing those specifications and testing their efficacy. However, although the ADZ EA was approved for seaweed cultivation, approval was only given for *Gracilaria gracilis* and no other seaweed species were included.

Due to increased international interest in seaweed and kelp, BSASA is part of a broader team trialing the farming technology of kelp in order to supply kelp to various sectors, including the existing demand of the abalone sector.

In a proactive approach, BSASA is looking to inform technology development of farming of kelp, identify additional mitigation measures that may need to be included in the Saldanha Bay ADZ EMPr and potential amendment to the EA. As part of this initiative, a detailed pre-feasibility

study¹ was commissioned. The final pre-feasibility study report, issued in June 2022 (hereafter referred to as the pre-feasibility study) formed the basis for this assessment since it deals specifically with kelp farming in South.

The kelp farming initiative in the Saldanha Bay ADZ will initially comprise one or two small experimental farms inside the existing ADZ, utilising existing mussel infrastructure. The experimental farms will be used to determine infrastructure requirements as well as farming methods for full commercialisation at a later stage.

This Impact and Risk Assessment Report is intended to support the application for an amendment of the EA to include additional seaweed species in the existing EA, if so required, in the absence of details of the impacts of seaweed cultivation in the original BA. The focus will be on the commercialised farms and not the small-scale experimental farms.

Since the BA did not evaluate the potential impacts and suitable mitigation measures for the cultivation of kelp specifically in Saldanha Bay ADZ, the pre-feasibility study report was supplemented with international research and used as a basis for the completion of the scope of work as detailed in the section below.

1.2 Scope of Work

The appointed Service Provider will be expected to conduct a desktop science-based impact identification for the commercial farming of indigenous kelp species within the Saldanha Bay ADZ and identify any specific activities that have not been assessed in the broader EIA. The SP should:

- a. Describe the activity associated with kelp farming (primary production)
- b. Assess any positive or negative impacts that have not been assessed as part of the existing EIA associated with kelp farming
- c. Identify mitigation measures
- d. Identify the potential risks associated with the kelp farming within the existing ADZ to the marine ecosystem or environment , including but not limited to-
 - (i) degradation and fragmentation of a species' habitat.
 - (ii) ecosystem impact
 - (iii) benthic impacts
 - (iv) further far field impacts on surrounding environment
 - (v) positive or negative affect on the water chemistry in and around the growth areas
- e. evaluation of the risk identified under paragraph (d) in terms of:
 - (i) the likelihood of the risk being realised.
 - (ii) the severity of the risk and consequences of the realisation of the risk for the particular species as well as for other species, habitats and ecosystems;
 - (iii) options for minimising potential risks; and
 - (iv) management of potential risks.

¹ Final Report: - Pre-feasibility Study on the potential for commercial cultivation of African kelp along South Africa's West Coast - Funded through UK aid by the UK government - Revision 1.1 - 13 June 2022

The service provider is to provide mitigation measures to be included in the existing ADZ Environmental Management Programme (EMPr) for the commercial farming of indigenous kelp species within the sea-based ADZ and submit this to the relevant Competent Authority (CA) for consideration.

The impact identification findings and mitigation recommendations findings must be presented on a virtual platform to the Aquaculture Management Committee for the Saldanha Bay ADZ as well as the Consultative Forum.

1.3 Project Team

In order to fulfil the scope of work, we have assembled a team of three people;

- Mark Sasman- Ecosense ECO and Project Manager who has been involved in Saldanha Bay ADZ since its inception. He is intimately familiar with the mechanics of the ADZ as well as aquaculture in general for over 25 years. He managed the team involved in reviewing and updating the ADZ EMPr and the teams responsible that served as Environmental Control Officers to many of the ADZ sector Companies including Molapong & Viking. He has also been involved in applications toward Mossel Bay and Algoa Bay ADZ proposals. The Company Profile is appended.
- Errol Cerff and Wynand (Erik) Botha (associates of Ecosense) who have fulfilled the roles of ECO and Secretariat at the ADZ for a total of 2.5 years. They have extensive experience of the management of the ADZ as well as challenges and opportunities faced by individual farmers. Their input to providing practical mitigation measures will be augmented by their wide-ranging experience in risk assessment. Their CVs are attached.

Both Mark Sasman and Errol Cerff are registered as Professional Scientists with SACNASP.

1.4 Approach

The identification of risk and impacts commenced with a detailed review of the pre-feasibility study to extract information regarding the environmental impacts and risks of cultivation of kelp from that report which could shed light on potential impacts and possible mitigation measures to be implemented in the Saldanha Bay ADZ.

This was followed by a review of international literature on similar aquaculture establishments to provide a background for the risk assessment based on international experience and identify any additional risk and/or impacts which could be relevant to the kelp cultivation in Saldanha Bay.

Finally, a risk assessment was conducted on the effect of uncertainty on the objectives of the kelp cultivation and the ADZ as a whole - as per the ISO approach. This exercise was based on international literature and sought to address both positive (opportunities) and negative risks and formulated possible strategies for their mitigation, removal or transfer. The method of risk identification and assessment followed the requirements of ISO 31000 in keeping with international best practice.

SANS 31000 Series standards for risk assessments. ARP 070:2009 ISO Edition 2 (ISO Guide 73:2009 Edition 1) RISK MANAGEMENT – VOCABULARY define risk as "The effect of uncertainty on objectives" whereas risk management is "coordinated activities to direct and control and organization with regard to risk"

1.5 Assumptions and Limitations

This report is issued subject to the following assumptions and limitations:

1.5.1 Assumptions

- The pre-feasibility study report contains all relevant information on the proposed kelp cultivation in Saldanha Bay ADZ at hand at the time of writing. This, coupled with *ad hoc* email communications with the kelp cultivation project team at BSASA provided the information based on what is currently planned. The assessment of environmental impacts and risks was conducted using this information.
- It is further assumed that this is the complete set of information and that no additional information was withheld intentionally or in error from the Ecosense CC assessment team.

1.5.2 Limitations

- This desktop assessment was limited to environmental risks and impacts. No attempt was made to examine commercial, technical or socio-economic risks and impacts since this is beyond the scope of work defined in the terms of reference.
- This assessment also does not assess the economic motivation for kelp cultivation or its location in Saldanha Bay.
- This is a desktop assessment and limited by deadlines imposed in the scope of work. While every effort has been made to access as wide a range of credible scientific literature, this cannot be regarded as a definitive literature review. A list of documents used in the compilation of this report are to be found in Appendix 1.
- The assessment focusses on the feasibility of commercial kelp cultivation in Saldanha Bay. The feasibility project which will be guided by the pre-feasibility report is only one component of the assessment.
- Further, since this is a desktop assessment, and conclusions based on available international literature, some of the conclusions reached may require further investigation by specialists for them to be confirmed.

2. Brief description of the affected environment

The following is a précis of information contained in the report: Pulfrich, Dr. A (2017) Concept for a Proposed Sea-Based Aquaculture Development Zone in Saldanha Bay, South Africa – Marine

Ecology specialist Study. Any additional references cited in the text will not be repeated here. It is provided for context and is not intended to fulfil the requirements of a detailed description of the affected environment which has already received sufficient attention in the above report.

Saldanha Bay is the only natural harbour of significant size on the West Coast of South Africa and offers relative protection from the high energy coastline and is directly linked to the shallow, tidal Langebaan Lagoon. The Saldanha Bay-Langebaan system can be divided into Outer Bay, Saldanha Bay (comprising Big Bay and Small Bay) and Langebaan Lagoon. The system contains five offshore islands, namely Malgas, Jutten, Marcus, Meeuw and Schaapen Islands. The Saldanha Bay-Langebaan Lagoon system is marine, with its waters originating in the continental shelf waters of the adjacent Benguela upwelling system. Most of the commercial activities in Saldanha Bay are concentrated in or just outside of Small Bay, while Langebaan Lagoon remains largely pristine in terms of existing development and forms part of the West Coast National Park. Langebaan Lagoon is internationally recognised as a Ramsar site in terms of the Convention on Wetlands of International Importance, especially as waterfowl habitat.

There is a strong seasonality in the winds over Saldanha Bay, reflecting the changes in the synoptic weather patterns prevailing at different times during the year. During summer the winds are predominantly southerly with significant south-westerly and, to a lesser extent, south-easterly wind components. In autumn the winds are predominantly southerly with the development of a north-westerly wind component as the season progresses. The regular passage of cold fronts in winter results in predominantly north-westerly winds with the occurrence of significant south-westerly and south-easterly wind components. The spring wind regime is similar to the summer wind regime but with increased south-easterly wind components.

The winds along the West Coast have a significant diurnal component, with the wind speed typically reaching a maximum in the late afternoon. These diurnal changes in the winds impact significantly on the heat fluxes at the sea surface over a 24 hour period.

The wave conditions inside the bay are sheltered compared to those outside, since all energy reaching the bay has to pass through the relatively narrow channel between Marcus Island and Elandspunt. The median significant wave height measured in the entrance to the bay is 1.1 m, while the greatest occurrence of peak periods lies in the 10 to 12 second (s) range. The most frequent direction of wave approach outside the bay is from the southwest.

In addition to waves originating from offshore, small wind-waves (up to 1 m in height) can be generated by strong winds within Saldanha Bay. Measurements of long wave energy in Saldanha Bay indicate significant energy in the period range of 30 s to 200 s.

The tides along the West Coast, including Saldanha Bay, are semi-diurnal with an approximate 2 m tidal range during spring tides. The currents in the bay are predominantly wind- and tide-forced, the relative importance of the two processes changing with depth and location in the bay. In general, wind is the dominant physical forcing mechanism determining the surface layer current speed and direction in both Small and Big Bay. Wave-driven currents are expected to dominate in the surf-zone.

Although residual tidal flows occur in the bay, the greatest water exchange between Saldanha Bay and the shelf is due to synoptic weather events, which occur on time scales of 3 to 10 days. South-south-easterly wind events result in a general surface outflow and a subsurface inflow of cold bottom water, while north-westerly wind events typically lead to the inflow of surface waters in the northern region of the mouth of Saldanha.

During periods of slack winds, generally weak tidal currents dominate and are the sole mechanism for flushing the bay. The tidal currents are generally weak, however strong tidal flows are observed at the entrance to the lagoon, particularly during spring tides. During tidal exchange, it is estimated that approximately half of the lagoon water passes through the Lagoon entrance channels into Saldanha Bay and velocities of up to 1.0 m/s are observed in the two channels connecting Big Bay and Langebaan Lagoon.

The water column structure in Saldanha Bay is seasonal, varying from a strongly thermally stratified water column for most of the year (August to May) to well-mixed conditions during the mid-winter months (June to July). Strong stratification is maintained by atmospheric heat fluxes into the surface waters and the inflow of cold bottom waters from upwelling on the adjacent continental shelf. The local winds periodically mix the water column and break down the thermocline, thus interrupting the stratification until it builds up again. These processes control the thermocline dynamics and vertical mixing of the water column, which together with wind- and tidally-driven currents, ultimately determine the behaviour of biogeochemical parameters and pollutants within the bay.

The variability in the water column stratification is predominantly synoptic and responds strongly to wind-forcing, which has a periodicity of 6 to 10 days in this region. During the mid-winter months the water column within the bay is largely well-mixed, due to reduced heat fluxes into surface waters and the reduced upwelling over the adjacent continental shelf.

The natural seawater temperature fluctuations in Saldanha Bay are substantial and typically occur on four-time scales, namely diurnal, synoptic, seasonal and interannual.

Diurnal temperature changes are greatest in summer when the surface waters experience diurnal temperature changes of typically 0,5°C to 1°C, but up to 2°C on occasion. In winter the water column is largely unstratified, and the diurnal temperature fluctuations are substantially reduced at all depths.

Changes in the **synoptic weather events** lead to substantial variability in water column temperature within the bay and over the adjacent shelf region. In Small Bay, temperature throughout the water column may change during a synoptic cycle by as much as 6°C to 8°C in summer and 1°C to 2°C in winter. This is mostly due to changes in the vertical mixing of the water column due to local winds, although during the upwelling season advection of cold bottom waters into Small Bay also play a significant role. Under north-westerly wind conditions warmer surface waters flow into Saldanha Bay.

The **mean seasonal change** in sea surface temperature is about 6°C, the magnitude of which is highest in Langebaan Lagoon and much smaller near the more exposed mouth of Saldanha Bay.

The seasonal changes in water temperature of the deeper waters in the bay (approximately 2.5 °C) are substantially less than those observed in the surface waters.

The **interannual sea surface temperature variability** typically has a magnitude of between 1°C and 2°C. These longer period changes in temperature are most likely due to persistent changes in the local synoptic weather conditions. The temperature signals associated with such episodic events are, however, largely masked in the surface waters by seasonal temperature variations due to changes in atmospheric heat input and vertical mixing of the water column.

The fate and behaviour of dissolved oxygen (DO) and the factors affecting fluctuations in DO levels are of critical importance to marine organisms. The principal anthropogenic activity resulting in changes in DO concentrations in the marine environment is the addition of organic matter.

In the Saldanha Bay system, the water in Small Bay experiences regular oxygen deficits during the late summer and winter months, whilst Big Bay experiences less frequent and lower magnitude oxygen deficits. The oxygen deficit in Small Bay is largely attributed to reduced flushing rates (due to the causeway and ore jetty construction) and discharges of organic rich effluents from fish processing factories. Localised anoxia in Small Bay (e.g., under the mussel rafts and within the yacht basin) is caused by excessive organic inputs.

The water of Saldanha Bay is fairly turbid, the turbidity comprising both organic and inorganic particulates. During active upwelling the turbidity of bottom waters decreases, but under strong wind conditions both wind and wave action result in significant water column turbidity. Particularly in Big Bay, the light-coloured sediments result in significant discolouration of the waters. The waters of Langebaan Lagoon, in contrast, are typically very clear and of low turbidity.

The Saldanha Bay - Langebaan Lagoon system falls within the Namaqua biogeographic province that extends from Cape Point to Lüderitz within the southern Benguela upwelling region. The bay and the lagoon together form one of the few sheltered habitats along the South African West Coast, with graded changes in wave action and substratum. The shallow lagoon is fully marine with a strong tidal exchange, and comprises extensive intertidal sandflats and salt marshes.

The benthic biota of soft bottom substrates constitutes invertebrates that live on (epifauna), or burrow within (infauna), the sediments, and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm).

The structure and composition of benthic soft bottom communities is primarily a function of water depth and sediment grain size, but other factors such as current velocity, organic content, and food abundance also play a role. Changes in benthic community structure in Saldanha Bay as a result of anthropogenic impacts have been reported by numerous authors. In Small Bay there has been a shift from communities dominated by suspension-feeders to communities characterised by deposit-feeders. This shift in community composition has been attributed to changes in water circulation patterns in the Bay, as well as organic pollution from fish factories and mussel farming in Small Bay.

The most recent study on benthic macrofauna was commissioned by the Saldanha Bay Water Quality Forum Trust in 2015. It revealed that benthic macrofaunal communities over the period 1999-2015 have been relatively stable in most parts of the Bay and Lagoon. Further studies conducted by Anchor consulting in 2021 and 2022 have confirmed this finding.

Subtidal macrophyte beds are dominated by the seagrass *Zostera capensis* and the agarophyte alga species *Gracilaria gracilis*, which occurs in Small Bay and adjacent to Schaapen Island in the southern portion of Big Bay. The alga is also characteristic of the subtidal sandy sediments in the Langebaan Lagoon. It occurs on sandy substrates at 2 – 10 m depths, and may either be anchored or drifting. A significant decrease in the biomass of the latter has been reported Rothman et al.

Saldanha Bay is thought to be the introduction point for many marine alien species. The main vectors responsible for the introduction of non-native species are fouling of ship hulls or ballast water, and via aquaculture. At least 30 introduced marine species are known to occur in Saldanha Bay and/or Langebaan Lagoon. Many of these alien species are considered invasive, including the Mediterranean mussel *Mytilus galloprovincialis*, the recently detected acorn barnacle *Balanus glandula* and the Pacific South American mussel *Semimytilus algosus*. An additional 20 species in Saldanha Bay are currently regarded as cryptogenic (of unknown origin) but very likely introduced to Saldanha Bay.

The pelagic communities are typically divided into plankton (phytoplankton and zooplankton including ichthyoplankton) and fish, and their main predators, marine mammals (seals, dolphins and whales).

Saldanha Bay is protected from the high-energy coastline but remains a highly productive system owing to its link to the Benguela upwelling system. Due to the nutrient supply from this upwelling system, phytoplankton concentrations in Saldanha Bay can attain chlorophyll concentrations of 18 mg Chl a/m³, with a mean value of 8.62 mg Chl a/m³. Highest values typically occur during the upwelling season.

Harmful algal blooms (HABs) are a regular late summer feature in the southern Benguela region. The geographical scales of Saldanha Bay are considered unsuitable for in situ development of HABs. Blooms, however, can be advected into Saldanha Bay from the adjacent continental shelf waters, but their development and duration in the bay is restricted by the system of exchange that operates between the bay and the coastal upwelling system, in that there is a net export of surface waters from the bay.

In contrast, blooms of the brown tide organism, *Aureococcus anophagefferens*, have been recorded in Saldanha Bay but not on the adjacent continental shelf. The blooms were mainly limited to the reclamation (oyster) dam in 1997, but spread throughout the entire system, including Langebaan Lagoon, in 1998, and led to retarded growth rates in mussels and oysters.

Zooplankton species in Saldanha Bay are composed predominately of species similar to those of the adjacent continental shelf. The zooplankton species of Langebaan Lagoon, however, were

found to be distinctly different from that of Saldanha Bay, although elements of the Saldanha Bay communities did penetrate the lagoon to various extents.

The waters of the Saldanha Bay system support an abundant and diverse fish fauna with a total of 47 species being recorded. Considering information from all surveys undertaken to date, species diversity was greatest in Big Bay (33), followed by Small Bay (32) and the Lagoon (23). However, species richness is typically highest in Small Bay, having varied little over time. Overall, there is no indication of a trend in species richness over time in any of the three parts of the Bay.

The Saldanha Bay/Langebaan Lagoon complex is an important nursery area for several ecologically important fish species as its sheltered, nutrient rich and sun-warmed waters provide a refuge from the cold and highly energetic adjacent continental shelf. The surf zone and shallow subtidal area in Big Bay extending southwards from the base of the iron ore quay appears to be particularly important in this respect, supporting juvenile white stumpnose. Since 2007, however, there has been a consistent declining trend in juvenile white stumpnose abundance in the nursery surf-zone habitats, suggesting that the protection afforded by the Langebaan MPA may not be enough to sustain the fishery at the current high effort levels.

The Cape fur seal *Arctocephalus pusillus pusillus* no longer breeds on islands in Saldanha Bay but is a regular visitor in both the inner and outer bays during all months of the year. The nearest seal colonies are at Paternoster Rocks and Jacobs Reef at Cape Columbine.

Five whale species have been recorded within Saldanha Bay: Killer whale (*Orcinus orca*), Humpback whale (*Megapteran ovaeangliae*) and southern Right whales (*Balaena glacialis*), along with Minke (*Balaenoptera acutorostrata*) and Bryde's (*B. edeni*) whales in the outer bay between Malgas, Jutten and Marcus Islands.

Dusky dolphins (*Lagenorhynchus obscurus*) and Heaviside's dolphin (*Cephalorhynchus heavisidii*) have been observed along the seaward side of the Marcus Island causeway. Of these the Humpback and Southern whales have an IUCN Conservation Status of "least concern", Bryde's and Minke whales are "data deficient", as are the toothed whales (Killer whale, Dusky and Heaviside's dolphins) that have been reported from the bay.

The most abundant migratory baleen whale species around southern Africa are southern right and humpback whales. In the last decade both species have been increasingly observed to remain on the West Coast well after the 'traditional' South African whale season (June – November) to feed in the upwelling zones off Saldanha and St Helena Bays during spring and early summer (October – February). Both species can be encountered close inshore as they favour sheltered bays as calving areas, but occurrence within the bay is likely to be infrequent.

Saldanha Bay and the associated islands provide important shelter, feeding and breeding habitat for at least 53 species of seabirds, 11 of which are known to breed on the islands. The islands of Malgas, Marcus, Jutten, Schaapen and Vondeling support breeding populations of African Penguin, Cape Gannet, four species of marine cormorants, Kelp and Hartlaub's Gulls, and Swift Terns. The islands also support important populations of the rare and endemic African Black Oystercatcher.

Langebaan Lagoon provides an important habitat for 67 species of waterbirds, of which half are waders. The lagoon has been identified as the most important wetland for waders on the west coast of southern Africa, with 17 of the wader species being regular migrants from the Palearctic region of Eurasia. Waterbird abundance is thus highest in summer and decreases in winter. Since 1980, there has been a decline in the numbers of waders, which has been attributed to the siltation of the lagoon reducing the amount of suitable feeding grounds and increasing levels of human disturbance.

Langebaan Lagoon was designated as a Ramsar site in April 1988 under the Convention on Wetlands of International Importance especially as Waterfowl Habitat. The Ramsar site includes the islands Schaapen (29 ha), Marcus (17 ha), Malgas (18 ha) and Jutten (43 ha), the Langebaan Lagoon, and a section of Atlantic coastline. The Langebaan Lagoon is also included within the boundaries of the West Coast National Park, which was established in 1985.

The Transnet National Ports Authority (TNPA) set aside a total of 395 ha of sea area within Saldanha Bay for aquaculture activities, of which 200 ha are situated in Big Bay, 130 ha are located in Small Bay and a further 65 ha lie adjacent to the breakwater and Small Craft Harbour.

The alien Mediterranean mussel *Mytilus galloprovincialis* and the indigenous black mussel *Choromytilus meridionalis* are cultured on dropper ropes, clustered 60 cm apart and suspended from rafts to a depth of 6 m. Settlement of larvae onto the ropes occurs naturally from the water column. Mussels are harvested, washed, and graded on board a boat, and juvenile mussels are hung back onto the ropes and held in place by cotton mesh 'socks' until attachment.

The agarophyte *Gracilaria gracilis* was previously harvested commercially in Saldanha Bay by Taurus Saldanha Seaweed (Pty) Ltd and trialed for aquaculture by West Coast Seaweeds (Pty) Ltd. Experimental cultivation of *Gracilaria gracilis* in Small Bay using suspended 'rafts' of rope and netting lines has proven to be technically and economically feasible. However, the surface water in the bay has been known to become warm and oligotrophic, leading to poor growth or death of *Gracilaria* grown in these experimental suspended systems, and so far, there is no commercial aquaculture production of the algae in South Africa.

3. Description of the Kelp Cultivation Envisaged in Saldanha Bay

The following information is summarized - Final Report: Pre-feasibility Study on the potential for commercial cultivation of African kelp along South Africa's West Coast. The sources of information cited in that document will not be repeated here.

3.1 Proposed species to be cultivated

Three species of kelp are proposed to be investigated and cultivated in the feasibility study. These are:

- *Macrocystis pyrifera*,
- *Laminaria pallida* &
- *Ecklonia maxima* – all of which are current found along the western coast of South Africa.

3.2 Site location

The initial sites selected for the pilot cultivation systems are located within the West Coast Oyster Growers (WCOG) aquaculture farming areas in Saldanha Bay Aquaculture Development Zone (ADZ) due to their existing capacity and resources to implement the trial.

West Coast Oyster Growers consists of two 15 ha longline bivalve farms (mussels, [*Mytilus galloprovincialis*], and oysters, [*Crassostrea gigas*]), within the in the Small Bay and Big Bay areas of the Saldanha Bay harbour, both of which are within the current boundaries of the ADZ.

WCOG have research permits for these sites, which is one of the regulatory requirements for the implementation of the pilot kelp rafts. The research permits are issued in order to conduct experiments into optimal infrastructure designs and composition as well as ongoing management. The rafts would be standalone structures, utilizing existing moorings to secure them.

The Small Bay farm utilizes a single dropper mussel longline culture method, as well as basket oyster culture. This site is much older and is currently undergoing a realignment, as well as a shift to more oyster production. Line numbers 1-26 was traditionally the mussel farming operation that is now discontinued, line 1-7 have been converted to oyster lines, the area of line 7 - 10 would be the site area for the kelp rope rafts. The site has an average water depth of 7 m, with a sandy substrate. Due to the kelp requiring water flow to obtain nutrients, there are concerns regarding the limited water flow at the Small Bay site. However, the mussel lines will be disconnected on installation of the kelp raft, and therefore are not expected to obstruct water flow.

The Big Bay farm uses continuous mussel long line culture and is restricted in the number of lines for cultivation of mussels by the ADZ thresholds on production. The vacant area closer to shore can be used for the kelp rope raft as the currents are weaker inshore. The site has an average water depth of 9 m, with a sandy substrate and a stronger wave regime.

If the pilot is successful, the concept will be to roll out kelp culture to all the lease holders in the ADZ, as per their interest and the market demand. Currently the production of mussels and oysters are limited in terms of the precautionary phased approach of the ADZ.

3.3 Kelp cultivation infrastructure and staff

Kelp raft cultivation is carried out internationally in relatively sheltered bays and inlets, although there is an international move, particularly in the North Atlantic, to grow kelps on larger structures further offshore in the open sea.

The production and infrastructure requirements for a South African kelp farm are based on the model developed for a vertically integrated commercial scale sugar kelp farm off the coast of New England. The vertically integrated operation included seed string production (nursery), the open water grow-out operation (farm) a processing facility, and marketing and distribution activities.

The South African kelp farming by various lease-holders, will produce either of the three species *E. maxima*, *L. pallida* and *M. pyrifera*, with the following products for sale:

- Fresh kelp fronds as abalone feed;
- Fresh whole kelp plants for extraction of plant growth stimulants; and,
- Dried, milled, and graded kelp for export (alginate extraction) and local sales to companies manufacturing niche products such as nutraceuticals and cosmetics.

A production system indicated in the pre-feasibility study is based on 250 longlines of 100 each, spaced 1.5 m apart. This will require a minimum farm space of 3.75 ha. Three scenarios are presented, based on different assumptions for average kelp production (10, 15 and 20 kg/m/harvest FW), and two harvests per year. The potential production ranges between 500 and 1000 t per farm per year.

The farming operation assumes employment of three employees during an eight-month grow-out and harvest cycle, 250 m longlines of 100 m each, and yield of 10 kg/m.

A kelp nursery will require an on-land facility with environmental controls to manipulate light intensity, photoperiod, water temperature, water filtration, water chemistry etc. for the preparation of kelp seedstock. It should also have the capacity to produce enough seed string to supply the farms it services (e.g., 25 000 m per farm). This will require access to natural kelp forests for collection of seed material.

There is a need for some degree of pre-processing before transportation and storage such as drying or fermenting. Wet kelp is heavy and does not store well so wet storage is avoided except when kelp is used for abalone feed.

On-land processing facilities already exist in Saldanha to process and store kelp, but an increase in production may require expansion or the development of new processing facilities in the near future. This will require access to water, energy, and sanitation services. The farm will also require access to boat launching and mooring facilities.

Farm equipment should include a work boat with a capacity to carry 4 crew members, 8 t capacity and winch to hold up the ropes, an inflatable boat or skiff, a trailer, a delivery vehicle, and harvesting tools. Labour required for farm operations include a skipper and four crew or cutters. A dive outfit will need to check the moorings and production system at least once a year.

3.4 Cultivation system design

The exact specifications of the kelp rafts have yet to be finalised since the results from the experimental pilot farms will be needed to refine the final the design.

The currently proposed pilot kelp rope raft can be used to grow any of the three kelp species considered for this study. The identification or risks and impacts will be conducted on this design in the absence of any alternatives. The raft dimensions are 20 x 64 m (1 280sqm). It will have the following components:

- Main frame:
 - Mooring blocks, shackles, and anchor warp.
 - Main frame grid and corner floats.
- Raft:
 - Raft outer frame and cultivation ropes.
 - Raft floats, weights, and bridle ropes.

The pilot raft has been designed to be angled so that culture ropes hang 1 m below the water surface on one side, and 4 m below the surface on the other side. This will allow observations of the effects of different light and other environmental conditions over the depth gradient on kelp growth.

Each pilot raft will have 13 culture ropes of 20 m each. Based on current understanding of pilot and commercial kelp farming in other parts of the world, expected yield could be about 10 kg/m. It is also expected that kelp grow-out time will be reduced through forced cultivation (using seeding and growing under controlled condition in a kelp hatchery/nursery).

The kelp pilots in Saldanha Bay will be used to test assumptions such as the number of harvests per year and yield per m of culture rope. It will also be used to gather critical technical and economic information to be incorporated in a kelp cultivation feasibility study. The figure below has been taken from the pre-feasibility study report and is intended to provide an overview of the layout rather than details.

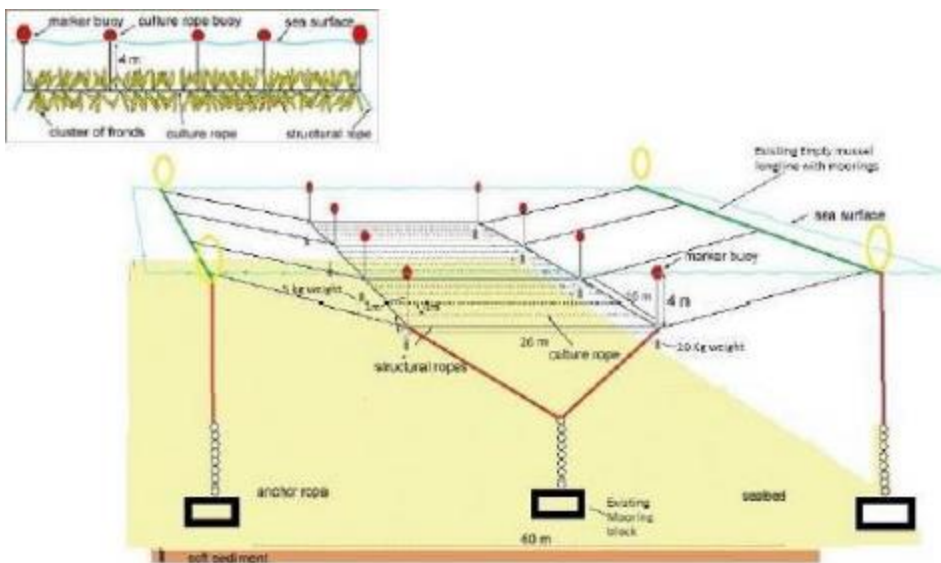


Figure 1: Proposed layout of pilot rafts

As most seaweed aquaculture takes place in East Asia, some lessons can be learnt from East Asian seaweed farmers such as the Japanese kelp (Kombu) growers. Their growth cycle can be halved from 2 years (natural cycle) to 1 year by 'force cultivation' in kelp

hatcheries.

Seedling production and culture of gametophyte phases take place in facilities with seeding and culture tanks and equipment to control seawater temperature, light, nutrients, and other conditions. Seeded strings/ropes are then hung onto cultivation rafts for acclimatisation. After 7-10 days the seeded strings are cut into lengths of 5 mm and inserted into the main cultivation ropes for regular cultivation. Blade wet weight of 1.25 kg could be achieved at harvest time.

A representation of the culture ropes is provided in Figure 2.

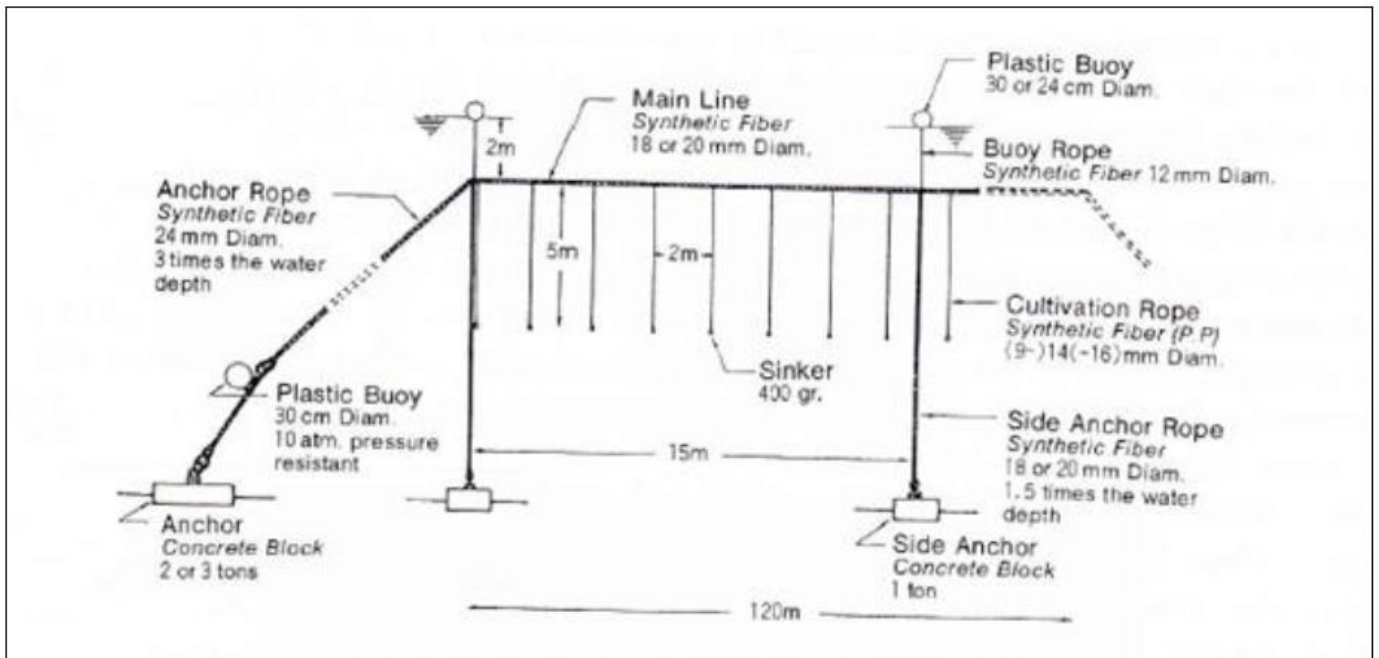


Figure 24: Japanese kelp (Kombu) cultivation raft
Source: (Kawashima, 1997)

Figure 2: Side view of ropes

The basic structure of a floating seaweed raft consists of three components: the rope raft structure, a method of flotation, and a method of anchoring.

Following the Japanese method, the raft structure itself consists entirely of rope, lacking any shackles or other connecting devices, to minimise damage through wearing of the ropes. Shackles are replaced by knots.

The floats can be anything which is functional, locally available and cheap. Plastic floats are commonly used, although glass floats have been used in China, bamboo in various regions, and because of the unavailability of other flotation material in Lüderitz, Namibia, the company purchased used cooldrink bottles for this purpose. The approved EMPr for the Saldanha Bay ADZ requires that the floats be of grey hues.

The anchoring is a critical part of the structure, and marine engineers have many ways of anchoring maritime structures.

This sort of raft was used successfully commercially for a few years in Namibia, and experimentally in Saldanha Bay and St Helena Bay in South Africa to grow *Gracilaria*.

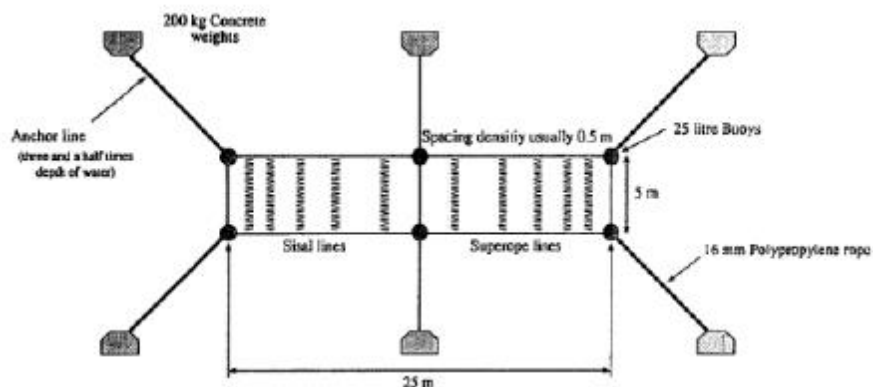


Figure 3: Diagram (plan view) of the basic test cell rope system used in lagoons in Namibia and South Africa

The rafts were constructed as arrays of 25 m x 5 m units, which assists with seeding and harvesting, and at the height of cultivation the systems covered 10 ha.

3.5 Kelp seeding and growing in a laboratory

The first phases of commercial kelp cultivation are conducted in controlled nursery conditions (temperature, light, etc).

Kelp reproductive material is collected from the ocean, sporulation induced, and spores allowed to settle on nylon ropes that are wound around PVC spools. The settled spores developed into gametophytes.

The seeded 'seed collectors' are placed in culture tanks with light, and are given nutrient medium, changed regularly. The seeded strings are placed in the sea for 7-10 days to strengthen attachment of the small kelps, and then seeded strings are cut into short lengths and inserted into the cultivation ropes.

In the longer term it is possible to keep and store kelp gametophytes in conditions which enable them to grow without becoming fertile (producing eggs and sperm), eventually producing small sporophytes (kelp plants) when required. Careful laboratory work is required to isolate cultures of separate male and female gametophytes. This makes use of the fact that gametophytes of some species have been shown to grow without producing eggs and sperm if there is no blue light available. They are grown in red light (lacking blue light), and individual gametophytes grow into small balls of male or female tissue. When sufficiently grown, these red-light produced gametophyte balls can be gently broken up in seawater in a mortar and pestle, and used as a suspension to seed kelp strings, as with the spores. This is a long-term procedure, which requires long-term, reliable culture systems, and skilled hatchery staff.

The strings seeded with small kelp sporophytes from the hatchery are attached to the rafts in one of two methods: either hanging vertically from the main line (vertical hanging type) or in parallel with the main line (longline method).

Following an acclimatisation period of 7-10 days in the sea, seedling strings (with attached small sporophytes from the hatchery) are cut into pieces and inserted into or wrapped around the main cultivation ropes for cultivation. Sometimes in wakame (*Undaria*) cultivation in Japan, the small sporophytes on seeded strings are placed for a while in the sea to grow before final attachment to the main cultivation ropes. Development of technology for spraying production ropes directly with seed to increase seeding capacity is currently underway internationally.

3.6 Cultivation conditions

The ADZ zones are located mostly in areas with average wave energy of less than 35 kW. The wave energy should not be a challenge, as kelp need wave energy for sufficient water flow and nutrient uptake. Reduced wave energy therefore may be a challenge for kelp nutrient uptake in Small Bay.

In the open sea, nitrogen is generally available year-round. This is not the case in Saldanha Bay, where it is known that seasonal stratification of the water column occurs in Inner Bay around March. This is when warm, nutrient poor water floats on top of cooler, deeper (around 6 m deep) nutrient rich water. This phenomenon caused crashes of *Gracilaria* in previous cultivation operations and may also cause die-offs of cultivated kelp during certain months. This may require a seasonal farming regime where kelp is harvested before autumn, which is yet to be established. Depth of farming could likewise have an impact on this as stratification occurs in the surface water.

The Saldanha Bay ADZ includes four areas that have been formally approved and have environmental authorisation for aquaculture activities including seaweed cultivation. Therefore, most limiting factors have been assessed for general aquaculture activities. For kelp cultivation, the limiting factors that could be identified during this phase of the Pre-feasibility Study phase, include potentially seasonal limiting nutrient levels in Inner Bay (Small and Big Bay) in March, fishing vessel traffic and cargo vessel traffic. The better areas for kelp cultivation may be Outer Bay North and South, where wave energy and water movement are relatively high in comparison to Inner Bay (Small Bay and Big Bay). However, the increased wave energy supplying nutrients to the kelp must be weighed against the wear and tear on infrastructure potentially resulting in infrastructure loss. Thus, the assumption that Outer Bay is an ideal site must be interrogated, taking into account the effects of wave energy on the infrastructure and not just the nutrient yield. It will therefore be important to include such investigation as follow-on research in funding applications for a full feasibility study.

3.7 Environmental impacts discussed in the pre-feasibility study report

- Two main biosecurity concerns with kelp aquaculture involve the potential for spreading kelp diseases and the possibility of affecting the genetics of natural kelp forests if material (usually as cultured gametophytes) is moved between different regions. Although biosecurity measures can be implemented, all three relevant species grow in or close to Saldanha Bay, so these need not be initial concerns here. **(Potentially negative but with very low probability).**

- Unlike 'fed' aquaculture (e.g. fish and shrimps) kelp is 'extractive' aquaculture. The major kelp nutrients, especially the potentially polluting macronutrients nitrogen and phosphorus, are present, dissolved in the water and are removed by the kelp. This has given rise to the idea of IMTA (Integrated Multi-Trophic Aquaculture) where seaweeds such as kelp are grown close to, and linked with, other aquaculture facilities, thus removing dissolved waste nitrogen and phosphorus released by other aquaculture activities. Saldanha Bay would be a good site to test these ideas locally. **(Potentially positive and likely).**
- Kelps have regular seasonal growth patterns which are critical in kelp aquaculture. From the limited local literature available it appears that local kelp growth correlates with available sunlight, growing fastest in summer. This is different from kelps grown elsewhere which tend to grow fastest in late winter/early spring, with slow growth in summer. In the North Atlantic, levels of major kelp nutrients in seawater are very low in the summer, whereas on the South African open West Coast these nutrient levels are high due to summer upwelling. **(Potentially positive and likely).**
- In the North Atlantic there is evidence that some kelp species store nitrogen and carbon seasonally for use in later growth. *Ecklonia maxima* can store nitrogen in the short-term (at upwelling events) but there is no evidence that local *Ecklonia* or *Laminaria* have a seasonal pattern of nitrogen (and hence, protein) storage. **(Potentially positive and unlikely).**
- The four main potentially limiting environmental factors for kelp growth in aquaculture in South Africa are seawater temperature, water flow/wave action, levels of dissolved nutrients (usually negatively correlated with water temperature), and light (linked to depth). **These have been largely overcome through site selection and testing various depths for optimal growth - (Potentially positive and likely).**
- In the open sea on the South African West Coast levels of the major macronutrient nitrogen are inversely correlated with seawater temperature and are generally available year-round. This is not the case in the Inner Bay in Saldanha where around March stratification occurs, with a warm, nutrient-poor layer of water floating on top of a cooler nutrient-rich layer (the latter around 6 m deep). Previous aquaculture operations growing the red seaweed *Gracilaria* were successful year-round apart from crashes of seaweed biomass in March, which may also affect kelp cultivation in the Bay. **(Potentially negative and uncertain).**
- Low salinity is only likely to be a problem with kelp aquaculture in South Africa close to river mouths. Low oxygen events (especially 'black tides') and perhaps periodic warm events can damage kelps and must be considered as sporadic risks to kelp aquaculture in certain parts of the South African coastline. **(Potentially negative and unlikely).**
- Epiphytes (other seaweeds and marine animals growing on the kelp) tend to become a problem in kelp aquaculture when kelp growth slows down. It is hypothesized that this may occur in later summer/early autumn in South Africa, but there is no data regarding this so far. In natural local kelp forests, there are few epiphytes except on kelps a few years old,

and then they mostly consist of 4 specific epiphyte seaweed species which grow on particular species of kelp. **(Potentially negative and unlikely).**

The pre-feasibility study was not intended to assess all possible environmental risks and impacts - rather it was intended to look at market forces and environmental constraints to production.

For this reason, it was necessary to use alternative sources for the identification of potential impacts and risks and correlate that with the pilot design detailed in the pre-feasibility study where possible.

4. Results

4.1 Basic Assessment for the Saldanha Bay ADZ

Although the Basic Assessments report notes that the application includes seaweed cultivation, no assessment of impacts is presented in the specialist reports or summary report.

For this reason, the only other source of impact identification is international literature.

4.2 International literature

The search of international literature gathered a plethora of articles and reports on the risk and impacts of seaweed cultivation. The assessments were mostly concerned with offshore farming but a significant number considered farming in marine embayments.

In addition, most of the reports concerned species other than the three to be used in Saldanha Bay. However, these differences notwithstanding, the methods of cultivation and the physical attributes of the cultivated rafts were sufficiently similar to extrapolate impacts and risks to the Saldanha ADZ.

Having noted this, however, in view of this being a feasibility pilot study- the implementations contained in this impact report must be treated with caution and monitored and tested for the duration of the pilot study with revisions as necessary.

Given the number and diversity of reports available, only a select few have been quoted in this assessment report since the results and conclusions of all the reports are all essentially similar.

Finally, risks and impacts associated with construction of the farms are not addressed in this report since the farms are already in place and use will be made of existing infrastructure. No additional risks or impacts are anticipated to result from this re-use.

4.2.1 Identified impacts/ risks

The list of potential impacts and benefits presented below are quoted from Wilding et al. (2021) since it was found to be the most comprehensive list and will therefore be used to identify any gaps in the pre-feasibility study report. As with other literature cited in this report, additional

references are not repeated. Additional risk and/or impacts identified as part of the Saldanha Bay ADZ monitoring programme will be added in the final assessment section of this report.

Seaweed farming can have positive and negative effects depending on many factors including site selection, scale of the farm(s), site design and choice of species. Benefits are loosely grouped below into socio-economic and environmental but there are overlaps as environmental remediation would increase the flow of goods and benefits and/or enhance human well-being. Risks from seaweed farming on species, habitats and the wider ecosystem are classified as direct resulting from infrastructure and ancillary activities (e.g., vessel traffic, shading and introduction of INNS) and indirect risks such as changes in water flow enhancing sedimentation on benthic habitats are described. Impacts may occur within the footprint of the farm or locally or regionally (although there is little evidence to support effects on that scale).

The **potential positive impacts** of seaweed farming can be summarised as follows. (A more comprehensive description of each benefit or impact is available in the original document):

- Socio-economic benefits directly through income generation and employment and indirectly by coastal protection that benefits other assets valued by people;
- Positive ecological enhancements, through:
 - provision of novel habitat (discussed in risks as these can also be negative);
 - mitigation of climate change;
 - water remediation;
- Protection of habitats and species through the exclusion of more damaging activities (de facto marine reserves); and
- Indirect socio-economic and ecological benefits resulting from seaweed use.

The **potential negative impacts** are summarised as follows:

- Direct and indirect impacts from infrastructure and ancillary activities
 - Impact of harvesting fertile material
 - Seabed scour from mooring chains
 - Noise and visual disturbance
 - Entanglement of marine mammals and birds
 - Wave energy attenuation and changes in coastal hydrology
 - Artificial habitat creation (cumulative with cultivated seaweeds also contributing)
 - Conflict with other users of marine space
- Direct and indirect impacts resulting from crops
 - Crop-to-wild gene flow
 - Changes to nutrient cycling and carbon storage
 - Absorption of nutrients
 - Release of dissolved or particulate organic matter
 - Spread of parasites and disease
 - Habitat for non-target nuisance species
 - Artificial habitat creation

- o Introduction and movement of INNS

Since this was the most comprehensive list, it will be used to determine what information is available for their mitigation or enhancement in the documentation available related to the feasibility study.

4.2.2 Impacts treatment in pre-feasibility study

Table 1: Benefits and impacts identified in the pre-feasibility study

Impact/ benefit	Available information
Socio-economic benefits directly through income generation and employment and indirectly by coastal protection that benefits other assets valued by people;	
<p>Positive ecological enhancements, through:</p> <p>provision of novel habitat;</p>	<p>There is considerable debate as to the benefit of providing new habitats in areas where similar habitats do not already exist. However, in this case, the mussel and oyster infrastructure are essentially similar to what will be installed for the kelp cultivation so additional considerations are not necessary.</p> <p>This benefit (and/or impact) will need to be assessed if a new kelp farm is situated in an area where no aquaculture has previously occurred. It is likely that a new farm will be subject to a formal assessment prior to commencement. This process will ensure that these impacts are considered by an appropriate specialist.</p>
<p>mitigation of climate change;</p>	<p>All plants (including seaweeds) fix carbon. Whether they sequester carbon depends on what happens to the carbon afterwards. This is currently a big scientific debate with respect to kelps, mainly to do with amounts of carbon sequestered. Kelp aquaculture can make aquaculture in the Bay closer to carbon neutral, but whether it could eventually be a source of carbon credits due to carbon sequestration is yet to be decided.</p> <p>This is mentioned in the pre-feasibility study in support of the application to cultivate kelp in Saldanha but is not accompanied by targets or monitoring systems.</p> <p>A further potential benefit is that dense kelp beds raise pH during the day, with the potential to mitigate ocean acidification. (Craig S. Young, et al.)</p> <p>The extent of carbon sequestration should ideally be monitored and modelled in the feasibility study. However, this has not been satisfactorily achieved internationally yet.</p>

Impact/ benefit	Available information
water remediation;	Kelp has been shown to absorb nitrogen (in various forms) and other pollutants to the benefit of the water columns. A monitoring programme will need to be established to determine the efficiency with which kelp removes nitrogen in the Saldanha location. This could then be a motivation for siting for future cultivation areas.
Protection of habitats and species through the exclusion of more damaging activities (<i>de facto</i> marine reserves); and	This is not applicable in Saldanha Bay since use will be made of existing infrastructure which already provides protection from other water users. This could, however, be applicable in other areas where there are potential user conflicts.
Indirect socio-economic and ecological benefits resulting from seaweed use.	The multiple uses of kelp are detailed in the pre-feasibility study report, and it is in an attempt to harness the revenue from such benefits that the feasibility study is being designed. Most of the potential socio-economic benefits will be as a result of the value adding and processing side. An additional benefit, not mentioned in the pre-feasibility study report is the optimal use of the area allocated to the ADZ. If there are areas which are under-utilised, kelp farm can maximise the productivity of the areas.

The potential negative impacts are summarised as follows:

Direct and indirect impacts from infrastructure and ancillary activities

Impact of harvesting fertile material	<p>To cultivate seaweeds, reproductive tissue (called sorus in kelps) must first be harvested from wild populations. The possible risk of this practice is that over-harvesting reproductive tissue may impact the reproductive output, life cycle and longevity of wild seaweeds.</p> <p>The intention is to take 10 fertile blades from 10 different plants. This is essentially non-destructive. A single <i>Ecklonia maxima</i> plant produces ca. 4 x 10¹⁰ spores per year (40 billion spores). (Joska & Bolton 1987).</p>
Seabed scour from mooring chains	<p>Mooring chain scour can cause a localised loss of physical habitat, however the tension through the longline system keeps the mooring chain and line from rotating. Impacts from mooring chain movements are relatively generic and small scale. This impact will be indistinguishable from that of the existing mussel farms.</p> <p>The lessons learned from the farms in Big Bay and Outer Bay in Saldanha will be useful in planning mooring arrays in other locations. However, the mooring locations must take cognizance of any reefs or other features on the seabed. As with the bivalve farmers, kelp farmers will be required to</p>

Impact/ benefit	Available information
	submit mooring plans and an amended farm-level EMPr to the AMC for approval prior to installation. This approval process will assist in ensuring industry best practice is applied to mooring arrays.
Noise and visual disturbance	No additional noise or visual impact is anticipated in Saldanha but in a new location any security lights may have nuisance value. The noise generated by kelp harvesting vessels will not contribute significantly to the ambient noise in the Saldanha Bay.
Entanglement of marine mammals and birds	<p>Entanglement often refers to snagging or encircling the animal, which results from a slack net or lines. There are reports of entanglement from fishing and aquaculture gear across a range of bird and mammal species in net structures and discarded gear.</p> <p>Interaction and entanglement risk can be separated between the species who use echo-location to identify and avoid structures, such as dolphins, and those which do not, such as whales. For species who use echo-location, the presence of taut lines is of limited danger and risks are limited.</p> <p>However, for species that do not echo-locate, reports of collisions with aquaculture are thought to be accidental and, in these cases, accidental interactions become a risk to consider in site design.</p> <p>This potential impact is not dealt with at all in the pre-feasibility and poses a significant threat. It will be discussed later in section 4.2.3.</p>
Wave energy attenuation and changes in coastal hydrology	While this is not relevant in Saldanha, wave attenuation can be a significant impact (or benefit) and should be reviewed for new farms outside of the Saldanha Bay ADZ as part of the formal assessment process. The lack of attention to this in the feasibility study is not considered important.
Artificial habitat creation (cumulative with cultivated seaweeds also contributing)	There is considerable debate as to the benefit of providing new habitats in areas where similar habitats do not already exist. However, in this case, the mussel and oyster infrastructure are essentially similar to what will be installed for the kelp cultivation so additional considerations are not necessary and as noted above, kelp beds already exist in Saldanha Bay. The only change would be that there will be kelp beds in areas where they were not found previously. However, The addition of inputs and organisms associated with kelps rather than bivalve communities, making a more diverse integrated aquaculture biomass.
Conflict with other users of marine space	Not applicable in Saldanha as the kelp farming will take place in previously designated areas. However, since the rafts are suspended below the water surface, the farm management will need to ensure that

Impact/ benefit	Available information
	<p>the marker buoys are visible at all times. The installation of navigation lights to delineate the area of the rafts should be discussed with TNPA and SAMSA as a further precautionary measure. Aids to navigation in Saldanha Bay are being considered here as well as a planned Risk Assessment to take place on the 14-15 June 2023 to assess the risk of the current markers</p> <p>Any incursions by ski-boats or other craft must be dealt with via the Saldanha Bay ADZ incident management system.</p>
<p>None of the above omissions are regarded as "show stoppers" in Saldanha. They would, however, benefit the kelp farming operations if they are enhanced in future sites.</p>	
<p>Direct and indirect impacts resulting from crops</p>	
<p>Crop-to-wild gene flow</p>	<p>Concern is variously raised in international literature about the movement of genes from cultivated kelp farms to the wild. This is particularly the case for kelp which is brought in from distant locations but is also applicable to long-term cultivation where inbreeding may change the genetic composition. In Saldanha, the sori will be collected from the same wild population so the risk of inbreeding is very low.</p> <p>A survey of local populations of <i>Laminaria pallida</i> shows genetic stability (Assis et al. 2022). No similar surveys have been conducted on the other two species to be tested.</p> <p>All three kelp species are native to the West Coast. However, it is recommended that a Standard Operating Procedure for commercial farms be established to ensure harvesting of spores complies with international best practice.</p>
<p>Changes to nutrient cycling and carbon storage</p>	<p>See carbon fixation above and absorption of nutrients below.</p>
<p>Absorption of nutrients</p>	<p>There is a possibility that the kelp could absorb nutrients from the water column to the detriment of the phytoplankton and hence the bivalves in the system-notably the bivalve farms. but the nutrient uptake needs to modelled and monitored for future large-scale farms.</p>
<p>Release of dissolved or particulate organic matter</p>	<p>Kelp plants are known to release dissolved and particulate organic matter. This can be seen as a negative impact, but since the releases contribute to the food source for the cultivated bivalves, in this instance, it</p>

Impact/ benefit	Available information
	<p>is regarded as a benefit due to its contribution to the multi-trophic approach to the ADZ.</p> <p>Modelling the nutrient uptake is relatively simple, but it is important to relate the nutrient uptake by the kelp to the nutrient flux in the Bay. It is likely that the uptake by 1000 t of kelp would be miniscule compared to the nutrient flux in the Bay.</p> <p>Furthermore, the time scales are different. Seaweeds remove dissolved nutrients, molluscs filter out particulate nutrients. There is a time lag - the time taken for the nutrients to be taken up by phytoplankton. By that time it is likely that the nutrients and phytoplankton will be replaced by water movement.</p>
Spread of parasites and disease	<p>The kelp sorus is disinfected and scrutinised for parasites or other diseases in the laboratory prior to stimulation of sporulation. The microscopic spores are then released into sterilized water to grow. Bringing "wild" parasites or diseases into the kelp farm is, therefore, unlikely.</p> <p>The potential of closely packed kelp plants in the farm becoming infected which could then infect the native populations does exist. However, close packed populations of kelp is the normal configuration in the wild. Introduction and spread of diseases is therefore considered unlikely.</p>
Habitat for non-target nuisance species	<p>Long-standing cultivated kelp farms do tend to accumulate other species which can become a nuisance and lower the quality of the kelp fronds at harvest. This is thus a potential negative impact on the farming quality. It is for this reason that the adult <i>Ecklonia</i> and <i>Laminaria</i> kelp plants will be completely replaced by the harvesting since it is not economically viable to leave them growing any longer.</p> <p><i>Macrocystis</i> however, may be able to produce harvests repeatedly for many years and thus may be more susceptible to colonization by nuisance species. The feasibility study will monitor this colonization and the results will be used to develop a management strategy for future full-scale farms.</p>
Artificial habitat creation	<p>There is considerable debate as to the benefit of providing new habitats in areas where similar habitats do not already exist. However, in this case, the mussel and oyster infrastructure are essentially similar to what will be installed for the kelp cultivation so additional considerations are not necessary even though the main species being farmed are completely different.</p>

Impact/ benefit	Available information
Introduction and movement of INNS	Invasive non-native species (INNS) are species of organisms that are introduced into an area in which they do not normally occur. Typically, such an introduction is from ballast water or the hulls of ships. This is already a problem in Saldanha Bay as a result of the international shipping visiting the Port. The kelp farm will not contribute significantly to the existing problem since it will be utilizing locally sourced plants thereby reducing the risk of the introduction of INNS.

In additional five further impacts have been identified during the operation of the existing aquaculture farms in Saldanha Bay ADZ:

Table 2: Additional impacts identified in international literature

Shading of benthic communities below the rafts;	<p>In Saldanha Bay, the water is naturally turbid and the rafts will be at the limit of the phototrophic layer. For this reason, this is not considered to be a significant impact in this location.</p> <p>The same rationale may not apply in other locations.</p>
Increased organic loading of benthos due to decay of dropped kelp matter.	<p>Kelp plants shed leaf material- especially during storms. The potential exists that this material sinks to the sea bottom and smothers any benthic organisms underneath.</p> <p>The plant matter laying on the seabed below the rafts will decay if left <i>in situ</i> resulting in increased localized organic loading and nutrient release.</p> <p>This is likely to be more significant in Small Bay than Big Bay due to the stronger current in the latter location.</p> <p>This will be monitored as part of the ongoing water and benthic quality monitoring commissioned by the Saldanha ADZ AMC.</p>
Smothering of benthic communities below the rafts;	<p>Kelp plants shed leaf material- especially during storms. The potential exists that this material sinks to the sea bottom and smothers any benthic organisms underneath.</p> <p>This may be a problem in Small Bay due to the weak currents. It is likely that a similar situation as is found under the mussel rafts will develop where there is a hypoxic area immediately under the rafts but that the impact of this weakens with distance. No information was available on the nature and volumes of such litter being generated by the three kelp species. If it is essentially similar to that generated by the mussel rafts, the impact is likely to be small. The extent of benthic die-off under the rafts</p>

	<p>will need to be monitored carefully as part of the pilot study and may inform decisions as to which of the three species is carried forward to full-scale production.</p> <p>The impact in Big- Bay due to the strong currents, is likely to be insignificant as any litter generated by the kelp plants will be washed away by the current.</p> <p>Changes to water chemistry will be monitored as part of the ongoing water and benthic quality monitoring commissioned by the Saldanha ADZ AMC.</p>
<p>Break-off of kelp material which is washed onto the beaches; and,</p>	<p>Kelp plants shed leaf material- especially during storms. Different species shed different volumes. The surrounding community in Saldanha Bay are not fully supportive of aquaculture in the Bay and are very opposed to general seaweed deposition on the beaches which is a natural occurrence.</p> <p>The quantum of debris from the kelp farms is unknown at this stage but pro-active plans must be made to detect and remove any such accumulations as they occur. Mr Vos Pienaar from BSASA is already involved in such an activity but a large increase in detritus volumes may stretch the capacity of his teams. Beach wash-up can also be used by existing Rights holders responsible for cleaning the beach as it has value or alternative the municipality which has beach cleaning activity.</p>
<p>Breakage of infrastructure resulting in debris which can cause a nuisance to other users (at sea or on the beaches).</p>	<p>Past experience in Saldanha Bay has shown that heavy seas can cause mussels rafts and finfish cages to tear loose from their moorings and can pose a shipping nuisance or are deposited on the beaches (sometimes in inaccessible places).</p> <p>While it is acknowledged that all possible precautions will be taken in the design and construction of the rafts, incidents such as those related above can occur.</p> <p>As part of the social compact, it is recommended that contingency plans (*including access by heavy duty earth-moving equipment or trucks) be developed prior to establishment to avoid delays in retrieval and consequence public outcry.</p>

4.2.3 Marine animal entanglement

Cetacean entanglement in aquaculture infrastructure is relatively rare (Würsig, 2020), entanglement in fishing gear is more prevalent.

Research into marine animal entanglements has resulted in the following principles being adopted internationally (Price et al. 2016, Würsig, 2020)):

- Mooring and other lines must be always kept taut to prevent looping; and,
- Any lines on the seabed must be sinking lines for the same reason.

The focus is on prevention rather than rescue so various deterrents have been tested ranging from different coloured lines to luminescent or LED-lit lines. Since amongst the marine animals there are echo-locating and non-echo-locating species deterrents must encompass the entire range of visual and acoustic spectra to be 100% effective. Clearly this is impossible and given the frequency of entanglement, possibly not necessary. However, the overarching principle is to avoid siting aquaculture in areas of known marine animal accumulations or migration.

Experience in Saldanha Bay indicates that dolphins and seals are common throughout but whales occur mainly in Outer Bay.

In the history of aquaculture in Saldanha Small Bay, no entanglements have occurred in Small, and Big Bays with only one occurring in Outer Bay in 2020 where best practice was not implemented. This would suggest that fewer whales enter Small and Big Bay and the dolphins and seals are able to navigate around the existing rafts and longlines.

The whale entanglement in Outer Bay North in 2020 involved a mussel logline that had become detached at one end and drifted out of position across the channel between adjacent mussel lines. One school of thought is that the whale became confused when confronted by a barrier across a channel and in attempting to escape, became entangled. There is no verifiable information to support this theory, but it does reinforce the need for clear channels between rafts of longlines through which marine animals can navigate with ease. The raft design for the feasibility study has not been finalised to date. It is understood that the rafts will be suspended from existing mussel topline and hang approximately 5 m below the sea surface. The rafts will be supported by coloured floats- (note that grey and black hues must be used except for navigation beacons). The final design must ensure that there are gaps between rafts to permit animals to navigate between them. The Emergency response protocol indicates the following distances as suggested by industry 10-20 m between lines in Small Bay and 30 m in Outer Bay North and Big Bay. The final designs for commercial farming must be approved by the Saldanha Bay ADZ AMC before implementation. That committee must ensure that there is adequate passage between rafts.

Finally, the debate on the thickness (or diameter and therefore breaking strain) of the aquaculture ropes is also in a state of flux (Würsig, 2020). A thicker, stronger rope will prevent the infrastructure from breaking off in storms and will be more visible. However, it will be more difficult to release any animal caught in such ropes. The ropes currently used in Saldanha Bay are 40 mm thick. Saldanha Bay ADZ has recently commissioned specially designed knives to cut through the thicker ropes for this purpose.

Thinner ropes may not be as secure for the infrastructure and, while they make it easier for the animals to break out of or be released, they can cause deeper cuts into the skin in the process.

Entanglement risk in seaweed farms will be increased where an intense accumulation of wild species, or co-culturing with intense fin-fish aquaculture are expected (Würsig, 2020). Long-line systems originally designed for mussels have a primary risk in the 'free' dropper lines, while those serving marker buoys can be designed to minimise slack and curvature, by increasing rope weight and thickness, and thus reduce associated risks. Alongside these systems, 'mesh' systems, with inter-crossing lines on a horizontal plane have also been trialed (Eynon, 2021). These systems will include rectangular near-surface mesh, but with mesh sizes of 10 m², the entanglement is not comparable to by-catch from fishing gear. As such, seaweed farms that using net structures for growing seaweed may have a higher entanglement risk than seaweed farms that use taut, longline structures (Clement, 2013), however by increasing mesh size, this risk can be mitigated.

There is, therefore, no simple solution. However, entanglement is not considered a major risk in Small Bay and only a slightly greater risk in Big Bay since whales do not frequent the areas. Outer Bay North appears to be a resting location for migrating whales and therefore the risk of entanglement is greater. Raft design and contingency planning must, therefore, be more rigorous in this area.

The Saldanha Bay ADZ Emergency Response Protocol has a section on entanglement but it requires the farm to have certain equipment (such as boats) to be readily available. The kelp farm management must ensure that all staff are trained in the emergency responses and what their individual roles are in such an event. Their skippers must also be trained by the South African Whale Disentanglement Network.

On the water staff must also be trained in the ETP, EA and EMPr training which will be undertaken by the ECO.

4.2.4 Information gaps

As detailed in the text above, the pre-feasibility study report provides extensive detail on the economic and market aspects of the feasibility plan coupled with details of the farming operations. However, the report does not provide information on the following which hampers any form of impact evaluation as revealed in the previous sections:

1. Final raft design
2. Entanglement prevention
3. Estimated volumes of debris from kelp plants
4. Details of monitoring and responses

In the absence of this information, certain impacts cannot be evaluated and therefore the benefit or impact of the kelp feasibility study cannot be fully evaluated. In the absence of such information, international literature must be used as a guide.

Since the most significant concern at this point is the layout and construction of the rafts, the final design must be approved by the ADZ AMC before installation.

4.3 Risk Assessment

The SANS31000 Series standards for risk assessments. ARP 070:2009 ISO Edition 2 defines risk as "The effect of uncertainty on objectives" whereas risk management is "coordinated activities to direct and control and organization with regard to risk. Implicit in this definition is the presence of uncertainty. If a known impact, will occur and the magnitude of the consequence is known or calculated- there is no longer uncertainty. If either the frequency or magnitude of the impact is unknown- a risk exists. With this definition in mind, the following section will explore the consequences of the uncertainty reflected in the previous sections of this report.

While several models have been used both in the ADZ and elsewhere in South Africa, for the purposes of this exercise, a simplified version as depicted in Table 3 below was utilized.

The uncertainty associated with each of the impacts listed in section 4.2.2 above eventuating, is presented in Table 4 with a postulated consequence **to the environment not to the feasibility study**. The likelihood of the event occurring which results in that consequence is then rated using Table 3 and the severity of the consequence using the same table.

Table 3: Risk rating categories

Risk Rating	
Probability / Likelihood of an Event / Incident Resulting in Adverse Consequences	
Rating selection	Description
Low	Very small chance of occurring.
Medium	50/50 chance of occurring.
High	Very high chance of occurring.
Severity of Consequences	
Rating selection	Description
Low	Positive: Effects localized and not significant- little impact on employment, local economy or species protection Negative: Effects localised and not severe. Damage to both the environment and production can be remedied easily and within operational budget. Typically requires clean-up only and environmental damage will restore by itself.
Medium	Positive: Effects felt on a regional scale, noticeable increase in the regional economy. Negative: Damage to the environment, crops or infrastructure is severe and cannot be remedied within operational budget. Additional funding may need to be sourced. Affected environment will not self-repair and requires active restoration. Business / production interruptions.
High	Positive: Economic effects felt on a national scale- measurable increases in employment. Negative: Irreversible damage to the environment /crops or infrastructure. Prosecution likely. Can result in closure of business.

Once the risks have been rated and ranked, they will be evaluated.

Risk evaluation is the process of comparing the results of the risk analysis against criteria set by the organisation to determine whether the risk is acceptable and tolerable, or whether treatment (mitigation) measures need to be employed in order to change one or more of the risk parameters. Central to this process is what is referred to as the organisation's "risk appetite".

The ISO 31000 risk management standard refers to risk appetite as the "Amount and type of risk that an organization is prepared to pursue, retain or take". In other words, risk appetite is the level of risk that an organization is willing to accept while pursuing its objectives and is informed by the organization's position on risk versus reward (is the potential consequence worth the potential gains?).

Risk appetite can vary based on several factors, such as:

- The nature of the organisation's activities given that industries with inherently low risk activities tend to have a higher risk appetite given that there is "less to go badly wrong".
- Company culture also plays a major role, very much a bull vs bear approach inherent in the way the company (or its shareholders) intend to realise return on investment.
- Market pressures and preferences – often dictate not only how much, but also what kind of risks they want their suppliers to take. Increasingly consumers have highly become risk averse when it comes to environmental factors.
- Market demand can also have the converse effect. When products are in high demand and command high prices the "risk pay-off" becomes greater and more attractive.
- The financial strength and capabilities of the organization (i.e., the more resources a company has, the more willing it may be to accept risks and the costs associated to them). It's also worth noting that risk appetite can change over time. It's always a good idea to assess risks against risk criteria periodically or continuously (e.g., once, or twice annually, or daily in specific risk scenarios), depending on the circumstances, available resources, skills, technologies, or systems.

Since kelp farming is a new venture in Saldanha and not all impacts fully understood, and in accordance with the principles contained in the National Environmental Management Act (No. 107 of 1998 as amended (NEMA), a risk averse approach will be adopted.

In the table following, the probability and severity of the risks identified are scored and then colour-coded according to the treatment or response to the risk.

In addition, there is a column which notes whether the effect of the identified risk has already been assessed in the ADZ BA, EA and/or EMPr. In this regard, it is noted that a number of activities can result in the same outcome. So, for example, debris settling to the seabed from the biofouling on mussel rafts will have a similar effect to that under kelp rafts. So if the effect

of the risk is already assessed in its general sense, this is noted in this column and a reference to the section in the Marine Specialist Report s provided.

The EA specifies mandatory environmental outcomes with management actions required to achieve the outcomes. If changes to management actions are required which do NOT change the environmental outcomes, a Part 1 Amendment is required. If, however, the mandated outcomes are affected, a Part 2 amendment is required. This this reason, a final column is added to note whether the environmental outcomes are affected by the risk identified with kelp farming. This will be used to decide the nature of any amendment required.

Since both positive and negative as well as neutral risks were identified, to facilitate the distinction in the text, the following colour codes were used.




Positive	
Neutral	
Negative	

Table 4: Risk assessment of uncertainties detailed in this report

Impact	Uncertainty	Consequence	+ve, neutral or – ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
Socio-economic benefits directly through income generation and employment and indirectly by coastal protection that benefits other assets valued by people								
1. Provision of novel (new) habitat	It is almost certain that a new habitat will be created by the dense kelp growth and associated holdfasts. This habitat will be seasonal (except possibly in the <i>Macrocystis</i> rafts, as the kelp plants are removed when harvested) and the rafts re-seeded.	If the new habitat is beneficial, it will increase biodiversity in the region of the rafts. If it is a negative impact, a habitat dependent on kelp growth will develop which will be destroyed when the kelp rafts are removed. The effect of a new habitat has been assessed in the Marine Specialist report in relation to bivalve infrastructure. The management actions will not therefore be altered by kelp farming.	?	Medium	Low	<ul style="list-style-type: none"> • Accept and monitor the risk caused by the uncertainty. • Update the annual monitoring plan to include annual assessments of new habitats. • Monitor the development of any new habitats through diver inspections, before and after harvest inspections. • Monitor any adverse impacts on surrounding communities. • This monitoring requirement must be included in the updated EMPr. 	Yes Pulfrich 2017 s 4.1.2	No
2.	Kelp has been shown to absorb CO ₂ . The uncertainty is whether	Carbon sequestration will occur but the uncertainty of	+ve	Low	Medium	<ul style="list-style-type: none"> • Accept the risk. 	No	No

Impact	Uncertainty	Consequence	+ve, neutral or – ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
Mitigation of climate change	this will be sufficiently significant to be extrapolated and used as a motivation for future- large-scale kelp farms.	extent of sequestration remains. Carbon sequestration as an outcome was not assessed in the Marine Specialist study. However, since this may be beneficial, it will not affect the environmental outcomes of the ADZ.				<ul style="list-style-type: none"> The fact that carbon sequestration will occur is definite. The pilot study can be used to obtain a more accurate estimate of the significance and consequence of this sequestration through ongoing research. Implement a monitoring programme to measure CO₂ uptake. This monitoring requirement must be included in the updated EMPr and Sampling Plan. 		
3. Water remediation	Kelp has been shown to absorb nitrogen (in various forms) and other pollutants to the benefit of the water columns.	Nitrogen removal will occur but the magnitude of this absorption is uncertain. This uncertainty will not affect the environmental outcomes of the ADZ.	+ve	Low	Medium	<ul style="list-style-type: none"> Accept the risk. The fact that nitrogen removal will occur is definite. The pilot study can be used to obtain a more accurate estimate of the 	No	No

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
						significance and consequence of this sequestration through ongoing research. <ul style="list-style-type: none"> Implement a monitoring programme to measure nitrogen uptake. This monitoring requirement must be included in the updated EMPr. 		
4. Protection of habitats and species through the exclusion of more damaging activities (<i>de facto</i> marine reserves);	This is not applicable in Saldanha Bay since use will be made of existing infrastructure within the boundaries of the ADZ which already provides protection from other water users.	There is no uncertainty regarding habitat protection - it is therefore not a significant risk. This will not affect existing environmental outcomes.	Neutral	N/A	N/A	N/A	N/A	N/A
5. Indirect socio-economic and ecological	The harvested kelp will be used in food additives, cosmetics, and abalone feed amongst others. The number of direct jobs created will be small.	The indirect socio-economic benefits are detailed in the pre-feasibility study report as part of the motivation for kelp farming as an industry. If the indirect benefits are	+ve	Low	Medium	<ul style="list-style-type: none"> Accept the risk. 	No	No

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
benefits resulting from seaweed use.	The uncertainty is around the magnitude of this benefit but this will not affect the feasibility of the kelp farming.	not as great as anticipated, this will not affect the feasibility of the kelp farm since these benefits are indirect and do not generate income for the farms themselves. This will have no effect on the existing environmental outcomes.						
The potential negative impacts are summarised as follows:								
Direct and indirect impacts from infrastructure and ancillary activities								
6. Impact of harvesting fertile material	Reproductive tissue (called sorus in kelps) is harvested from wild populations. Although the effect on the wild populations is expected to be small since one sorus can produce multiple spores- the uncertainty of the magnitude of the impact remains. There is no mention of this risk in the Marine Specialist Report nor is any activity likely to have a similar environmental outcome.	If harvesting kelp sori results in depletion of natural populations or reduced recruitment, the use of wild-harvested sori may be prohibited. This will mean that laboratory grown spores will be used with the associated risks of genetic in-breeding. If any adverse effect on the wild populations is detected, management actions will need to be developed and implemented to eliminate or reduce the impacts.	-ve	Low	Low	<ul style="list-style-type: none"> This risk is considered unlikely and of low consequence so, the recommended action is to accept the risk. The ongoing health of the wild populations that are harvested must be monitored. This monitoring requirement must be included in the updated EMPr. 	No	Uncertain
7.	Mooring chain scour can cause a small loss of physical habitat,	Movement of the mooring blocks and anchors is	-ve	Low	Low	<ul style="list-style-type: none"> Accept the risk. 	Yes	No

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
Sea-bed scour from mooring chains	however the tension through the longline system keeps the mooring chain and line from shifting.	possible during severe storms resulting in damage to the seabed. Mooring diagrams must be submitted before installation so that the position and infrastructure used complies with minimum requirements of the ADZ to limit such scour. Past experience shows this to be minimal and infrequent. Kelp farming will not increase the risk of scour nor will it change the environmental outcomes.				<ul style="list-style-type: none"> Annual physical monitoring will be used to detect any significant scour and prompt appropriate remedial action. 	Pulfrich 2017 s 4.1.1	
8. Noise and visual disturbance	The commercial kelp farms will be situated inside the already operational ADZ. Navigation lights are already operational and service vessels and crew service the various farms regularly. The kelp farms will not, therefore increase any visual or noise disturbance.	N/A	Neutral	N/A	N/A	<ul style="list-style-type: none"> Accept the risk. 	Yes Pulfrich 2017 s 4.1.5	No
9. Entanglement of marine	Marine animals such as whales, dolphins, seals, turtles, and seabirds can become entangled in the ropes and other	The risks of entanglement are not significant in Small Bay but are significant in Outer and Big Bays.	-ve	Low	High	<ul style="list-style-type: none"> The recommended management 	Yes Pulfrich 2017 s 4.1.4	No

Impact	Uncertainty	Consequence	+ve, neutral or – ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
mammals and birds	<p>infrastructure of the kelp rafts. If not freed urgently they can suffer severe injuries or can drown.</p> <p>The rafts and associated infrastructure have been designed to limit entanglement and if the event of entanglement occurring, maximise the chance of freeing the trapped animal.</p> <p>The uncertainty is whether such precautions are sufficient.</p> <p>Furthermore, the design and layout of the rafts have not yet been finalized.</p> <p>The conceptual designs included in the pre-feasibility study report do not provide sufficient information on the distance between rafts etc.</p>	<p>In the event that the provisions to prevent entanglement are not sufficient, severe injuries or death of trapped animals can result.</p> <p>The authorization for this activity could be revoked.</p> <p>Using international best practice in the design and layout of the rafts could minimize the risk of entanglement.</p> <p>The only entanglement suffered at the Saldanha ADZ occurred when best practice was not implemented.</p> <p>The international best practice principles were addressed in the Marine Specialist report as they apply to longlines and rafts in general. Thus, although the species farmed is different, the principles of entanglement prevention are similar.</p> <p>The environmental outcomes will not be affected.</p>				<p>response is to avoid the risk.</p> <ul style="list-style-type: none"> This would entail having the final layout and design scrutinised by the South African Whale Disentanglement Network and other marine mammal specialists and the AMC before installation. The scrutiny must include distance between rafts, thickness of ropes and chains, any auditory or visual deterrents and response in the event of entanglement. These plans must be approved prior to installation. The design and layout specifications must 		

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
						be included in the updated EMPr.		
10. Wave energy attenuation and changes in coastal hydrology	Large-scale farms have the potential to attenuate nearshore waves. This could change the sand transport systems or affect marine life in the area which depends on high wave energy. The uncertainty is whether wave attenuation will occur and whether it will have an adverse effect on the local ecology. It is assumed to be negative since there is no erosion risk at present for which this could be seen as mitigation.	Wave attenuation can affect intertidal and subtidal organisms that rely on wave energy for food and oxygen. Wave attenuation could occur in Outer and Big Bays. This risk is considered low since the kelp farms are to be located inside the existing ADZ boundary. While they may contribute to any wave attenuation, the area covered by the kelp farms in relation to the overall area of the bivalve farms would suggest that the effect would not be noticeable. This was not addressed in the Marine Specialist Study report, but it will not have any impact on the environmental outcomes.	-ve	Low	Low	<ul style="list-style-type: none"> • Accept the risk. • In the event that significant changes to the Outer Bay and Big Bay shorelines are detected, an investigation must be initiated to determine whether the kelp farms or any of the ADZ farms are responsible. • No changes to the existing EMPr are required. 	No	No
11. Cumulative artificial habitat creation	See risk 1 above							

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
12. Conflict with other users of marine space	Conflict between users in Saldanha Bay ADZ have occurred in the past. These conflicts were primarily the result of confusion as to the exact boundaries of the ADZ and what activities were permitted. The coordinates of the ADZ have now been published by the South African Hydrographic office and no further conflicts have occurred. In addition, SAMSA has made recommendations for the installation of additional marker and warning buoys through the Aids to Navigation Plan.	Conflicts do not usually result in injuries or severe damage to craft or infrastructure, but some damage is possible. There are ongoing conflicts between the ADZ farmers and ski-boats. The latter regularly ruin over submerged lines or over ropes and other infrastructure that has broken loose from the farms. The mitigation measures implemented thus far are not 100% effective, but this is not a new risk resulting from the kelp farms. The potential conflicts between ADZ farmers and the other Bay users was addressed in the BA Report. The introduction of kelp farming will not change the environmental outcomes or actions.	-ve	Low	Medium	<ul style="list-style-type: none"> • Manage the risk. • No changes to the existing EMPr are required. 	Yes Pulfrich 2017 s 4.1.5	No
Direct and indirect impacts resulting from crops								
13. Crop-to-wild gene flow	Concern is variously raised in international literature about the movement of genes from	This risk is only attendant on the use of imported foreign genetic material.	-ve	Low	Medium	<ul style="list-style-type: none"> • Avoid the risk. • The requirement to use only sori from local populations 	No	No

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
	cultivated kelp farms to the wild kelp populations. Since there is frequently no visible evidence of genetics changes, the uncertainty about how significant any such genetics changes may be and how rapidly they will spread remains. The only way to manage this risk is to not take stock from areas of different genetic structure.	Only local populations will be used for stock so this risk is not significant. No change to environmental outcomes will occur.				should be included in the EA and EMPr.		
14. Changes to nutrient cycling and carbon storage	See risk 3 above.							
15. Absorption of nutrients	See risk 3 above							
16. Release of dissolved or particulate organic matter	Kelp plants are known to release dissolved and particulate organic matter. This could alter the nutrient levels in the water column.	See risk 3 above.						
17. Spread of parasites and disease	The kelp sorus is disinfected and scrutinised for parasites or other diseases in the laboratory prior to stimulation of sporulation.	If the cleansing is inadequate it is likely that the invasive plants or parasites will out compete	-ve	Low	Medium	<ul style="list-style-type: none"> This risk should be accepted. The existing bio-monitoring should 	Yes Pulfrich 2017 s 4.1.4	No.

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
	The uncertainty lies in whether such provisions are adequate.	the kelp plants negatively affecting the harvest. This risk is addressed in a generic manner in the BA Report but not specifically addressing kelp cleansing. The management outcome of preventing invasive species is addressed in some detail in the BA report as well as the EMPr. No additional management actions are required and the environmental outcomes will not be affected.				be expanded to include any probable pest species. <ul style="list-style-type: none"> This will require an amendment to the existing EMPr. 		
18. Habitat for non-target nuisance species	Long-standing cultivated kelp farms tend to accumulate other species which can become a nuisance and lower the quality of the kelp fronds at harvest. The uncertainty is how rapidly this colonization takes place and whether annual replacement of standing stock is sufficient to control this infestation without damage to the environment.	If the colonization overtakes production replacement, the anticipated revenue generated may be less as a consequence of poor-quality fronds. This risk, although of low significance should be avoided by employing annual harvesting and cleaning of the infrastructure. This will not affect the management outcome of the EA, but the requirement	-ve	Low	Low	<ul style="list-style-type: none"> Avoid this risk with frequent complete harvesting and infrastructure cleansing. This requirement must be included in the updated EMPr. 	No	No

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
		for infrastructure cleaning should be included in the updated EMPr.						
19. Artificial habitat creation	See risk 1 above							
20. Introduction and movement of INNS	Invasive non-native species (INNS) are species of organisms that are introduced into an area in which they do not normally occur. The cultivation of kelp in Saldanha ADZ will not introduce INNS since only wild-caught sori will be used from nearby populations.	There is little uncertainty as biosecurity measures will ensure that the sori are sterilized upon arrival at the laboratory.	-ve	Low	Low	<ul style="list-style-type: none"> • Accept this risk. • The annual biological monitoring conducted under the auspices of the AMC will check for any INNS. 	Yes Pulfrich 2017 s 4.1.4	No
21. Shading of benthic communities below the rafts;	Internationally, kelp is often grown in shallow areas where the phototrophic layer is on the seabed. As a consequence of the high turbidity and greater depth in the Saldanha Bay, the effect of shading will be very insignificant and unlikely.	The effect of rafts on the seabed were assessed in the BA report and as such this is not a new risk and does not change the management outcome.	-ve	Low	Low	<ul style="list-style-type: none"> • Accept this risk. 	Yes Pulfrich 2017 s 4.1.2	No
22. Increased organic loading of benthos	Increased organic loading as a result of decaying kelp and biofouling under the rafts is a possibility.	The BA report assessed the impact of biofouling decaying on the seabed. The principle of organic	-ve	Medium	Low	<ul style="list-style-type: none"> • Accept this risk. • The existing annual monitoring will be used to track any changes in 	Yes Pulfrich 2017 s 4.1.2	No

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
	The extent of such an organic loading is uncertain.	loading is therefore essentially similar. Thus the measures implemented to monitor organic accumulations will remain the same after the introduction of kelp farms. This will not affect the management outcome.				organic composition under the rafts. <ul style="list-style-type: none"> No change to the EMPr is required. 		
23. Smothering of benthic communities below the rafts;	Kelp plants shed leaf material- especially during storms. The potential exists that this material sinks to the sea bottom and smothers any benthic organisms. The uncertainty is whether the smothering and hypoxia will have a more wide-spread and significant impact.	It is highly likely that any organisms under the rafts will be smothered and that hypoxic conditions will occur. However, this will be localized and temporary- recovery will take place as soon as the rafts are removed. The principle of smothering by decaying vegetation was addressed in the BA Report and no additional management actions would be required beyond the existing monitoring plan. The environmental outcomes will not be affected by the installation of kelp farms.	-ve	Medium	Low	<ul style="list-style-type: none"> Accept this risk. Continue to monitor hypoxia under the rafts. 	Yes Pulfrich 2017 s4.1.2	No

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
24. Break-off of kelp material which is washed onto the beaches; and,	Kelp plants shed leaf material- especially during storms. Different species shed different volumes. The surrounding community in Saldanha Bay are not fully supportive of aquaculture in the Bay and are very opposed to seaweed deposition on the beaches.	It is likely that kelp fronds will be torn during storms and be washed ashore. This cannot be prevented but the uncertain impacts of adverse stakeholder response can be mitigated by speedy clean-up. While adding kelp farms to the ADZ areas may increase the amount of debris being deposited on the beach, no additional management actions are required and the environmental outcomes of the EA will not be affected.	-ve	Medium	Medium	<ul style="list-style-type: none"> • Mitigate this risk. • Beaches in Big Bay and Outer Bay need to be monitored more regularly and any debris removed speedily especially after a storm. 	No	No
25. Breakage of infrastructure resulting in debris which can cause a nuisance to other users (at sea or on the beaches).	Past experience in Saldanha Bay has shown that heavy seas can cause mussels rafts and finfish cages to tear loose and pose shipping nuisance or are deposited on the beaches (sometimes in inaccessible places). Instructions for infrastructure maintenance and repair are included in the existing EMPr. The addition of kelp farms may increase the total amount of infrastructure, but the	It is possible that pieces of infrastructure can be torn loose during storms and be washed ashore. This cannot be prevented but the uncertain impacts of adverse stakeholder response can be mitigated by speedy clean-up. It is important that all farmers share responsibility in this event so that valuable clean-up time is	-ve	Medium	Medium	<ul style="list-style-type: none"> • Mitigate this risk. • Infrastructure must be maintained regularly. • The ECO must be instructed to monitor the maintenance and condition of the kelp farms in addition to the bivalve farms. 	No	No

Impact	Uncertainty	Consequence	+ve, neutral or - ve	Probability	Severity	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmenta l outcomes of EA or EMPr?
	maintenance activities required will not change.	not lost as a result of conflict over who is responsible. The mandated maintenance and cleaning requirements for farm infrastructure must be implemented. No change to the environmental outcomes will result from the introduction of kelp farms.				<ul style="list-style-type: none"> This will need to be included in the updated EMPr. 		

4.4 Summary

Table 5 below summarises the risk evaluated in the previous section. It provides an indication of the spread of positive and negative risks as well as their probability and severity.

Table 5: Summary of risks

Impact	+ve, neutral or - ve	Probability	Severity	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
1. Provision of novel (new) habitat	?	Medium	Low	Yes	No
2. Mitigation of climate change.	+ve	Low	Medium	No	No
3. Water remediation.	+ve	Low	Medium	No	No
4. Protection of habitats and species through the exclusion of more damaging activities.	Neutral	N/A	N/A	N/A	N/A
5. Indirect socio-economic and ecological benefits resulting from seaweed use.	+ve	Low	Medium	No	No
6. Impact of harvesting fertile material.	-ve	Low	Low	No	No
7. Sea-bed scour from mooring chains.	-ve	Low	Low	Yes	No
8. Noise and visual disturbance.	Neutral	N/A	N/A	Yes	No
9. Entanglement of marine mammals and birds.	-ve	Low	High	Yes	No
10. Wave energy attenuation and changes in coastal hydrology.	-ve	Low	Low	No	No
11. Cumulative artificial habitat creation.	See risk 1				
12. Conflict with other users of marine space.	-ve	Low	Medium	Yes	No
13. Crop-to-wild gene flow.	-ve	Low	Medium	No	No
14. Changes to nutrient cycling and carbon storage.	See risk 3				
15. Absorption of nutrients.	See risk 3				
16. Release of dissolved or particulate organic matter.	See risk 3				
17. Spread of parasites and disease.	-ve	Low	Medium	Yes	No.

Impact	+ve, neutral or – ve	Probability	Severity	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
18. Habitat for non-target nuisance species.	-ve	Low	Low	No	No
19. Artificial habitat creation.	See risk 1				
20. Introduction and movement of INNS.	-ve	Low	Low	Yes	No
21. Shading of benthic communities below the rafts.	-ve	Low	Low	Yes	No
22. Increased organic loading of benthos.	-ve	Medium	Low	Yes	No
23. Smothering of benthic communities below the rafts.	-ve	Medium	Low	Yes	No
24. Break-off of kelp material which is washed onto the beaches.	-ve	Medium	Medium	No	No
25. Breakage of infrastructure resulting in debris which can cause a nuisance to other users (at sea or on the beaches).	-ve	Medium	Medium	Yes	No

Table 6: Summary of ratings

-ve, neutral, +ve		Probability		Severity	
uncertain	3	N/A	2	N/A	2
-ve	14	Low	16	Low	11
neutral	2	Medium	7	Medium	11
+ve	6	High	0	High	1
Total	25	Total	25	Total	25

Table 6 further summarises the results. Points of note at this stage are that there is only one risk rated a high severity and this refers to the risk of entanglement. This arises from the extreme negative consequences which can be

anticipated in the event of such an entanglement. The most effective manner in which this risk can be managed is to attempt to prevent such entanglements in their first place. To this end, it is recommended that the designs be scrutinised by the South African Whale Disentanglement Network and other marine mammal specialists and AMC prior to installation.

Table 7 below summarises the recommended management actions in response to the risk ratings. Column 2 is the most relevant column in this regard as it details recommended actions to mitigate the risks identified. These will need to be examined in detail before adoption. However, the most critical columns for this investigation are the final two columns. These columns address:

- whether there is currently sufficient generic information in the Basic Assessment Report, Environmental Authorisation or Environmental Management Program to effectively evaluate the risk identified.

- Whether any substantive changes to the environmental outcomes would be required to mitigate the risk identified. This will determine whether as Part 1 or Part 2 Amendment process is required.

This column is further summarized in Table 8.

Table 7: Summary of additional actions required

Impact	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
1. Provision of novel (new) habitat.	<ul style="list-style-type: none"> • Accept the risk caused by the uncertainty. • Update the annual monitoring plan to include annual assessments of new habitats. • Monitor the development of any new habitats through diver inspections, before and after harvest inspections. • Monitor any adverse impacts on surrounding communities. • This monitoring requirement must be included in the updated EMPr. 	Yes	No
2. Mitigation of climate change.	<ul style="list-style-type: none"> • Accept the risk. • The pilot study can be used to obtain a more accurate estimate of the significance and consequence of this sequestration through ongoing research. 	No	No
3. Water remediation.	<ul style="list-style-type: none"> • Accept the risk. • The fact that nitrogen removal will occur is definite. The pilot study can be used to obtain a more accurate estimate of the significance and consequence of this sequestration through ongoing research. 	No	No
4. Protection of habitats and species through the exclusion of more damaging activities.	N/A	N/A	N/A
5. Indirect socio-economic and ecological benefits resulting from seaweed use.	<ul style="list-style-type: none"> • Accept the risk. 	No	No
6. Impact of harvesting fertile material.	<ul style="list-style-type: none"> • This risk is considered unlikely and of low consequence so, the recommended action is to accept the risk. • The ongoing health of the wild populations that are harvested must be monitored. • This monitoring requirement must be included in the updated EMPr. 	No	Uncertain
7. Sea-bed scour from mooring chains.	<ul style="list-style-type: none"> • Accept the risk. • Annual physical monitoring will be used to detect any significant scour and prompt appropriate remedial action. 	Yes	No
8. Noise and visual disturbance.	<ul style="list-style-type: none"> • Accept the risk. 	Yes	No

Impact	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
9. Entanglement of marine mammals and birds.	<ul style="list-style-type: none"> The recommended management response is to avoid the risk. This would entail having the final layout and design scrutinised by the South African Whale Disentanglement Network and other marine mammal specialists and the AMC before installation. The scrutiny must include distance between rafts, thickness of ropes and chains, any auditory or visual deterrents and response in the event of entanglement. These plans must be approved prior to installation. The design and layout specifications must be included in the updated EMPr. 	Yes	No
10. Wave energy attenuation and changes in coastal hydrology.	<ul style="list-style-type: none"> Accept the risk. In the event that significant changes to the Outer Bay and Big Bay shorelines are detected, an investigation must be initiated to determine whether the kelp farms or any of the ADZ farms are responsible. No changes to the existing EMPr are required. 	No	No
11. Cumulative artificial habitat creation.	See risk 1		
12. Conflict with other users of marine space.	<ul style="list-style-type: none"> Manage the risk. No changes to the existing EMPr are required. 	Yes	No
13. Crop-to-wild gene flow.	<ul style="list-style-type: none"> Avoid the risk. The requirement to use only sori from local populations should be included in the EA and EMPr. 	No	No
14. Changes to nutrient cycling and carbon storage.	See risk 3		
15. Absorption of nutrients.	See risk 3		
16. Release of dissolved or particulate organic matter.	See risk 3		
17. Spread of parasites and disease.	<ul style="list-style-type: none"> This risk should be accepted. The existing bio-monitoring should be expanded to include any probable pest species. This will require an amendment to the existing EMPr. 	Yes	No.
18. Habitat for non-target nuisance species.	<ul style="list-style-type: none"> Avoid this risk with frequent complete harvesting and infrastructure cleansing. This requirement must be included in the updated EMPr. 	No	No

Impact	Risk response	Effect of risk assessed in EA/ EMPr?	Change in Environmental outcomes of EA or EMPr?
19. Artificial habitat creation.	See risk 1		
20. Introduction and movement of INNS.	<ul style="list-style-type: none"> • Accept this risk. • The annual biological monitoring conducted under the auspices of the AMC will check for any INNS. 	Yes	No
21. Shading of benthic communities below the rafts.	<ul style="list-style-type: none"> • Accept this risk. 	Yes	No
22. Increased organic loading of benthos.	<ul style="list-style-type: none"> • Accept this risk. • The existing annual monitoring will be used to track any changes in organic composition under the rafts. • No change to the EMPr is required. 	Yes	No
23. Smothering of benthic communities below the rafts.	<ul style="list-style-type: none"> • Accept this risk. • Continue to monitor hypoxia under the rafts. 	Yes	No
24. Break-off of kelp material which is washed onto the beaches.	<ul style="list-style-type: none"> • Mitigate this risk. • Beaches in Big Bay and Outer Bay need to be monitored more regularly and any debris removed speedily especially after a storm. 	No	No
25. Breakage of infrastructure resulting in debris which can cause a nuisance to other users (at sea or on the beaches).	<ul style="list-style-type: none"> • Mitigate this risk. • Infrastructure must be maintained regularly. • The ECO must be instructed to monitor the maintenance and condition of the kelp farms in addition to the bivalve farms. • This will need to be included in the updated EMPr. 	Yes	No

Table 8: Summary of status of recommendations with regard to the amendment process

Risk assessed in BA		Revise env outcomes	
N/A	1	N/A	1
No	11	No	24
Yes	13	Yes	0
Uncertain	0	Uncertain	0
Total	25	Total	25

Of the risks identified, 13 were considered in detail in the BA report, EA or EMPr. It is noted that frequently the treatment was generic, i.e., the impact of biofouling dropping onto the seabed from the rafts can be comparable to the loss of kelp fronds onto the seabed. Where possible, cross references are provided to guide the reader to the relevant section of the document.

Of the remaining risk, 10 were not dealt with at all but since their probability and severity are low, it is not concerned that these are significant gaps in information at this stage.

Based on consideration of the nature of the risks identified, their probable impacts and provisions made in the existing EMPr, the degree to which the environmental outcomes articulated in the EA will need to be changed is assessed.

The EA was issued with mitigation measures to have the following environmental outcomes:

- No significant change to the water chemistry;

- No significant change to the benthic chemistry and biota;
- Limit conflict with other users of Saldanha Bay;
- Limit the spread of diseases and invasive species; and,
- Limit impact of marine species amongst others.

The EA was issued based on the management actions detailed in the EMPr which takes into account seaweed cultivation although not the same species as envisaged in this Pilot Study. The risk assessment detailed in this report coupled with review of risks detailed in the Marine seaweed aquaculture risk assessment by Jo Kelly, Australian Seaweed Institute January 2023 did not identify any additional risks or risk that could compromise the approved environmental outcomes. However, a Change of Scope application will need to be made to include the three new species in the EA.

This would suggest that a Part 1 amendment process would be applicable. However, the author is not a registered Environmental Assessment Practitioner, although registered with SACNASP and thus the final decision on which amendment process to follow should remain with the case officer at DFFE.

4.5 Conclusion and recommendations

This draft report (version 2) is issued to BSASA and the ADZ AMC to check factual accuracy. Findings and recommendations will be adjusted when all inputs have been received.

Preliminary conclusions are:

1. While neither the original BA or the pre-feasibility reports considered environmental impacts *per se*, the majority of potential impacts and risks are of low significance and can be accepted but subject to monitoring throughout the pilot study.
2. The only risk that is currently not adequately addressed and must be resolved, is the layout and design of the rafts to prevent entanglement and facilitate release. This must be scrutinised by a specialist and the AMC and finalized prior to commencement of the pilot study.
3. Any entanglements must be rigorously investigated, and changes made to infrastructure immediately if required.
4. Each new commercial kelp farm needs to have a dedicated EMPr which must be approved by the AMC prior to installation of the infrastructure. This EMPr must detail monitoring and inspection routines as well as responses to the monitoring results. It must also include details of reporting to the ECO and AMC/ Component Authority.

Appendix 1: Literature consulted

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- Würsig, B. 2020. Marine Mammals and Aquaculture, with special emphasis on Open Ocean Water of New Zealand. Draft report prepared for Fisheries New Zealand.

Appendix 2: Project team qualifications

Errol Cerff is a qualified environmental auditor with thirty years of experience in auditing a range of activities from post construction audits to manufacturing and mining concerns.

Errol has extensive experience in the field of marine environmental management. While in the employ of the CSIR he developed beach and coastal zone management plans for local authorities and was part of a team which provided technical advice on coastal management to a range of local authorities and private concerns.

He was the External Environmental Control Officer for the Project Ikhwezi drilling off Mossel Bay, a contract which entailed stakeholder engagement, oversight of spill management and general environmental protection. He was also responsible for drafting a First Response Protocol to accompany the Ikhwezi Emergency Response Plan.

He has since completed a 12-month Fixed Term Contract as Corporate Environmental Leader for PetroSA. This position within a large company, as opposed to an outside external part as is normally the case, has provided him with a more experiential knowledge of environmental protection in a dynamic marine environment. Part of his duties were to revise and update the PetroSA Oil; Spill Response Plan and to take part on the Phakisa National Oil Spill Response Planning.

Of more relevance to the Saldanha Bay ADZ is the three projects on coastal zone access he managed for the Western Cape Provincial Department of Environmental Affairs and Development Planning (DEA&DP), a series of projects which provided an in-depth understanding of marine environmental management at local and provincial level and the needs and aspirations of stakeholders in the coastal zone.

He was the project manager for the revitalisation of the Breede River Estuary Advisory Forum (BREAf) under the auspices of the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) which involved resolving past conflicts and designing the new BREAf to avoid repetition of such conflicts.

Finally, his experience as the ECO for the ADZ under the auspices of Ecosense for two years has given him a detailed understanding of the ADZ and the aquaculture activities taking place there and a further six months as ECO from March to September 2020 and again on a month-to-month basis from October 2021. He was responsible for refining the Emergency Response Protocol subsequent to the whale entanglement and developing monitoring and checking checklists for all operations. He was responsible for two annual updates of the EMPr. He is therefore well qualified to undertake this project.

Wynand (Erik) Botha fulfilled the functions of secretariat and provided a back-up to the ECO). Erik is a qualified and experienced environmental management practitioner and has been involved in and managed a wide range of projects ranging from basic assessments, impact assessments, environmental risk assessments, management systems design and implementation, due diligence investigations, management plans, waste management plans and enterprise-wide risk

assessments. These projects covered a wide range of public and private sector activities and included a variety of industries. The bulk of his project experience has been in the coastal region of South Africa, and he is very familiar with the salient issues and drivers associated with the coastal environment.

Erik was involved as a senior consultant in the coastal access audits for both the West Coast and Eden District Municipalities, in accordance with the Provincial Coastal Access Strategy and Plan. During the course of the last three years, he has been involved as a senior consultant in the coastal access audit and pilot study for the Overberg District, the development of the Coastal Access Strategy for the Western Cape, the development of a Limited Environmental Management Framework (EMF) in Support of the Mossel Bay Spatial Development Framework (SDF) as well as the facilitation and reporting on an Estuary Management Stakeholder Workshop for the Western Cape.

He also has extensive experience as an ECO, EO and ESM on a variety of projects.

He managed the stakeholder engagement process towards revitalising the Breede River Estuary Advisory Forum (BREAf) under the auspices of the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) which involved resolving past conflicts and designing the new BREAf to avoid repetition of such conflicts.

During 2018, Erik served as the Secretariat for the Saldanha Bay ADZ. He fulfilled this role again from October 2020 to September 2021 and again on a month-to-month contract basis from October 2021, which has been extended to March 2022.

Erik is a member of IAIA SA, and the Institute of Waste Management of South Africa.

His involvement in Saldanha has made him familiar with the area and operations and the range of authorities involved- these contacts will be useful in ensuring that this project achieves its desired aims.

Appendix 3: Team member CVs



Curriculum Vitae: Errol Christopher Cerff:

Sole Proprietor:
Independent Environmental
Consultant

Personal Details

Date of birth	11 October 1958
ID Number	581011 5240 084
Citizenship	RSA
Home language	English

Contact Details

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website	www.errolcerff.co.za

Qualifications

Degree	B.Sc	B.Sc (Hons)	M.Sc
University	Natal (Durban)	Natal (Durban)	Natal (Durban)
Year	1981	1982	1989
Subjects	Environmental Biology Cell Biology	Estuarine ecophysiology Vertebrate physiology	Estuarine ecophysiology

Professional registration

South African Council for Natural Scientific Professions (SACNASP)	Registered as Principal Natural Scientist (Pr. Sci. Nat) Reg Number 400047/12
The Institute of Waste Management South Africa (IWMSA)	Member
The Institute of Risk Management South Africa (IRMSA)	Member
IAIA (SA)	Member
Environmental Management & Assessment (IEMA)	Formerly registered as international environmental auditor (registration

	allowed to lapsed in response to low recognition in SA)
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Summary Of Experience

Errol began his career with the CSIR conducting estuarine surveys and providing advice on coastal management to local authorities. He was then involved in developing coastal management plans before the advent of the National Environmental Management Act.

He worked with the likes of Dr George Begg in the early days of the Natal Town and Regional Planning Commission to establish wetland management programmes. He assisted the Working for Wetlands Programme develop their five-year strategy in 2015 and then conducted external compliance assessments of the programme for 7 consecutive years from 2008 to 2014 when the external assessments ceased. He is currently contracted to develop a comprehensive performance assessment tool which not only examines the inner workings of Working for Wetlands but also its value in the wider South African and Global communities.

He is a qualified environmental auditor and management system consultant with over twenty years of experience in auditing a range of activities from post construction audits to ongoing environmental risk assessments of manufacturing and mining concerns. Specifically, his involvement in phase one due diligence investigations for a number of organisations has given him the ability to identify possible pollution source and impacts and then manage phase two detailed investigations to confirm the pollution and plan remediation.

He has participated in and managed environmental risk assessments and compiled environmental and waste management plans for heavy industry and SMMEs as well as construction companies. His involvement in Enterprise-wide Risk Assessments has given a more strategic, business-based and corporate governance approach to both environmental risk assessments and environmental management plans.

He was the external Environmental Control Officer (ECO) for the Project Ikhwezi drilling off Mossel Bay during which time he gained valuable experience in both the oil and gas industry and ECO work.

His strength is his ability to think outside of the box and adapt to a variety of situations and teams to provide pragmatic and practical solutions to environmental problems. His experience gained while participating in total quality management teams has enabled him to design management systems that dovetail smoothly with client's existing systems and not exist as add-ons.

His experience as the Corporate Environmental Leader for PetroSA in the HSEQ department has further extended his experience in aspects of the oil and gas industry by being on the management side, rather than the advisory side. In this capacity he was responsible for compiling SHE management plans for various phases of oil and gas exploration, developing risk assessment matrices as well as monitoring compliance of the contractors. This has given him a keen understanding of HSEQ management in the O&G industry.

His portfolio of service offerings include:

- Strategic evaluation
- Strategic planning
- Environmental risk assessments
- Environmental audits
- Coastal and estuarine management plans
- Coastal access audits
- Monitoring and evaluation programmes
- Environmental strategy development
- Environmental management plans
- Waste minimisation
- Waste management plans
- Project management of environmental projects

More details on his work experience and project resume follow.

EMPLOYMENT RECORD			
Date	Employer	Position	Duties
Aug 2005 to present	Self Employed	Sole Proprietor: Independent Environmental Consultant	<ul style="list-style-type: none"> ➤ Conduct strategic evaluation & planning ➤ Conduct Environmental Risk Assessments and audits ➤ Develop Environmental Management Plans (EMPs) ➤ Develop and perform monitoring and evaluation programmes ➤ Environmental ➤ Assemble teams to conduct cleaner production assessments ➤ Project manage general environmental projects
Mar 2002 to Aug 2005	Common Ground SDC (Pty) Ltd	Principal Environmental Consultant	<ul style="list-style-type: none"> ➤ Conduct and/ or manage environmental audits, risk assessments, impact assessments and management systems design and general environmental consulting on a contract basis for various clients both private and public. ➤ Overall management of all project budgets for the company.
Aug 1996 to Feb 2002	Environmental Risk Services (Pty) Ltd (a division of Alexander Forbes) (Formerly called CRM International: a division of Price Forbes)	Environmental management consultant and then Deputy Managing Director from December 1997	<ul style="list-style-type: none"> ➤ Conduct and/ or manage environmental audits, risk assessments, impact assessments and management systems design on a contract basis for various clients. ➤ Conduct training and awareness programmes for various clients. ➤ From 1997, as Deputy Managing Director, take functional responsibility for the preparation of the company's budget and both short and long term financial tracking and for the human resource management of the company. ➤ Take responsibility for initiating product development within the company in response to market needs (such as a revised environmental risk assessment technique.)

EMPLOYMENT RECORD

Date	Employer	Position	Duties
1991 – July 1996	CSIR: STELLBOSCH: Division of Earth, Marine & Atmospheric Science Technology (transfer)	Senior researcher, Coastal Environmental management Programme	<ul style="list-style-type: none"> ➤ Participate in and conduct research into estuarine biology. ➤ Provide environmental management advice to developers and planners in the coastal zone. ➤ Participate in the development and implementation of a low level environmental monitoring programme (CLEO) for beaches and estuaries. ➤ Participate in the establishment of a CSIR core team to develop environmental auditing and management system design capabilities and skills in the CSIR. ➤ Conduct environmental audits for private enterprises. ➤ Develop environmental management systems for private enterprises. ➤ Develop and conduct environmental auditing and awareness courses.
1983 – 1991	CSIR: DURBAN: Division of Water Technology	Senior researcher, Natal Estuarine and Coastal Research Programme (NECRU)	<ul style="list-style-type: none"> ➤ Conduct and manage biological surveys of all 73 estuaries on the Natal Coast on behalf of the Natal Town and Regional Planning Commission. ➤ Conduct ad hoc environmental investigations with respect to proposed developments or rezoning applications on behalf of Natal Town and Regional Planning Commission. ➤ Participate in the Coastal Zone Action Committee (COZAC) meetings chaired by the Natal Town and Regional Planning Commission (Physical Planning Directorate) as a scientific advisor. ➤ Development of coastal zone management plans for local authorities. ➤ Assist in the development of a coastal zone management manual on behalf of the Department of Environmental Affairs and Tourism and assist in the series of courses presented to local authorities in Natal and the Cape Provinces.

Recent Environmental Project Experience in South and Southern Africa

Year	Project Description	Client
Contracts and Projects as a Sole Proprietor		
2022	Environmental Due Diligence Review of four sites for Denel Properties	Profica (Pty) Ltd
2022	OEMP and MMP for Erven 1341 and 1884 – Bakoven	McGregor Family Trust
2022	External chair of the A-Thermal and Cecor Environmental Monitoring committee	A-Thermal
2022	External compliance audit of Chapmans Bay Estate	HOA
2021	External compliance audit of Longbeach Mall	Van der Spuy & Ass
2021	OEMPr and MMP of erven 11341 and 1884	McGregor Family Trust
2021	External ECO for the Saldanha Bay Aquaculture Development Zone (ongoing)	DFFE
2021	Implementation of the Breede River Estuary Management plan and reformation of the Breede River Estuary Advisory Forum	DEA&DP
2020	External ECO for the Saldanha Bay Aquaculture Development Zone (ongoing)	DAFF
2019	Development of a comprehensive performance assessment system for Working for Wetlands	DEFF
2019	External Compliance audit of Big Bay Development, Blouberg	Big Bay MPOA
2019	External Compliance audit of Stonehaven Estate, Kuisrivier	Bo Mo Properties
2018	External ECO for the Saldanha Bay Aquaculture Development Zone	DAFF
2018	Audit of coastal access on the West Coast and Garden Route	DEADP
2018	Limited EMF of Mossel Bay	DEADP
2018	Audit of Coastal Access in the Overberg Municipality	DEADP
2017	Project Phakisa- assistance in the development of the National Oil Spill Contingency Plan and associated risk assessment and organisational structure	Phakisa B1
2017	Development of a waste management plan for Temane gas power station- Mozambique	Impacto Lda
2017	FTC Corporate Environmental Leader	PetroSA
2016	Screening for a proposed sand winning mine in Atlantis	Atlantic sands
2016	Limited EMF for Mossel Bay	DEADP
2016	Development of a Coastal Access Strategy for the Western Cape Government	DEA&DP
2016	FTC Corporate Environmental Leader	PetroSA
2016	Review of waste management impact specialist study for a refinery in Mozambique	Impact Lde
2016	EIR for Kamiesberg Landfill	Ecosense
2016	Facilitate two day workshop for Estuary Management Forums	DEADP

Year	Project Description	Client
2015	Lecture on offshore risk and waste management for the Tanzanian Government's National Environmental Management Council	Lwandle Technologies
2015	Scoping report for a landfill for Kamiesberg Municipality	Ecosense
2015	Registration of a waste transfer station for Hondeklipbaai	Ecosense
2015	Risk assessment for Saldanha Bay mussel farm	Ecosense
2015	Development of a timeline for environmental approvals and stakeholder engagement for decommissioning of an oil field	McGregor Family Trust
2015	Registration of a waste transfer station and management plan development for Hondeklipbaai	Ecosense
2014	External ECO Offshore drilling program	PetroSA
2014-15	HSE Co-ordinator for metocean data collection for Palma offshore oil exploration by Anadarko	Lwandle technologies Pty Ltd
2014-15	HSE Co-ordinator for metocean data collection for Durban Dig-out Harbour	Lwandle technologies Pty Ltd
2014-16	Three year external audit cycle of all waste management facilities	City of Cape Town
2014	Incident management plan and hazardous materials handling plan for a sugar factory in Massingir, Mozambique	Impact Lda.
2014	External ECO Offshore drilling program	PetroSA
2014	External Performance Audit of Working for Wetlands	Working for Wetlands
2013	External compliance audit of the Water Use License at the GTL site	PetroSA
2013	External compliance audit of the GTL waste disposal facility	PetroSA
2013	Waste management impacts assessment for the proposed Massingir Sugar plantation and factory	Impacto Lda
2013	External performance assessment of Working Wetlands	SANBI
2013	Update the Breekon waste management procedure	Breekon Construction
2013	Development of a storm water management plan for Hotel Verde for LEED registration	Morroff and Kuhn
2013	Environmental Compliance Audit of Big Bay	Big Bay ELC
2013	Environmental Compliance Audit of Green Point Stadium	Ecosense
2013	Assistance with the development of aspect and impacts registers for GTL Refinery and associated facilities. Mossel Bay	PetroSA
2013	External Environmental Control Officer for the Project Ikhwezi offshore gas drilling programme	PetroSA
2012	Input to the marine impacts assessment of a proposed Manganese Terminal in Coega Harbour	Lwandle Technologies (Pty) Ltd
2012	Review of waste management compliance of two service providers	Bergstan (Pty) Ltd
2012	External performance assessment of Working Wetlands	SANBI
2012	oEMP for abalone ranching	Ecosense CC
2012	External compliance audit of Worcester Interchange	Ecosense CC
2012	Environmental risk assessment of abalone ranching in Hondeklip Bay	Ecosense CC

Year	Project Description	Client
2012	External environmental compliance Audit of Green Point Stadium	Ecosense CC
2012	Development of an Integrated Waste Management Plan for Total*	Environment Counsel CC
2012	Baseline marine ecology survey for the proposed OTGC bulk storage facility, Ngqura Harbour*	Lwandle Technologies (Pty) Ltd
2012	Development of a waste management plan for Breekon Construction	Breekon Construction (Pty) Ltd
2011	Development of a waste management plan for Giuricich Construction	Giuricich Brothers Construction (Pty) Ltd
2011	Development of a waste management plan for Sea Kay Construction	Sea Kay Construction (Pty) Ltd
2011	Development of a construction phase and operational phase Environmental Management Programme for the City of Cape Town proposed Water Treatment works at Muldersvlei	Chand Environmental Consulting
2011	External Performance Audit	Working for Wetlands
2011	Risk report and waste management plan for BoysTown Nyanga	Ecosense CC
2011	Environmental review of FPT Group (Pty) Ltd – Durban	FPT Group (Pty) Ltd – Durban
2011	External environmental compliance Audit of Green Point Stadium	Ecosense CC
2011	Phase One Environmental Investigation	Dorbyl Magnetto
2011	Facilitation of strategic planning workshops	Working for Wetlands
2011	Development of standard operating procedures for Working for Wetlands	Working for Wetlands
2010	External Performance Audit of Working for Wetlands	Working for Wetlands
2010	*Development of an Invasive Alien Species Policy for the City of Cape Town	City of Cape Town
2010	Development of clean-up method statement for Vusela Construction (Pty) Ltd	Vusela (Pty) Ltd
2010	*Development of and inauguration of the Green Point Urban Park Forum	City of Cape Town
2010	Environmental compliance audit of the life science building at University of the Western Cape	Ecosense CC
2010	Environmental due diligence audit of Paarl Media Cape	Paarl Media Cape
2010	Environmental due diligence audit of Paarl Media Paarl	Chameleon Architects
2010	Environmental compliance audits of Grinaker-LTA Building division in Western and Eastern Cape	Grinaker-LTA Building Cape

Year	Project Description	Client
2009-2010	*Revision of the EMPs of all PetroSA offshore installations and revision of decommissioning options for all offshore structures owned by PetroSA.	PetroSA
2009	External Compliance audit of Big Bay	Big Bay ELC
2009	External Performance Audit of Working for Wetlands	Working for Wetlands
2009	*Environmental audits of 4 General Motors Sites in Port Elizabeth for General Motors (including hazardous waste management facilities)	General Motors
2009-2010	*Development of the compliance management system for Green Point Stadium and Urban Park	City of Cape Town
2008	*Performance audits of 41 Working for Wetlands Rehabilitation sites	Working for Wetlands
2008	*Compilation of an Estuarine Management Plan for the Bot River	C.A.P.E
2008	Post construction environmental compliance audit of Fernkloof Golf Estate	Rabie Property Administrators
2008	External environmental audit of the waste management facility at the GTL Refinery: Mossel Bay	PetroSA
2008	External Audit of Big Bay	Big Bay ELC
2008	External audit of Green Point Stadium	Ecosense
2008	Feasibility study of using norms and standards for the regulation of environmental activities in SA	DEAT
2007	*Compilation of an Estuarine Management Plan for the Klein River	C.A.P.E
2007	*Environmental Risk Assessments and audits of selected Tiger Brands Sites	Alexander Forbes
2007	Post-construction environmental audit of Pinnacle Point Beach and Golf Estate: Mossel Bay	Pinnacle Point Development
2007	*Compilation of the South African Country Study on Wetlands	IUCN
2007	Assistance with the evaluation of environmental impact assessment applications in terms of the ECA	DEADP
2007	*Evaluation of the impact of the poverty alleviation projects of the Western Cape Provincial Department of Social Development	Pdg (Pty) Ltd
2006	*Evaluation of decommissioning options for the decommissioning of the PetroSA Oribi/ Oryx Oilfields	Lwandle Technologies
2006	Interim Environmental Audit of Fernkloof Golf Estate	Ecosense CC
2006	Interim environmental audit of Big Bay, Melkbosstrand	Rabie Property Administrators
2006	*Supplementation for the EIA Regulations	DEADP
2006	Socio-economic evaluation of the ICLEI 2006 World Congress	ICLEI/ City of Cape Town
2006	*Supplementation of the EIA Regulations	DEA&DP
2005	*Strategic evaluation of the Upstream Training Trust	Upstream Training Trust
Contracts and Projects Whilst in the Employ of Common Ground Consulting		
2005	*Development of an overarching strategy for the Working for Wetlands Programme	Working for Wetlands

Year	Project Description	Client
2003	External review of the appeal against the Record of Decision for the proposed upgrade of the Pavilion swimming pool in Sea Point	DEA&DP
2005	Environmental audit of Lake Michelle	Lake Michelle Home Owners Association
2004	Environmental risk assessments for three Meadowfeeds operations	Alexander Forbes
2004	*Development of a business plan for a cleaner production centre in Durban	Capacity Building, Leadership and Action (CBLA)
2003	Development of guidelines for the demolition of a Daphne class submarine	SA Navy
2003	Environmental due diligence/ property transfer audit of Biovac Laboratories	BIOVAC
2003	*Participated in review of the Danced cleaner production initiatives in the textile and metal finishing industries	DANCED
2003	Peer review of IEM briefing documents produced for the Department of Environmental Affairs and Tourism	CSIR
2003	*Development of an environmental management plan for the Cape Agulhas Municipal application for a recreation use area at Die Plaat	Cape Agulhas Municipality
2003	*Development of an environmental management plan for the construction of a test groyne to remedy erosion problems at Langebaan Lagoon	Saldanha Bay Municipality
2003	*Development of an environmental management plan for the demolition of damaged resort infrastructure at La Mercy Lagoon, KwaZulu Natal	eThekweni Municipality
2003	External review of the appeal against the Record of Decision for the proposed Arniston Pipeline	DEA&DP
2003	External review of the appeal against the Record of Decision for the proposed Kraaibosch Regional Shopping Mall	DEA&DP
2003	External review of the appeal against the Record of Decision for the proposed Lake Michelle Development in Noordhoek	DEA&DP
2003	*Technical inputs to a handbook on greening conferences and other events	IUCN
2003	*Waste minimisation guidelines for use in the EIA approval process focusing on the following industries: construction, resorts, wine cellars and feedlots and abattoirs	DEA&DP
2002	Monitoring and evaluation of the greening of the World Summit on Sustainable Development	IUCN
2002	Aspects and impacts register	Fresh produce Terminals
2002	*Briefing documents on sustainable development	BCSD

Year	Project Description	Client
Contracts and Projects Whilst in the Employ of Environmental Risk Services (Pty) Ltd¹		
Institutional and Policy Work		
1999 / 2000	* Identification and evaluation of options for the development of an environmental management department in the iGoli unicity initiative	Cowi and Southern Metropolitan Substructure
1999	Project Management of the Global Carbon Initiative: National Strategy for Joint Implementation Study.	World Bank
1997	* Participation in the drafting of the Discussion Document and White Paper on Integrated Pollution and Waste Management	Department of Environmental Affairs and Tourism.
Legal Studies		
1998	* Legal review of aspects and impacts register of environmental management system in accordance with the requirements of ISO 14001	Metpro
1997	* Legal compliance audits of all operating entities	Ingwe
1996	* Environmental legal compliance audits of all operating companies	Samancor
Environmental Reviews		
2000	* Phase one environmental investigations	Meadowfeeds Pietermaritzburg and Paarl
2000	Phase one environmental investigation for Central East African Railways in Malawi to satisfy World Bank requirements.	CEARL
1999	* Environmental performance reviews	Meadowfeeds Pietermaritzburg and Paarl
1999	* Environmental surveys at fifty operations	Dorbyl
1999	Initial environmental reviews of four Consol operations	Consol
1999	Environmental reviews of Plascon operations throughout South Africa	Plascon
1999	Initial environmental review of the National Accelerator in Faure	National Accelerator Centre
1998	Initial environmental review of a steel foundry	CISCO Steel
1997	Environmental reviews of seven power stations	Kenya Power and Lighting Company
1996	Environmental reviews of the Chapalet and Port Elizabeth sites of Cadburys Pty Ltd#	Cadburys Schweppes
1996	Environmental reviews of two Bromor Foods sites in the Western Cape#	Cadburys Schweppes
1996	Environmental reviews of a pine plantation and sawmill in the Mpumalanga area	Safcol

¹ Note: Prior to 1 April 1997, projects were conducted in the name of CRM International (Pty) Ltd

Year	Project Description	Client
Environmental Management Systems Design		
1999	Development of an aspects and impacts register for ISO 14001	Metpro
1999/ 2000	ISO 14001 environmental management system	Plascon Inks Packaging and Coatings:: Epping
1998	Development of an integrated management plan for Robben Island Museum	Robben Island Museum
1997	* Initial environmental review towards the development of an ISO 14001 environmental management system	Delta Motor Corporation
1997	Development of an environmental management system (joint venture with Sue Lane and Associates and African Environmental Solutions)#	De Beers Marine
1997- 1999	Development of an environmental management system#	Kenya Power and Lighting Company
Risk Surveys		
2000	Facilitate business risk workshops for AVMIN in Kitwe, Zambia	Avmin
1999	* Environmental risk surveys	Goldfields
1997	Assessment of environmental risks and liabilities at Telkom Submarine Cable Station, Melkbosstrand	Telkom
1997	Identification of environmental risks and liabilities at Telkom – Gauteng Central	Telkom
Due Diligence Audits		
2000	Environmental Due Diligence Assessment of 7 sites	Ethos Private Equity Ltd
2000	Environmental Due Diligence Assessment of 3 sites	Webber Wentzel Bowens
1998	* Environmental due diligence for tyre manufacturing operation#	First Corp Capital
1998	Environmental due diligence for quarrying operations	First Corp Capital
Environmental Impact Assessments		
1998	* Scoping phase EIA for infrastructure upgrades	Robben Island Museum
1997	* Environmental impact assessments of two proposed bottling plants#	Century Bottling Company, Uganda
Chemical Handling/ Additional Services		
2000	* MHI risk assessment	Plascon
1999	* MHI risk assessment	Toyota
Training		

Year	Project Description	Client
1998	* Environmental legal Training	Plascon
1998	General environmental and auditing training	Kenya Power and Lighting Company
1997	* Training of senior management in auditing, ISO 14000 series, South African legal requirements and the EIA process#	Plascon
Other		
1999	External review of submissions for the application for World Heritage Status of Sterkfontein	Kagiso-Cowi
2000-2001	* Enterprise wide risk management and development of risk management manual for BHP-Billiton	BHP Billiton
2001	Enterprise wide risk management for Duferco Steel	Duferco Steel Saldanha
2001	Development of a business continuity plan	I&J
Some Contracts and Projects Whilst in the Employ Of CSIR		
1996	Expert witness in the Township Appeal Board hearings in respect of the proposed Chlookop hazardous waste landfill site	Midrand Town Council
1996	Development of a mine closure protocol	Chamber of Mines
1996	* Environmental impact assessment: FA Satellites Development Project	Mossgas
1996	* Environmental Impact Assessment: E-BT oil fields: Agulhas Bank	Soekor
1995	Environmental audit	Alusaf Hillside Smelter
1995	Environmental management system audit: Saldanha Bay:	Portnet Saldanha and SFF
1995	Development of an environmental policy	MMC
1995	Development of the environmental manager's portfolio	MMC
1995	* Environmental situation analysis: Manganese Metal Company: Krugersdorp and Nelspruit	MMC
1995	Property transfer audits	Siemens
1995	Environmental situation analysis	PFG
1994	Environmental auditor training course	Sasol 1, 2 & 3
1994	*Development of an environmental management manual	Portnet Richards Bay
1994	Property transfer audits of nine sites in South Africa	CPC International
1994	Environmental situation analysis	Portnet Richards Bay
1993	Environmental management systems audit	Sasdiens
1991	*Drafting of a white paper on environmental auditing	DEAT

Curriculum Vitae: Wynand Frederik (Erik) Botha

Personal Details	
Date of birth	12 November 1967
ID Number	671112 5020 087
Citizenship	RSA
Language	English, Afrikaans

Contact Details	
Address	15 Brigantine Avenue, Sun Valley, Fish Hoek 7975
Telephone	021-7855664
Cell	082-451 6881
e-mail	erik@erikbotha.co.za

Qualifications	
1990	B.Sc in Botany and Entomology from the University of Pretoria
1991	Basics of Environment Auditing for the Business Manager at UCT's GSB
1992	Certificate course in auditing techniques from ESKOM
1993	Advanced environmental auditing and management system design at IEA, Lincoln, UK
1994	Basic facilitator skills development, Participlan, Stellenbosch
2013	IRMSA Ongoing Training, Principles of Risk Management

Professional registration	
The Institute of Waste Management South Africa (IWMSA)	Member
International Association for Impact Assessment South Africa	Member

Summary of experience

Erik has been involved in environmental consulting for almost 30 years, specialising in environmental auditing. He has undergone extensive training in this field, both locally and internationally. His experience base covers a wide spectrum of private and public sector clients and ranges from internal baseline audits, initial reviews, pre-acquisition audits, due diligence investigations, regulatory audits and compliance audits. He also has extensive experience as an ECO, EO and ESM on a variety of sectors.

He has also been involved in and managed a wide range of projects ranging from basic assessments, impact assessments, environmental risk assessments, management systems design and implementation, due diligence investigations, management plans, waste management plans and enterprise wide risk assessments. These projects covered a wide range of public and private sector activities and included a variety of industries.

The bulk of his project experience has been in the coastal region of the Western Cape and he is very familiar with the salient issues and drivers associated with the coastal environment.

Erik is a member of the Institute of Waste Management of South Africa and the International Association for Impact Assessment South Africa.

Service offerings include

- Environmental risk assessments
- Environmental audits
- Environmental Control Officer, Environmental Officer and Environmental Site Manager
- Monitoring and evaluation programmes
- Environmental and cleaner production strategy development
- Waste management plans
- Cleaner production assessments
- Basic Assessments and Scoping Environmental Impact Assessments
- Project management of environmental projects

Employment Record

Date	Employer	Duties
2012 to Current	Self Employed	<ul style="list-style-type: none"> • Participate in and project manage general environmental projects • Conduct Environmental Assessments (BAs and Scoping EIAs) • Conduct Environmental Risk Assessments and Audits • Develop Environmental Management Plans (EMPs) • Develop and perform monitoring and evaluation programmes • Conduct waste management assessments • Conduct cleaner production assessments
2000 to 2012	Self Employed	<ul style="list-style-type: none"> • Involved in a variety of activities and initiatives in the manufacturing industry
1995 to 2000	Environmental Risk Services (Pty) Ltd (a division of Alexander Forbes)	<ul style="list-style-type: none"> • Conduct and/ or manage environmental audits, risk assessments, impact assessments and management systems design on a contract basis for various clients. • Conduct training and awareness programmes for various clients.
1993 to 1995	CSIR: STELLBOSCH: Division of Earth, Marine & Atmospheric Science Technology	<ul style="list-style-type: none"> • Participate in the establishment of a CSIR core team to develop environmental auditing and management system design capabilities and skills in the CSIR. • Conduct environmental audits for private enterprises. • Develop environmental management systems for private enterprises. • Develop and conduct environmental auditing and awareness courses. • Participate in and manage Environmental Impact Assessments.
1991 to 1993	Department of Environment Affairs	<ul style="list-style-type: none"> • Assist in the Department's initiatives relating to environmental auditing and resource economics.
1990 to 1991	SANDF	<ul style="list-style-type: none"> • SO4 Ecological Services for Northern Province Command responsible for initiating and coordinating SANDF conservation programmes in the area.

Environmental Project Experience

Year	Project Description	Client
2022	Regulation 34 External Compliance Audit of Chapman's Bay Estate	Chapman's Bay Estate Manager
2022	Regulation 34 External Compliance Audit of Longbeach Mall, Operational Phase Environmental Management Plan	AVDS Environmental Consultants
2021	Breede River Estuary Management Plan Implementation Assistance	Western Cape Department of Environmental Affairs and Development Planning (DEA&DP)
2021	A-Thermal: EMC Meeting Secretariat duties	Mondial
2020 ongoing	Saldanha Bay Aquaculture Development Zone: Secretariat to the Consultative Forum and the Authorities Management Committee.	DFFE: MLRF
2020	De Beers EIA for bulk sampling activities, Sea Concession 6C: Stakeholder Engagement Process Consulting	SLR Consulting (South Africa) (Pty) Ltd
2019	Mile 16 Yzerfontein EMPr	inClover Environmental Consulting (Pty) Ltd
2019	ECO: Saron Bulk Water Pipeline Replacement Phase 2	Knight Piésold (Pty) Ltd (Cape Town)
2019	ECO: Farm 220 Sandown Estate, Pearly Beach - Section 24G Rectification	InClover Environmental Consulting
2019	Development of a Comprehensive Performance Assessment Tool for Working for Wetlands: Senior Consultant	DEFF: Natural Resource Management Programmes
2019	Basic Assessment: Oakdene Aquaculture/Aquaponic Project	Lynne Matthysen Catering CC
2019	Stonewood Estate: Auditing of compliance with environmental authorisation	Bo Mo Property Developers (Pty) Ltd
2019	Part 2 Amendment: Proposed expansion of the agricultural areas on Farm: Welvaart 443, Ceres	InClover Environmental Consulting
2019 ongoing	Coastal Access Audit for the West Coast and Garden Route Districts in accordance with the Provincial Coastal Access Strategy and Plan	Western Cape Department of Environmental Affairs and Development Planning (DEA&DP)

Year	Project Description	Client
2022	Regulation 34 External Compliance Audit of Chapman's Bay Estate	Chapman's Bay Estate Manager
2022	Regulation 34 External Compliance Audit of Longbeach Mall, Operational Phase Environmental Management Plan	AVDS Environmental Consultants
2018	Saldanha Bay Aquaculture Development Zone: Secretariat to the Consultative Forum and the Authorities Management Committee.	Department of Agriculture, Forestry and Fisheries
2018	Coastal access audit and pilot study for the Overberg District in accordance with the Provincial Coastal Access Strategy and Plan	Western Cape Department of Environmental Affairs and Development Planning (DEA&DP)
2017	Basic Assessment for the proposed Atlantic Sands, Sand winning operation in Saxonwold: Assistant EAP	Ecosense CC
2017	Basic Assessment for the proposed Atlantis Crematorium: Assistant EAP	Ecosense CC
2017	External Environmental Compliance Audit of Big Bay, Milnerton: Principal Auditor	Big Bay Master Property Owners Association
2017	Development of a Coastal Access Strategy and Plan for the Western Cape: Senior Consultant	Western Cape Department of Environmental Affairs and Development Planning (DEA&DP)
2016 - 2017	Development of a Limited Environmental Management Framework (EMF) in Support of the Mossel Bay Spatial Development Framework (SDF): Senior Consultant	Western Cape Department of Environmental Affairs and Development Planning (DEA&DP)
2016 - 2017	Scoping EIA for the proposed Garies landfill site: Assistant EAP	Ecosense
2016	Good Hope Construction: Erf 24745 Parow - Site Environmental Management Plan: Author	BPAS Architecture
2016	Tender No. 218Q/2014/15- Rehabilitation of De la Rey Street between Franci van Zijl Drive and Robert Sobukwe Road – Environmental Control Officer (ECO)	Knight Piésold (Pty) Ltd (Cape Town)
2016	Project: 115Q/2015/16 Rehabilitation of various roads in Bishop Lavis – Environmental Control Officer (ECO)	Knight Piésold (Pty) Ltd (Cape Town)
2016	Develop a Demolition Phase Integrated Waste Management Plan for the Woodstock Quarter Project	Swish Property Eighteen (Pty) Ltd

Year	Project Description	Client
2022	Regulation 34 External Compliance Audit of Chapman's Bay Estate	Chapman's Bay Estate Manager
2022	Regulation 34 External Compliance Audit of Longbeach Mall, Operational Phase Environmental Management Plan	AVDS Environmental Consultants
2016	Facilitation and Reporting on an Estuary Management Stakeholder Workshop	Western Cape Department of Environmental Affairs and Development Planning (DEA&DP)
2014-17	City of Cape Town, Waste Disposal Facilities: External Compliance Auditing Program - Auditor	Chand Environmental
2015	Ravensmead Informal Settlement: Initial Screening	Bergstan SA
2015	Bodensee, Cape Farm 953/12, Sardinia Drive (Sunnydale): Environmental Officer	3 Green Development
2015	Dock Road Office Building, V&A Waterfront: ECO	Ecosense CC
2015-2018	Basic Assessment for the proposed development of the Maroela Informal Settlement: Assistant EAP	Ecosense CC
2014	Development of a Framework Environmental Management Plan	DriftXtreme
2014	Working for Wetlands Annual External Audit: Auditor	Ecosense CC
2014	Development of a Generic Environmental Management Plan	MSD Construction
2014	Development of a Risk Based Methodology for Auditing of Monitoring Systems	Lwandle Technologies
2014-15	Rehabilitation and Stabilisation of Chapman's Peak Drive : Designated Environmental Officer	Penny Farthing Engineering (SA)
2014-15	Atlantic Beach Estate: Environmental Auditor	Ecosense CC
2013	ROADMAC MR282, Development of Method Statements	ROADMAC Cape (Pty) Ltd
2013-14	Massingir Agricultural Project Mozambique, Waste Assessment and Preparation of a Waste Management Plan: Specialist Consultant	Impacto
2013-14	Development of the CPV1 Solar Touwsriver Solar Power Plant: ECO	Ecosense CC
2013	Working for Wetlands Annual External Audit: Auditor	Ecosense CC
2013	PetroSA Water Use Licence Compliance Audit: Auditor	Lwandle Technologies
2013-14	Basic Assessment for the Proposed upgrading of the Kalkfontein Informal Settlement: Assistant EAP	Ecosense CC
2013	Hotel Verde Stormwater Management Plan and LEED registration: Lead Environmental Practitioner	Moroff & Kuhne Consulting Engineers
2013	Ad Hoc Setback Application for Erf 404 Clifton: Assistant EAP	Ecosense CC
2013	Green Point Stadium Closure Audit: Assistant Auditor	Ecosense CC
2013	Big Bay Development Annual Environmental Audit: Lead Auditor	City of Cape Town
2013	Green Point Stadium Audit: Assistant Auditor	Ecosense CC
2012	Develop environmental management procedures for Sun International	Chand Environmental Consulting
2012	Assist with data collation and report review of Working for Wetlands External Performance Audit	Ecosense CC

Year	Project Description	Client
2022	Regulation 34 External Compliance Audit of Chapman's Bay Estate	Chapman's Bay Estate Manager
2022	Regulation 34 External Compliance Audit of Longbeach Mall, Operational Phase Environmental Management Plan	AVDS Environmental Consultants
2002	Monitoring and evaluation of the greening of the World Summit on Sustainable Development	IUCN
2001	Enterprise wide risk management and development of risk management manual for BHP-Billiton	BHP Billiton
2000	Phase one environmental investigations	Meadowfeeds Pietermaritzburg and Paarl
2000	MHI risk assessment	Plascon
1999/ 2000	ISO 14001 environmental management system	Plascon Inks Packaging and Coatings:: Epping
1999	Environmental performance reviews	Meadowfeeds Pietermaritz-burg and Paarl
1999	Environmental surveys at fifty operations	Dorbyl
1999	Initial environmental reviews of four Consol operations	Consol
1999	Environmental reviews of Plascon operations throughout South Africa	Plascon
1999	Environmental risk surveys	Goldfields
1999	MHI risk assessment	Toyota
1998	Development of an integrated management plan for Robben Island Museum	Robben Island Museum
1998	Environmental due diligence for tyre manufacturing operation	First Corp Capital
1998	Environmental due diligence for quarrying operations	First Corp Capital
1998	Scoping phase EIA for infrastructure upgrades	Robben Island Museum
1998	General environmental and auditing training	Kenya Power and Lighting Company
1997- 1999	Development of an environmental management system	Kenya Power and Lighting Company
1997	Legal compliance audits of all operating entities	Ingwe
1997	Environmental reviews of seven power stations	Kenya Power and Lighting Company
1997	Initial environmental review towards the development of an ISO 14001 environmental management system	Delta Motor Corporation
1997	Environmental impact assessments of two proposed bottling plants	Century Bottling Company, Uganda
1996	Environmental legal compliance audits of all operating companies	Samancor
1996	Environmental reviews of the Chapalet and Port Elizabeth sites of Cadburys Pty Ltd	Cadburys Schweppes
1996	Environmental reviews of two Bromor Foods sites in the Western Cape	Cadburys Schweppes
1996	Environmental impact assessment: FA Satellites Development Project	Mossgas

Year	Project Description	Client
2022	Regulation 34 External Compliance Audit of Chapman's Bay Estate	Chapman's Bay Estate Manager
2022	Regulation 34 External Compliance Audit of Longbeach Mall, Operational Phase Environmental Management Plan	AVDS Environmental Consultants
1996	Environmental Impact Assessment: E-BT oil fields: Agulhas Bank	Soekor
1995	Environmental audit	Alusaf Hillside Smelter
1995	Environmental management system audit: Saldanha Bay	PortnetSaldanha and SFF
1995	Development of an environmental policy	MMC
1995	Development of the environmental manager's portfolio	MMC
1995	Environmental situation analysis: Manganese Metal Company: Krugersdorp and Nelspruit	MMC
1995	Property transfer audits	Siemens
1995	Environmental situation analysis	PFG
1994	Environmental auditor training course	Sasol 1, 2 & 3
1994	Development of an environmental management manual	Portnet Richards Bay
1994	Property transfer audits of nine sites in South Africa	CPC International
1994	Environmental situation analysis	Portnet Richards Bay
1993	Environmental management systems audit	Sasdiens