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Capricorn Fisheries Monitoring cc was contacted and asked to provide updated fishing maps and to provide input on the fishing industries operating off the west coast of South Africa. 14 April 2011.

APPENDIX 1

DEA's STANDARD BAR TEMPLATE

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

	(For official use only)
File Reference Number:	
Application Number:	
Date Received:	

Basic assessment report in terms of the Environmental Impact Assessment Regulations, 2010, promulgated in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended.

SECTION A: ACTIVITY INFORMATION

Has a specialist been consulted to assist with the completion of this section? YES / **NO ✓**
If YES, please complete the form entitled "Details of specialist and declaration of interest" for appointment of a specialist for each specialist thus appointed:
Any specialist reports must be contained in Appendix D.

1. ACTIVITY DESCRIPTION

Describe the activity, which is being applied for, in detail[1]:

De Beers Consolidated Mines Ltd (De Beers) is the current Prospecting Rights holder for the sea areas: 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c. AuruMar (Pty) Ltd (AuruMar), the operator, would undertake the proposed prospecting activities, which includes the indentification of heavy minerals, platinum group metals, gold and sapphire (gemstones).

The prospecting activities would be conducted in a phased approach, with each phase dependant on the results of the previous phase. The two phases planned are as follows and it is proposed that they would run from October 2010 to November 2013:

- Phase I: Initial Deposit Assessment Programme
- Phase II: Resource Delineation Programme

It should be noted that AuruMar has already undertaken a desktop study and developed a geological model and an associated mineralisation model, based on existing information. The desktop study included the review of published geophysical, geotechnical and sampling data as well as the review of data that De Beers has collected from existing and adjacent concession areas. Geophysical surveys and follow up ground-truthing was also undertaken in areas highlighted as potential targets by the desktop studies and where there was insufficient detail to guide further exploration.

AuruMar is currently in the processes of identifying the potential sampling areas for Phase I. However, this information is only likely to be completed towards September 2011.

Phases I and II would utilise the exploration sampling method, detailed below.

[1] Please note that this description should not be a verbatim repetition of the listed activity as contained in the relevant Government Notice, but should be a brief description of activities to be undertaken as per the project description.

EXPLORATION SAMPLING

The proposed prospecting activities would utilise AuruMar's Sonic VibroCorer (SVC) in order to collect the required samples. The system utilises a vibratory head, which has been adapted from land based technology, where the vibration energy is transferred into the drill string and enables the drill-string to penetrate into the seabed down to 10 m with a radius of 75 mm. The system can penetrate through most unconsolidated seabed lithologies, to produce a discrete high integrity core, which can then be analysed in detail. The sampling system is mounted in a frame, which is lowered to the seabed from a purpose built Launch and Recovery System (LARS) on a suitable vessel of opportunity (refer to Section 3.4.3 below).

Noise measurements have been taken for the SVC and at a distance of 25 m from the tool the noise was measured at 160 – 180 dB re 1µPa. At a distance of 110 m from the tool the noise is typically 155 dB re 1µPa and 164dB re 1µPa. The 1/3 octave analysis showed there was a 1/3 octave tone at 100 Hz and 125 Hz with harmonics at 200Hz and 250Hz (Hegley, 2010).

SVC core samples would be logged and stored onboard the vessel and transferred ashore at regular intervals for further analysis. Once the cores are logged they would then be analysed onshore for heavy mineral content. This would entail initial sizing, screening and sub-sampling, followed by an evaluation of a sub-sample at an appropriately accredited onshore laboratory. Results from the sample treatment and the evaluation process would provide inputs into the geological model.

PHASE I – INITIAL DEPOSIT ASSESSMENT PROGRAMME

The aim of Initial Deposit Assessment Programme would be to groundtruth the geological model compiled during the desktop study and to identify the possible presence of mineralisation for further resource delineation (i.e. Phase II).

It is proposed that approximately 300 cores would be collected within identified areas in the prospecting rights areas. Up to 60 target areas would be selected over the 27 600 km^2 prospecting area based on the results of an ongoing desktop study. Clusters of up to five cores would be collected in each target area with individual core spacing of approximately 70 metres. The 300 core sampling activities would result in a total disturbance area of 53 m^3 (see Table 1).

The Initial Deposit Assessment Programme would extend for approximately 80 days.

Table 1: Total disturbance area during Phase I.

Total disturbance for Deposit Assessment Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
300	5	1.8 x 10^{-8}	53
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2			

PHASE II - RESOURCE DELINEATION PROGRAMME

Phase II is split into a detailed geophysical survey as well as further exploration sampling.

Geophysical Survey

A detailed geophysical survey would be undertaken, based on the findings of Phase I. The following geophysical tools are available for prospecting surveys:

- *Swath bathymetry*
  The swath bathymetry system produces a digital terrain model of the seafloor.
- *Shallow (2 to 10 Khz) and medium penetration (0.5 to 2 Khz) "Chirp" seismic systems*:
  Chirp seismic systems generate profiles up to 10 m beneath the seafloor to give a cross section view of the

sediment layers.

- *Medium penetration Sleevegun seismic systems*:
  Sleevegun seismic systems generate medium penetration profiles up to 50 m beneath the seafloor to give a cross section view of the sediment layers.
- *100 Khz side scan sonar*:
  Side scan sonar systems produce acoustic intensity images of the seafloor and are used to map the different sediment textures of the seafloor.
- *Magnetometer:*
  The magnetometer measures local variations in the intensity of the Earth's magnetic field, which are caused by differences in composition of the sediment layers beneath the seafloor and help identify where deposits lie in the seabed.

It is proposed that the Focus towfish could be used to collect side scan sonar as well as Chirp seismic data. Hull mounted swath bathymetry and towed magnetometers would be deployed to gather additional data. In addition, the Autonomous Underwater Vehicle (AUV) could be used to survey in areas where the survey line spacing is less than 50 m apart. The survey tools are deployed off a vessel of opportunity contracted for the period of the survey programme. Table 2 lists the survey tools likely to be used for the geophysical survey.

Table 2: Specifications of acoustic equipment to be utilised in the proposed survey

Type	Frequency	Cycle (impulses per second)	Source level (dB re 1 µPa at 1m)
Chirp sub - bottom profiler	1.5 to 12.5 kHz	4	202
Klein Side Scan Sonar	100 or 500 kHz	10	210
SRD swath Bathymetry	240 kHz	15	190
AVTRAK acoustic positioning	18 to 35 kHz	0.5	190
RDI Doppler system	1200 kHz		214
RESON 8101 Bathymetry system	240 kHz	up to 30	220
10 inch Sleeve gun system	100-800 Hz	1	about 220

Resource Delineation Programme

Once the detailed geophysical surveying has been completed and the results further analysed, it is assumed that these results would yield at least one deposit that would justify further sampling in the Resource Delineation Programme. The proposed method of sampling would be the same as the process undertaken in Phase. Phase II is intended to increase the level of confidence regarding the presence of a mineral resource in the deposit area. This confidence level would ultimately determine whether it is viable to apply for commercial mining rights.

It is assumed that the potential deposit area to be sampled would be approximately 56 km² in extent. It is estimated that up to 4 500 core samples would be required within this deposit area. The core spacings would be between 50 and 200 m apart. The total volume of disturbance would be approximately 799 m³ (see Table 3).

Table 3: Total disturbance area for the Resource Delineation Programme.

Total disturbance for Resource Delineation Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
4500	80	$2.9 \times e^{-7}$	799
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10 m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2.			

2. FEASIBLE AND REASONABLE ALTERNATIVES

Site Alternative:
All the prospecting rights areas for which De Beers has Prospecting Rights, i.e. 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c, are being considered in the Basic Assessment. AuruMar is proposing to undertake prospecting activities in these areas, which includes the identification of heavy minerals, platinum group metals, gold and sapphire (gemstones). Actual sample sites are still to be determined based on existing data and the desktop study (ongoing).

Other Alternatives:
These include:

- Number of sample sites:
  AuruMar is currently proposing to take 300 core samples during Phase I and 4 500 core samples in Phase II. However, the total number of cores to be taken will be determined by the ongoing desktop study, which aims to identify specific sampling areas. Therefore, the number of cores is subject to change.

- Sampling techniques:
  AuruMar has investigated various options of collecting samples including the use of standard vibrocorers and the skirted mega-drill with an airlift system. However, the standard vibrocorers are unable to penetrate clays and do not collect samples of sufficient volume. The mega-drill is unable to collect high integrity, isolated samples in the vertical profile. This sampling tool also has difficulty in penetrating consolidated sediments and collects larger samples than required for the purposes of this prospecting programme. Thus, it is proposed to use the SVC in order to collect the core samples (refer to Section A 1 above).

- Choice of survey tools:
  Numerous geophysical tools are available, however, AuruMar is proposing to use shallow penetration seismic tools and multibeam ecosounders for sea floor analysis (refer to Section A 1 above.)

- Choice of sampling platform:
  AuruMar conducts global reviews of potential vessels of opportunity to ensure selection of vessels that both meet operation needs and comply with international maritime requirements. The SVC tool requires a particular aft deck space for the launch and recovery system. Review of various vessels of opportunity have identified rig support vessels as being the most appropriate vessel type for these operations. These are typically 60 m in length and 16 m wide. Survey programmes require smaller vessels, typically 45 m in length and 10 m wide.

No-Go Alternative:
The implications of not going ahead with the proposed prospecting activities are as follows:

- Loss of opportunity to establish whether or not a viable offshore heavy mineral resource exists off the west coast of South Africa; and
- Lost economic opportunities related to costs already incurred in the initial prospecting phase.

3. ACTIVITY POSITION

The co-ordinates of the proposed prospecting area boundary are provided below and refer to Figure 3.1 in Chapter 3 of the Draft BAR.

Point	Latitude	Longitude
Prospecting Right Areas 1c -10c		
1	16° 25.094' E	28° 41.056' S
2	16° 33.595' E	28° 52.491' S
3	16° 43.129' E	29° 5.490' S
4	16° 53.281' E	29° 21.372' S
5	16° 59.347' E	29° 37.885' S
6	17° 4.881' E	29° 54.322' S
7	17° 10.278' E	30° 10.890' S
8	17° 17.461' E	30° 26.489' S

9	17° 26.495' E	30° 42.271' S
10	17° 35.211' E	30° 57.871' S
11	17° 45.478' E	31° 12.853' S
12	17° 9.077' E	31° 12.852' S
13	16° 57.543' E	30° 57.870' S
14	16° 53.077' E	30° 42.271' S
15	16° 44.910' E	30° 32.655' S
16	16° 37.076' E	30° 29.789' S
17	16° 37.226' E	30° 26.489' S
18	16° 36.043' E	30° 18.039' S
19	16° 10.112' E	30° 10.939' S
20	15° 58.742' E	30° 4.407' S
21	15° 53.175' E	29° 56.441' S
22	15° 41.725' E	29° 56.441' S
23	15° 39.674' E	29° 54.274' S
24	16° 3.567' E	29° 54.394' S
25	16° 3.722' E	29° 37.724' S
26	16° 3.872' E	29° 21.374' S
27	16° 4.016' E	29° 5.492' S
28	16° 4.078' E	28° 58.528' S
29	16° 14.298' E	28° 52.491' S
30	16° 18.653' E	28° 49.603' S
Prospecting Right Area 12c		
31	17° 56.745' E	31° 27.269' S
32	18° 9.296' E	31° 42.584' S
33	17° 11.860' E	31° 42.584' S
34	17° 15.577' E	31° 27.268' S
Prospecting Right Areas 14c – 20c		
35	18° 11.612' E	31° 48.951' S
36	18° 13.712' E	31° 54.734' S
37	18° 10.212' E	32° 5.166' S
38	18° 10.495' E	32° 12.182' S
39	18° 6.928' E	32° 19.165' S
40	17° 52.461' E	32° 33.464' S
41	17° 45.261' E	32° 49.613' S
42	17° 37.660' E	32° 49.615' S
43	17° 42.928' E	32° 33.464' S
44	17° 23.010' E	32° 19.165' S
45	17° 17.910' E	32° 12.182' S
46	17° 15.277' E	32° 5.166' S
47	17° 10.677' E	31° 54.733' S
48	17° 9.027' E	31° 48.950' S

4. PHYSICAL SIZE OF THE ACTIVITY

The entire prospecting area covers 27 600 km^2 and is located between the 50 m and 200 m depth contours. Sampling would occur in water depths ranging from 90 m to 200 m and would cover an area of approximately 85 m^2.

5. SITE ACCESS

N/A – The proposed project is located off the west coast of South Africa.

6. SITE OR ROUTE PLAN

Refer to Chapter 3 of the Draft BAR, specifically Figure 3.1.

7. SITE PHOTOGRAPHS

Refer to Chapter 3 of the Draft BAR. No specific photographs of the site are available, as it is located on the seabed and in the ocean.

8. FACILITY ILLUSTRATION

Refer to Chapter 3 of the Draft BAR.

9. ACTIVITY MOTIVATION

9(a) Socio-economic value of the activity

What is the expected capital value of the activity on completion?	Zero (Prospecting activities are conducted in order to prove up resources for potential future mining activities.)	
What is the expected yearly income that will be generated by or as a result of the activity?	Zero – no income is expected during the prospecting phase. Income would only materialise if, based on the result of the prospecting phase, AuruMar were to obtain a Mining Right and commence with production.	
Will the activity contribute to service infrastructure?	YES	**NO ✓**
Is the activity a public amenity?	YES	**NO ✓**
How many new employment opportunities will be created in the development phase of the activity?	Zero	
What is the expected value of the employment opportunities during the development phase?	n/a	
What percentage of this will accrue to previously disadvantaged individuals?	n/a	
How many permanent new employment opportunities will be created during the operational phase of the activity?	n/a – the current application forms part of a prospecting right application and there would be no permanent operations envisaged during the prospecting phase. This would only be applicable on application for a mining right.	
What is the expected current value of the employment opportunities during the first 10 years?	n/a	
What percentage of this will accrue to previously disadvantaged individuals?	n/a	

9(b) Need and desirability of the activity

Motivate and explain the need and desirability of the activity (including demand for the activity):

When considering the need and desirability of this project it is important to consider the role that mining plays within the South African economy. The Minister's statement in the Department of Minerals Resources Strategic Plan 2008/09 - 2010/11 refers "*the growth of the mining industry is historically intertwined with the growth of our economy*" and states further that "*Mining has and will continue to be the mainstay of our economy.*"

In order for mining to continue to be a core contributor to the South African economy and in the pursuance of the sustainable development of the nation's mineral resources it is necessary to identify new resources through prospecting.

A key intent of the Minerals and Mining Policy of South Africa states that Government will: "*promote exploration and investment leading to increased mining output and employment*" (Minerals and Mining Policy of South Africa, 1998). The Policy states further that:

- *"The South African mining industry, one of the country's few world-class industries, has the capacity to continue to generate wealth and employment opportunities on a large scale.*
- *Mining is an international business and South Africa has to compete against developed and developing countries to attract both foreign and local investment. Many mining projects in South Africa have tended to be unusually large and long term, requiring massive capital and entailing a high degree of risk.*
- *South Africa has an exceptional minerals endowment, and in several major commodities has the potential to supply far more than the world markets can consume."*

If one looks at gold in particular, the Chamber of Mines' explains that *"With the stabilisation in world mine production and central bank sales, the prospect of any major sources of new supply of gold have diminished. The continued focus on productivity and consolidation in the South African gold mining industry will result in a decline in production - although replacement tonnage from new mines will slow the rate of decline.* "

This project aims to establish whether economically viable heavy mineral deposits, including gold, occur on the continental shelf off the west coast of South Africa.

Rationale for the proposed project

The principal objective of this project is to use the best available technology to ground-truth the geological model for the existence and regional distribution of potentially economic and accessible placer deposits within the prospecting rights areas, to determine the mineralogical content of such deposits and to determine the regional distribution of grades in technologically and economically assessable shelf sediments.

10. APPLICABLE LEGISLATION, POLICIES AND/OR GUIDELINES

List all legislation, policies and/or guidelines of any sphere of government that are applicable to the application as contemplated in the EIA regulations, if applicable:

Title of legislation, policy or guideline:	**Administering authority:**	**Date:**
Minerals and Petroleum Resources Development Act (No. 28 of 2002)	Department of Mineral Resources	2002
National Environmental Management Act (No. 107 of 1998)	Department of Environmental Affairs (DEA)	1998
National Heritage Resources Act (No. 25 of 1998)	South African Resources Agency	1998

11. WASTE, EFFLUENT, EMISSION AND NOISE MANAGEMENT

11(a) Solid waste management

Will the activity produce solid construction waste during the construction/initiation phase?	YES	**NO ✓**
If yes, what estimated quantity will be produced per month?	m^3	
How will the construction solid waste be disposed of (describe)?		
Where will the construction solid waste be disposed of (describe)?		
N/A		
Will the activity produce solid waste during its operational phase?	**YES ✓**	NO
If yes, what estimated quantity will be produced per month?	m^3	PTO

Estimated volume/mass of wastes produced during sampling activities of 100 days.

Waste Type	Volume / Mass produced per day	Total Volume / Mass produced during sampling
Rubbish/trash	120 kg	12 000 kg
Scrap metal	50 kg	5 000 kg
Drums/containers	0-2 units	Up to 200 units
Used oil	0.1 m^3	10 m^3
Chemicals/hazardous water	0.02 m^3	2 m^3
Infectious waste	negligible	negligible
Filters and filter media	5 kg	500 kg

How will the solid waste be disposed of (describe)?

All solid waste would be temporarily stored onboard in containers until being transported onshore. The solid waste would then be taken to a local registered landfill site. Where possible, material for recycling of waste, such as scrap metal, wood, glass, used oil, etc., would be stored separately onboard and taken to a local land based recycling facility. Solid waste is likely to comprise the following:

Garbage: This includes waste paper, plastics, wood, metal, glass, etc.

Scrap metal and other metals: Scrap metal would be stored and disposed of or recycled on land.

Drums and containers: Rinsed and non-rinsed drums brought onshore would be disposed of in a local landfill site.

Used oil: Examples include used lubricating and gear oil, solvents, hydrocarbon-based detergents and machine oil. Toxicity varies depending on oil type. All non-recycled waste oils would be securely stored, transported to shore and disposed of at a licensed site acceptable to the relevant authorities.

Infectious Wastes: Infectious wastes include bandages, dressings, surgical waste, tissues, medical laboratory wastes, needles, and food wastes from persons with infectious diseases. Only minor quantities of medical waste are expected. Prevention of exposure to contaminated materials is essential, requiring co-operation with local medical facilities to ensure proper disposal.

Chemical waste:
Disposal of any unexpected chemical and hazardous substance (e.g. fluorescent tubes, toner cartridges, batteries, etc.) would be done on a case-by-case basis and in a manner acceptable to appropriate regulatory authorities.

Filters and filter media:
Infectious wastes include bandages, dressings, surgical waste, tissues, medical laboratory wastes, needles, and food wastes from persons with infectious diseases. Only minor quantities of medical waste are expected. Prevention of exposure to contaminated materials is essential, requiring co-operation with local medical facilities to ensure proper disposal. All such waste will be stored and brought onshore for disposal via a registered medical waste company.

Where will the solid waste be disposed if it does not feed into a municipal waste stream (describe)?

N/A

If the solid waste (construction or operational phases) will not be disposed of in a registered landfill site or be taken up in a municipal waste stream, then the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA. N/A

Can any part of the solid waste be classified as hazardous in terms of the relevant legislation?	YES	**NO ✓**

If yes, inform the competent authority and request a change to an application for scoping and EIA.

Is the activity that is being applied for a solid waste handling or treatment facility?	YES	**NO ✓**

If yes, then the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA.

11(b) Liquid effluent

Will the activity produce effluent, other than normal sewage, that will be disposed of in a municipal sewage system?	YES	**NO ✓**
If yes, what estimated quantity will be produced per month?		N/A
Will the activity produce any effluent that will be treated and/or disposed of on site?	**YES ✓**	NO

If yes, the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA. N/A

Note:

The types of liquid waste and the associated treatment, storage and disposal thereof are presented in detail in the BAR (see Section 3.5). In summary, effluent would include:

Sewage: Whilst South Africa is not yet a signatory to MARPOL Annex IV - Regulations for the Prevention of Pollution by Sewage from Ships – the contracted vessels would be required to comply wherever possible with the requirements of this Annex.

Will the activity produce effluent that will be treated and/or disposed of at another facility?	YES	**NO ✓**
If yes, provide the particulars of the facility:	N/A	

Describe the measures that will be taken to ensure the optimal reuse or recycling of waste water, if any:

N/A

11(c) Emissions into the atmosphere

Will the activity release emissions into the atmosphere?	**YES ✓**	NO
If yes, is it controlled by any legislation of any sphere of government?	YES	**NO ✓**

If yes, the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA. N/A

If no, describe the emissions in terms of type and concentration:

Air emissions would result from the vessels themselves (see Section 3.5 of the Draft BAR).

11(d) Generation of noise

Will the activity generate noise?	**YES ✓**	NO
If yes, is it controlled by any legislation of any sphere of government?	YES	**NO ✓**

If yes, the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA.

If no, describe the noise in terms of type and level:

Noise would be generated by the vessels, the Sonic VibroCorer (SVC) and the geophysical survey tools. Noise from the vessels is likely to be no higher than noise from other shipping vessels of a similar size in the region. Noise from the SVC has been measured at 160 to 180 dB re 1µPa at a distance of 25 m from the tool.

Sound levels from the acoustic equipment would range from 190 to 220 dB re 1 µPa at 1m. The sounds emitted would probably be insufficient to result in auditory or non-auditory trauma to marine mammals in the region (Findlay, 2005).

12. WATER USE

Please indicate the source(s) of water that will be used for the activity by ticking the appropriate box(es)

municipal	water board	groundwater	river, stream, dam or lake	other	**the activity will not use water ✓**

If water is to be extracted from groundwater, river, stream, dam, lake or any other natural feature, please indicate the volume that will be extracted per month:

	N/A
Does the activity require a water use permit from the Department of Water Affairs?	YES / **NO ✓**

If yes, please submit the necessary application to the Department of Water Affairs and attach proof thereof to this application if it has been submitted.

13. ENERGY EFFICIENCY

Describe the design measures, if any, that have been taken to ensure that the activity is energy efficient:

None

Describe how alternative energy sources have been taken into account or been built into the design of the activity, if any:

None

SECTION B: SITE/AREA/PROPERTY DESCRIPTION

Important notes:

1. **For linear activities (pipelines, etc) as well as activities that cover very large sites, it may be necessary to complete this section for each part of the site that has a significantly different environment. In such cases please complete copies of Section C and indicate the area, which is covered by each copy No. on the Site Plan.** Refer to the Draft BAR for full details of the proposed project.

Section C Copy No. (e.g. A):

2. **Paragraphs 1 - 6 below must be completed for each alternative.**

3. **Has a specialist been consulted to assist with the completion of this section?** **YES ✓** / NO

If YES, please complete the form entitled "Details of specialist and declaration of interest" for each specialist thus appointed:

All specialist reports must be contained in Appendix D.

Please refer to Appendix 3 of the Draft BAR for the Benthic Specialist Report.

Property description/physical address:	The proposed core sampling and geophysical survey would be undertaken within the sea areas 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c off the west coast of South Africa (refer to Figure 1.1 of Draft BAR). Sea areas 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c and 10c are located off the Northern Cape coast, while the remaining sea areas are located off the Western Cape coast. The entire prospecting area covers 27 600 km^2 and is located between the 50 m and 200 m depth contours. Sampling would occur in water depths ranging from 90 m to 200 m. The co-ordinates of the proposed prospecting area boundary are provided in Section A 1, above.
Current land-use zoning:	Offshore concession areas.

Is a change of land-use or a consent use application required?	YES / **NO ✓**
Must a building plan be submitted to the local authority?	YES / **NO ✓**

Locality map: Refer to Figure 1.1 in Chapter 1 of the Draft BAR.

1. GRADIENT OF THE SITE

Alternative S1:

Flat	1:50 – 1:20	1:20 – 1:15	1:15 – 1:10	1:10 – 1:7,5	1:7,5 – 1:5	Steeper than 1:5

* The proposed project is located offshore in water depths ranging from 90 m to 200 m and the floor slope varies within the prospecting area. A bathymetry map is presented in Chapter 4 of the Draft BAR, Figure 4.2.

2. LOCATION IN LANDSCAPE

Indicate the landform(s) that best describes the site:

2.1 Ridgeline
2.2 Plateau
2.3 Side slope of hill/mountain
2.4 Closed valley
2.5 Open valley
2.6 Plain
2.7 Undulating plain / low hills
2.8 Dune
2.9 Seafront
2.10 Offshore / open water ✓

3. GROUNDWATER, SOIL AND GEOLOGICAL STABILITY OF THE SITE

Is the site(s) located on any of the following (tick the appropriate boxes)?

	Alternative S1:	
Shallow water table (less than 1.5m deep)	YES	**NO ✓**
Dolomite, sinkhole or doline areas	YES	**NO ✓**
Seasonally wet soils (often close to water bodies)	YES	**NO ✓**
Unstable rocky slopes or steep slopes with loose soil	YES	**NO ✓**
Dispersive soils (soils that dissolve in water)	YES	**NO ✓**
Soils with high clay content (clay fraction more than 40%)	YES	**NO ✓**
Any other unstable soil or geological feature	YES	**NO ✓**
An area sensitive to erosion	YES	**NO ✓**

4. GROUNDCOVER

Indicate the types of groundcover present on the site: The location of all identified rare or endangered species or other elements should be accurately indicated on the site plan(s).

Natural veld – good condition[E]	Natural veld with scattered aliens[E]	Natural veld with heavy alien infestation[E]	Veld dominated by alien species[E]	Gardens
Sport field	Cultivated land	Paved surface	Building or other structure	**Bare soil ✓***

* Sediments within the broad prospecting area are dominated by muddy sands, sandy muds, mud and some sand. Sediments are discussed further in Chapter 4 of the Draft BAR (see Section 4.1.2.4).

5. LAND USE CHARACTER OF SURROUNDING AREA

Indicate land uses and/or prominent features that does currently occur within a 500 m radius of the site and give description of how this influences the application or may be impacted upon by the application:

5.1 Natural area ✓
5.2 Low density residential
5.3 Medium density residential
5.4 High density residential
5.5 Informal residential[A]
5.6 Retail commercial & warehousing
5.7 Light industrial
5.8 Medium industrial [AN]
5.9 Heavy industrial [AN]
5.10 Power station
5.11 Office/consulting room
5.12 Military or police base/station/compound
5.13 Spoil heap or slimes dam[A]
5.14 Quarry, sand or borrow pit
5.15 Dam or reservoir
5.16 Hospital/medical centre
5.17 School
5.18 Tertiary education facility
5.19 Church
5.20 Old age home
5.21 Sewage treatment plant[A]
5.22 Train station or shunting yard [N]
5.23 Railway line [N]
5.24 Major road (4 lanes or more) [N]
5.25 Airport [N]
5.26 Harbour
5.27 Sport facilities
5.28 Golf course
5.29 Polo fields
5.30 Filling station [H]
5.31 Landfill or waste treatment site
5.32 Plantation
5.33 Agriculture
5.34 River, stream or wetland
5.35 Nature conservation area
5.36 Mountain, koppie or ridge
5.37 Museum
5.38 Historical building
5.39 Protected Area
5.40 Graveyard
5.41 Archaeological site
5.42 Other land uses (describe) ✓

The proposed study area is located offshore in water depths ranging from 90 m to 200 m. A number of fisheries operate in this area. There are also a number of diamond mining and prospecting concession areas and petroleum exploration blocks located within and adjacent to the study area. Refer to Chapter 4, Section 4.1.4 for further details and figures.

If any of the boxes marked with an "[N] "are ticked, how will this impact / be impacted upon by the proposed activity?

N/A

If any of the boxes marked with an "An" are ticked, how will this impact / be impacted upon by the proposed activity?

N/A

If any of the boxes marked with an "H" are ticked, how will this impact / be impacted upon by the proposed activity.

N/A

6. CULTURAL/HISTORICAL FEATURES

Are there any signs of culturally or historically significant elements, as defined in section 2 of the National Heritage Resources Act, 1999, (Act No. 25 of 1999), including Archaeological or palaeontological sites, on or close (within 20m) to the site?	YES	NO
	Uncertain ✓	
If YES, explain:		

If uncertain, conduct a specialist investigation by a recognised specialist in the field to establish whether there is such a feature(s) present on or close to the site.

Briefly explain the findings of the specialist:	The proposed project is located offshore with a total surface area of 27 600 km² and it is not yet known whether there are any historical features, e.g. shipwrecks in the proposed sampling areas. However existing maritime heritage desktop studies, such as JJ Boshoff (2009) have concluded that there is a low probability of finding historical shipwrecks in these prospecting areas. The majority of the shipwrecks are located along the coastline in shallow waters and it is less likely that historical wrecks would be found in deeper water. Whilst this does not rule out the possibility of unknown wrecks in the area, the existence of unknown wrecks should be brought to light by the geophysical survey activities. Should potential wreck sites be identified from survey data, AuruMar would ensure that sampling sites avoid any shipwrecks. (Also see Section 4.1.4.6 and Figure 4.28 of the Draft BAR).

Will any building or structure older than 60 years be affected in any way?	YES	**NO ✓**
Is it necessary to apply for a permit in terms of the National Heritage Resources Act, 1999 (Act 25 of 1999)?	YES	**NO ✓**

If yes, please submit or, make sure that the applicant or a specialist submits the necessary application to SAHRA or the relevant provincial heritage agency and attach proof thereof to this application if such application has been made.

SECTION C: PUBLIC PARTICIPATION

Tasks undertaken to date include the following:

- An Application Form and Declaration of Interest were submitted to DEA on 31 March 2011 (see Appendix 2 of Draft BAR).
- Specialist input was provided on the likely impact on the benthic environment by the proposed prospecting activities (see Appendix 3 of Draft BAR). Impacts were assessed according to pre-defined rating scales (see Appendix 4 of Draft BAR).
- The specialist input and other relevant information have been integrated into this Draft BAR. The Draft BAR aims to present all information in a clear and understandable format, suitable for easy interpretation by I&APs and authorities, and to provide an opportunity for I&APs and authorities to comment on the proposed project and Basic Assessment process (see Section 1.4 of Draft ABR).
- A preliminary interested and affected party (I&AP) database has been compiled which consists of authorities (local and regional), Non-Governmental Organisations, Community-based Organisations and other key stakeholders. This database was compiled using databases of previous studies in the area. To date 59 I&APs have been registered on the project database (see Appendix 5 of Draft BAR).

The following tasks will be undertaken in order to notify I&APs of the release of the Draft BAR for a 40-day review / comment period:

- Advertisements will be placed in two regional newspapers (namely Cape Times and Die Burger) and two local newspapers (namely Die Weslander and Ons Kontrei) (see Appendix 6); and

- A notification letter will be sent to all I&APs registered on the project database. A copy of the Draft BAR Executive Summary will be enclosed with the letter.

It should be noted that I&APs have previously been consulted as part of the MPRDA Prospecting Rights application for proposed Marine Prospecting Activities. During this process, comments received did not raise any significant issues of concern.

1. ADVERTISEMENT

It should be noted that since the proposed project is located offshore, in the open ocean there are no adjacent landowners and no notice has been erected on site, as is recommended. The following tasks will be undertaken in order to notify I&APs of the release of the Draft BAR for a 40-day comment period:

- A notification letter will be sent (on Friday 15 April 2011) to all I&APs registered on the project database. A copy of the Draft BAR Executive Summary will be enclosed with the letter.

It should be noted that since the proposed project is located offshore in the open ocean no notice has been erected on site.

2. CONTENT OF ADVERTISEMENTS AND NOTICES

Adverts have been placed in the following papers and provided information on the proposed prospecting activities, public participation process and 40-day commenting period (see Appendix 6 of the Draft BAR):

- Ons Kontrei – 14 April 2011
- Weslander – 14 April 2011
- Cape Times – 18 April 2011
- Die Burger – 18 April 2011

3. PLACEMENT OF ADVERTISEMENTS AND NOTICES

Four adverts have been placed in the relevant newspapers (see above for details).

4. DETERMINATION OF APPROPRIATE MEASURES

An Information-sharing Meeting is not considered necessary. All the key stakeholders are included on the project database (see Appendix 5 of Draft BAR) and they will be notified of the proposed project and availability of the Draft BAR. It should be noted that I&APs have previously been consulted as part of the MPRDA Prospecting Rights application for proposed Marine Prospecting Activities. During this process, comments received did not raise any significant issues of concern. Key I&APs include:

- Diamond mining / prospecting industries;
- Oil and gas exploration and production industries;
- South African Navy Hydrographic Office;
- South African and foreign fishing vessels (including the Association of Small Hake Industries, South African Deep Sea Trawling Industry Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, Shark Long-line Association);
- South African Maritime Safety Authority (SAMSA); and
- Government departments, particularly DEA: MRM, SAHRA and DMR.

5. COMMENTS AND RESPONSE REPORT

To be completed once the Draft BAR has been made available for public comment.

6. AUTHORITY PARTICIPATION

Please note that a complete list of all organs of state and or any other applicable authority with their contact details must be appended to the basic assessment report or scoping report, whichever is applicable.

Refer to Appendix 5 of the Draft BAR for the I&AP Database.
Authorities are key interested and affected parties in each application and no decision on any application will be made before the relevant local authority is provided with the opportunity to give input.

List of authorities informed:

Department of Environmental Affairs: Oceans and Coast
Department of Agriculture, Forestry and Fisheries: Marine Resource Management
Department of Environmental Affairs and Development Planning (DEA&DP) (Western Cape)
Department of Environmental Affairs and Nature Conservation (Northern Cape)
South African Heritage Resources Agency

List of authorities from whom comments have been received:

No comments have been received, as the process has just commenced.

7. CONSULTATION WITH OTHER STAKEHOLDERS

Has any comment been received from stakeholders?	YES	**NO ✓**

Key authorities who will be contacted include the following (also complete I&AP list in Appendix 5 of Draft BAR):

- Department of Mineral Resources;
- Department of Environmental Affairs: Oceans and Coast;
- Department of Agriculture, Forestry and Fisheries: Marine Resource Management;
- South African Heritage Resources Agency; and
- South African Maritime Safety Authority.

Other key stakeholders include the following:

- Diamond mining / prospecting industries;
- Oil and gas exploration and production industries;
- South African and foreign fishing vessels (including the Association of Small Hake Industries, South African Deep Sea Trawling Industry Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, Shark Long-line Association).

If "YES", briefly describe the feedback below (also attach copies of any correspondence to and from the stakeholders to this application):

N/A*

* It should be noted that I&APs have previously been consulted as part of the MPRDA Prospecting Rights application for proposed Marine Prospecting Activities. During this process, comments received did not raise any significant issues of concern. Records of consultation formed part of the submission to the DMR.

SECTION D: IMPACT ASSESSMENT

1. ISSUES RAISED BY INTERESTED AND AFFECTED PARTIES

List the main issues raised by interested and affected parties.

IA&PS have yet to review and comment on the Draft BAR. The main IA&P comments will be provided in the Final BAR.

Response from the practitioner to the issues raised by the interested and affected parties (A full response must be given in the Comments and Response Report that must be attached to this report as Annexure E):

N/A – to be provided with the Final BAR.

2. IMPACTS THAT MAY RESULT FROM THE PLANNING AND DESIGN, CONSTRUCTION, OPERATIONAL, DECOMMISSIONING AND CLOSURE PHASES AS WELL AS PROPOSED MANAGEMENT OF IDENTIFIED IMPACTS AND PROPOSED MITIGATION MEASURES

Alternative (preferred alternative)

For the comprehensive assessment of the proposed project, refer to Chapter 5 of the Draft BAR. The following is a summary table of the findings for the proposed prospecting activities.

Potential impact		Significance	
		Without mitigation	With mitigation
Vessel operatiosn:			
Deck drainage into the sea		VL	VL
Machinery space drainage into the sea		VL	VL
Sewage effluent into the sea		VL	VL
Galley waste disposal into the sea		VL	VL
Solid waste disposal into the sea		N/A	N/A
Impact on marine fauna:			
Sediment removal		VL	VL
Physical crushing of benthic biota		VL	VL
Noise associated with sampling activities		VL	VL
Noise associated with geophysical sampling		L	VL
Impact on other users of the sea:			
Fishing industry	Pelagic purse-seine	L	L
	Demersal long-line	L	L
	Tuna pole	VL	VL
	Pelagic long-line	VL	VL
Marine mining and prospecting	Diamond mining	VL	VL
	Other mining	VL	VL
Petroleum exploration		VL-L	VL
Marine transport routes		VL	VL
Impact on cultural heritage material:			
Impact on historical shipwrecks		M	VL
NO-GO ALTERNATIVE:			
Lost opportunity to establish whether or not a viable offshore heavy mineral resource exists off the West Coast and the lost economic opportunities related to costs already incurred in the initial prospecting phase.		L-M	-

VH=Very High	H=High	M=Medium	L=Low	VL=Very low	Insig = insignificant	N/A= Not applicable

3. ENVIRONMENTAL IMPACT STATEMENT

Taking the assessment of potential impacts into account, please provide an environmental impact statement that summarises the impact that the proposed activity and its alternatives may have on the environment after the management and mitigation of impacts have been taken into account, with specific reference to types of impact, duration of impacts, likelihood of potential impacts actually occurring and the significance of impacts.

Alternative A (preferred alternative)

All of the impacts associated with sampling and geophysical surveying would occur in the immediate vicinity of the vessels, would be of short term duration and of low to high intensity, and are considered to be of **VERY LOW to LOW** significance after mitigation.

The proposed activities would not result in any potential impacts that could cause severe damage to the environment. Based on the total prospecting area, the proposed sampling and geophysical activities would have a low impact on the environment. Phase I of the sampling would disturb an area of 1.8 x 10^{-8}%, while Phase II would disturb 2.9 x e^{-7}%, which equates to an area of 85 m^2 of the 27 600 m^2 prospecting area.

No-go alternative (compulsory)

The implications of not going ahead with the proposed prospecting activities relate to the lost opportunity to establish whether or not a viable offshore heavy mineral resource exists off the West Coast and the lost economic opportunities related to costs already incurred in the initial prospecting phase. This potential impact of the No-Go Alternative is considered to be of **LOW** to **MEDIUM** significance.

SECTION E. RECOMMENDATION OF PRACTITIONER

Is the information contained in this report and the documentation attached hereto sufficient to make a decision in respect of the activity applied for (in the view of the environmental assessment practitioner)?	**YES ✓**	NO

If "NO", indicate the aspects that should be assessed further as part of a Scoping and EIA process before a decision can be made (list the aspects that require further assessment):

N/A

If "YES", please list any recommended conditions, including mitigation measures that should be considered for inclusion in any authorisation that may be granted by the competent authority in respect of the application:

The following mitigation measures should be adhered to during the prospecting activities:

Compliance with the Environmental Management Programme
All phases of the proposed project must comply with the Environmental Management Programme presented in Chapter 7 of the Draft BAR. In addition, vessels must ensure compliance with MARPOL 73/78 standards.

Notification and communication with key stakeholders

- Notify PetroSA, Forest Exploration International, Thombo Petroleum, BHP Billiton and Transhex and its contractors, as well as any other operators, prior to the commencement of activities.
- AuruMar should liaise with all petroleum exploration operators to ensure that there is no overlapping of activities in the same area over the same time period.
- Prior to the commencement of activities, AuruMar must notify relevant bodies including: DMR, South African Maritime Safety Authority (SAMSA), the South African Navy (SAN) Hydrographic Office, relevant Port Captains and DAFF: MRM. These bodies must be notified of the navigational co-ordinates of any location prior to commencement of such activities.
- Communication channels should be set up with I&APs. This would involve pre-sampling and survey notifications and regular updates on the sampling and survey progress via email (see bullet below). Key stakeholders should include:
  - > Fishing industry (Association of Small Hake Industries, South African Deep Sea Trawling Industry

Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, and Shark Long-line Association);
- > Marine mining / prospecting industry (Transhex); and
- > Authorities (SAN Hydrographic office, DAFF: MRM, DMR, SAMSA and relevant Port Captains).

- Appropriate notices should be distributed timeously to mariners (including the fishing and diamond mining industries). A Notice to Mariners should provide:
  1. the co-ordinates of the sampling and survey activities;
  2. an indication of the sampling and survey timeframes; and
  3. reports on the location of prospecting vessels.

Discharges and emissions

- Provide training and awareness to crew members of the need for thorough cleaning up of any spillages immediately after they occur in order to minimise the volume of contaminants washing off decks.
- Use low toxicity, biodegradable detergents and reusable absorbent cloths during deck cleaning to further minimise the potential impact of deck drainage on the marine environment.
- Collect deck drainage in oily water catchment systems.
- Undertake adequate maintenance of all hydraulic systems.
- Minimise the discharge of waste material should obvious attraction of marine fauna be observed.

Vessel sea worthiness

- The vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas).
- Vessels should be equipped with collision prevention equipment including radar, multi-frequency radio, foghorns, etc. The law also requires equipment and training to ensure the safety and survival of the crew in the event of an accident.

Geophysical surveying

- Carry out visual scans around the survey vessel prior to the initiation of any acoustic impulses;
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment;
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area; and
- "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes.

Is an EMP attached? The EMP must be attached as Appendix F.	**YES ✓***	NO

* Refer to Chapter 7 of the Draft BAR.

SECTION F: APPENDIXES

Refer to the Draft BAR for the list of appendices:

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST

Specialist:	Pisces Environmental Services (Pty) Ltd		
Contact person:	Dr Andrea Pulfrich		
Postal address:	PO Box 31228, Tokai		
Postal code:	7966	Cell:	
Telephone:	021 782 9553	Fax:	021 782 9553
E-mail:	apulfricj@pisces.co.za		
Professional affiliation(s) (if any)	Registered Environmental Assessment Practitioner and member of the South African Council for Natural Scientific Professions, South African Institute of Ecologists and Environmental Scientisits and IAIA (South Africa).		

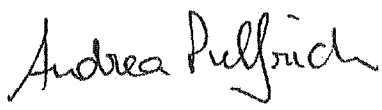
Project Consultant:	N/A		
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

4.2 The specialist appointed in terms of the Regulations

I, Andrea Pulfrich, declare that --

General declaration:

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.



Signature of the specialist:

Pisces Environmental Services (Pty) Ltd

Name of company (if applicable):

15 April 2011

Date:

APPENDIX 2

DEA CORRESPONDENCE AND I&AP LETTER

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

APPLICATION FORM FOR ENVIRONMENTAL AUTHORISATION

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST

SITE IDENTIFICATION AND LINKAGE

Please indicate all the Surveyor-general 21 digit site (erf/farm/portion) reference numbers for all sites (including portions of sites) that are part of the application.

Not applicable. The proposed study area is located off the West Coast of South Africa. The proposed core sampling would be undertaken within the prospecting right areas 2c, 3c, 4c and 5c (inshore portions), 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c (refer to Figure 1).

1. BACKGROUND INFORMATION

Project applicant:	De Beers Consolidated Mines Ltd		
Trading name (if any):			
Contact person:	Mr Neil Fraser, Venture Manager, AuruMar (Pty) Ltd		
Physical address:	DBM Gardens, Golf Park, Raapenberg Rd, Pinelands, Cape Town		
Postal address:	PO Box 87, Cape Town		
Postal code:	8000	**Cell:**	083 388 8788
Telephone:	021 658 3213	**Fax:**	021 658 3354
E-mail:	neil.fraser@aurumar.co.za		
Provincial Authority:	Department of Environmental Affairs and Development Planning (DEA&DP: Western Cape)		
Contact person:	Mr Anthony Barnes		
Postal address:	Directorate: Integrated Environmental Management (Region B) Private Bag X 9086 Cape Town		
Postal code:	8000	**Cell:**	
Telephone:	021 483 4094	**Fax:**	021 483 4372
E-mail:	Anbarnes@pgwc.gov.za		
Provincial Authority:	Department of Environmental Affairs and Nature Conservation (Northern Cape)		
Contact person:	Mr Julius Mutyourauta (Director: Environmental Management)		
Postal address:	Private Bag X6102, KIMBERLY		
Postal code:	8300	**Cell:**	083 285 2373
Telephone:	053 807 7430	**Fax:**	053 831 3530
E-mail:	jmutyorauta@half.ncape.gov.za		
Landowner:	N/A – The study area is located off the west coast of South Africa.		
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

In instances where there is more than one landowner, please attach a list of landowners with their contact details to this application.

Local authority in whose jurisdiction the proposed activity will fall:	N/A – Project is located offshore.

Nearest town or districts:			
Contact person:			
Postal address:			
Postal code:		**Cell:**	
Telephone:		**Fax:**	
E-mail:			

In instances where there is more than one local authority involved, please attach a list of local authorities with their contact details to this application. See attached list.

2. ACTIVITIES APPLIED FOR TO BE AUTHORISED

For an application for authorisation that involves more than one listed or specified activity that, together, make up one development proposal, all the listed activities pertaining to this application must be indicated.

Indicate the number and date of the relevant notice:	**Activity No (s) (in terms of the relevant notice) :**	**Describe each listed activity as per project description:**
GN No, R544, 18 June 2010	16(vi)	*Construction or earth moving activities in the sea …, in respect of infrastructure covering 50 m² or more.* Sampling activities are planned in the prospecting rights areas identified above from October 2011 to November 2013. During the initial deposit assessment phase, it is proposed that a minimum of 300 core samples would be obtained. This would be followed by a resource delineation phase during which a maximum of 4 500 cores would be obtained. The sampling would be undertaken utilising a vibracoring tool, mounted in a frame which is lowered to the seabed during the coring operation to provide stability. The frame has a footprint of 6 m x 6 m. It is not fixed to the seabed in any way and is only positioned on the seabed during the coring process, which takes approximately 1.5 hours. The tool is then recovered to the deck of the sampling vessel where the sediment core is removed. The vessel then moves to the next sampling location.
GN No, R544, 18 June 2010	18(ii)	*The infilling or depositing of any material of more than 5 m³ into, or the dredging, excavation, removal or moving soil, sand, shells, shell grit, pebbles or rock from the sea.* The 300 core samples planned for the initial deposit assessment programme would be collected in up to 60 targets over the 27 600 km² prospecting area. Clusters of up to five cores would be collected at each target area with individual core spacing of approximately 70 metres. The volume of each core would be approximately 0.178m³ at each core site and therefore the total

		volume of seabed sediment that would be removed would be approximately 53 m^3 over the total prospecting area. The estimated 4 500 cores that would be collected during the resource delineation programme would be at a core spacing of 50 m to 200 m apart. The total volume of seabed sediment that would be removed during this phase would be approximately 799 m^3 over the total prospecting area. There would be no infilling or depositing of material during the sampling process.

3. OTHER AUTHORISATIONS REQUIRED

3.1 DO YOU NEED ANY AUTHORISATIONS IN TERMS OF ANY OF THE FOLLOWING LAWS?

3.1.1	National Environmental Management: Waste Act	YES	**NO ✓**
3.1.2	National Environmental Management: Air Quality Act	YES	**NO ✓**
3.1.3	National Environmental Management: Protected Areas Act	YES	**NO ✓**
3.1.4	National Environmental Management: Biodiversity Act	YES	**NO ✓**
3.1.5	Mineral Petroleum Development Resources Act *	**YES ✓**	NO
3.1.6	National Water Act	YES	**NO ✓**
3.1.7	National Heritage Resources Act	YES	**NO ✓**
3.1.8	Other (please specify)	YES	**NO ✓**
3.2	Have such applications been lodged already?	YES	**NO ✓**

* Note that in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) four separate Environmental Management Programmes have previously been submitted and approved by DMR for the relevant prospecting rights areas.

4. DECLARATIONS

4.1 The Applicant

I, MICHAEL MARTIN BROWN ,declare that I -

- am, or represent[1], the applicant in this application;
- have appointed an environmental assessment practitioner to act as the independent environmental assessment practitioner for this application / will obtain exemption from the requirement to obtain an environmental assessment practitioner[2];
- will provide the environmental assessment practitioner and the competent authority with access to all information at my disposal that is relevant to the application;
- will be responsible for the costs incurred in complying with the Environmental Impact Assessment Regulations, 2010, including but not limited to –
  - costs incurred in connection with the appointment of the environmental assessment practitioner or any person contracted by the environmental assessment practitioner;
  - costs incurred in respect of the undertaking of any process required in terms of the Regulations;
  - costs in respect of any fee prescribed by the Minister or MEC in respect of the Regulations;
  - costs in respect of specialist reviews, if the competent authority decides to recover costs; and
  - the provision of security to ensure compliance with conditions attached to an environmental authorisation, should it be required by the competent authority;
- will ensure that the environmental assessment practitioner is competent to comply with the requirements of these Regulations and will take reasonable steps to verify whether the EAP complies with the Regulations;
- will inform all registered interested and affected parties of any suspension of the application as well as of any decisions taken by the competent authority in this regard;
- am responsible for complying with the conditions of any environmental authorisation issued by the competent authority;
- hereby indemnify the Government of the Republic, the competent authority and all its officers, agents and employees, from any liability arising out of the content of any report, any procedure or any action which the applicant or environmental assessment practitioner is responsible for in terms of these Regulations;
- will not hold the competent authority responsible for any costs that may be incurred by the applicant in proceeding with an activity prior to obtaining an environmental authorisation or prior to an appeal being decided in terms of these Regulations;
- will perform all other obligations as expected from an applicant in terms of the Regulations;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the applicant[3]/ Signature on behalf of the applicant:

DE BEERS CONSOLIDATED MINES

Name of company (if applicable):

30 MARCH 2011

Date:

[1] If this is signed on behalf of the applicant, proof of such authority from the applicant must be attached.
[2] If exemption is obtained from appointing an EAP, the responsibilities of an EAP will automatically apply to the person conducting the environmental impact assessment in terms of the Regulations.
[3] If the applicant is a juristic person, a signature on behalf of the applicant is required as well as proof of such authority.

DE BEERS
A DIAMOND IS FOREVER

CONFIRMATION OF SIGNING AUTHORITY

I, **IAN NORMAN SCHEEPERS**, in my capacity as the Assistant Secretary of **DE BEERS CONSOLIDATED MINES LIMITED** (DBCM) hereby confirm that Mr Michael Martin Brown, the Chief Operations Officer of DBCM, is a member of the Executive Committee of DBCM and in that capacity is duly authorised to sign the Application form for Environmental Authorisation (File Reference No. 12/12/20; NEAS Reference No. DEAT/EIA) with the Project Title "Basic assessment process for marine prospecting activities in various South African sea areas off the west coast" in terms of the attached resolution of the directors of DBCM under the heading "Signing Authorities" dated 2 August 2004.

I N Scheepers
ASSISTANT SECRETARY
31 March 2011

HEAD OFFICE
De Beers Consolidated Mines Limited Registration No. 1888/000007/06

36 STOCKDALE STREET KIMBERLEY 8301
PO BOX 616 KIMBERLEY 8300
TEL +27 (0) 53 839 4111 FAX +27 (0) 53 839 4210
www.debeersgroup.com

DE BEERS CONSOLIDATED MINES LIMITED

EXTRACT FROM THE MINUTES OF A MEETING OF DIRECTORS OF DE BEERS CONSOLIDATED MINES LIMITED HELD ON MONDAY, 2 AUGUST 2004

SIGNING AUTHORITIES
RESOLVED :

1.1 that the resolution of directors passed at a meeting of the board held on 13 November 1964 under the subject "Signature of Documents" is hereby rescinded;

1.2 that the resolution of directors passed at a meeting of the board held on 28 November 1989 under the subject "Banking Arrangements" is hereby rescinded;

1.3 that the resolution of directors passed at a meeting of the board held on 17 September 1990 under the subject "General Signing Authority" is hereby rescinded;

1.4 that the resolution of directors passed at a meeting of the board held on 3 February 2003 under the subject "Signing Authorities - Corporate Headquarters" is hereby rescinded;

1.5 that

i) any two directors or,

ii) any one director and the Secretary or Assistant Secretary or any member of the Executive Committee of the Company for the time being

be hereby authorised to sign:

1.5.1 all powers of attorney, guarantees, suretyships, bonds, deeds, contracts, undertakings and any such other documents; and

1.5.2 any documents required in connection with the opening of any banking account, any agreement relating to the provision to the Company of any banking facility, the appointment of signatories to operate any banking account or any changes to such signatories and the appointment of representatives related to electronic banking and matters incidental thereto.

RESOLVED FURTHER :

that, in the absence of a Director of the Company, all notarial agreements, deeds of suretyship, bonds of indemnity, powers of attorney to pass transfer, transfer deeds, consents to cancellation of bonds or releases of properties from the operation on bonds, applications to any Deeds Registry or any other documents required in connection with the registration or endorsement of any title in any Deeds Registry, and all other documents requiring the official signature of the Company, be signed by the Secretary or the Assistant Secretary or any member of the Executive Committee of the Company.

Certified a true extract

I N Scheepers
Assistant Secretary
Kimberley
31 March 2011

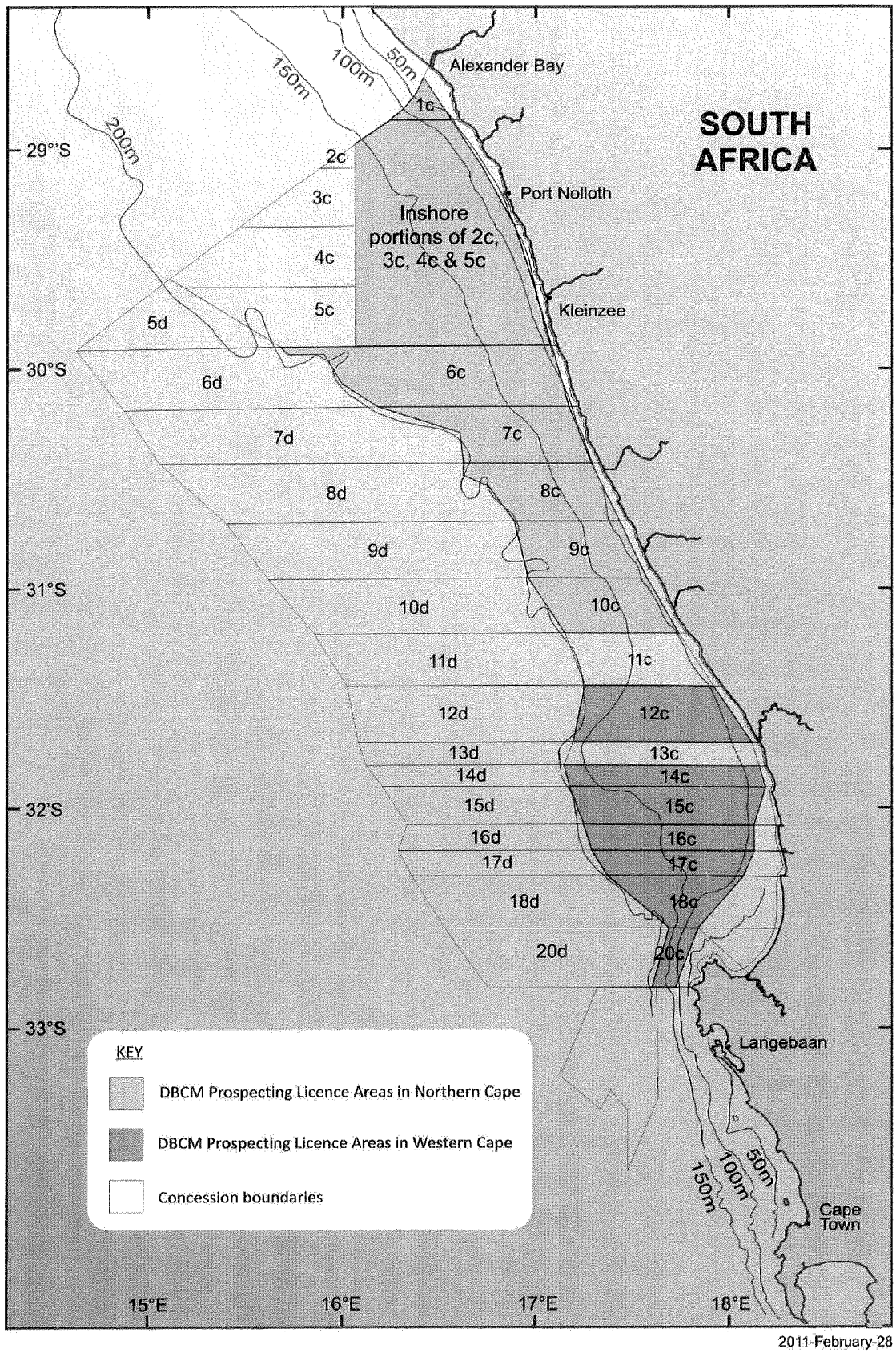


Figure 1: **The proposed coring / sampling activities would be undertaken in the blue and green shaded blocks off the West Coast of South Africa.**

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF EAP AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST

Environmental Assessment Practitioner (EAP):[1]	CCA Environmental (Pty) Ltd		
Contact person:	Jonathan Crowther / Tamryn Heydenrych		
Postal address:	PO Box 10145, Caledon Square, CAPE TOWN		
Postal code:	7905	Cell:	
Telephone:	(021) 461 1118/9	Fax:	(021) 461 1120
E-mail:	jonathan@ccaenvironmental.co.za tamryn@ccaenvironmental.co.za		
Professional affiliation(s) (if any)	Jonathan Crowther: • Registered Professional Natural Scientist (Pr.Sci.Nat.) - Environmental Scientist • Certified as an Environmental Practitioner with The Interim Certification Board for Environmental Assessment Practitioners of South Africa - CEAPSA		

Project Consultant:	N/A		
Contact person:			
Postal address:			
Postal code:		**Cell:**	
Telephone:		**Fax:**	
E-mail:			

4.2 The Environmental Assessment Practitioner

I, Jonathan Crowther , declare that –

General declaration:

- I act as the independent environmental practitioner in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will keep a register of all interested and affected parties that participated in a public participation process;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- Will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010;

Signature of the environmental assessment practitioner:

CCA ENVIRONMENTAL (PTY) LTD

Name of company:

28/3/2011

Date:

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

Private Bag X 447 · PRETORIA · 0001 · Fedsure Building · 315 Pretorius Street · PRETORIA
Tel (+ 27 12) 310 3911 · Fax (+ 2712) 322 2682

Reference: 12/12/20/2254
Enquiries: Nyiko Ngoveni / Mmatlala Rabothata
Tel: 012 310 1694 /1768 **Fax:** 012 320 7539
E-mail: nngoveni@environment.gov.za / mrabothata@environment.gov.za

Mr Jonathan Crowther
CAA Environmental (Pty) Ltd
PO Box 10145
CALEDON SQUARE
7905

Fax: 021 461 1120

PER FACSIMILE / MAIL

Dear Mr Crowther

APPLICATION FOR ENVIRONMENTAL AUTHORISATION: MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST

The Department confirms having received the Application Form and Declaration of Interest submitted by you on 5 April 2011 for environmental authorisation for the abovementioned project. You have submitted these documents to comply with the Environmental Impact Assessment Regulations, 2010.

The Application is accepted. You are hereby reminded that the activity may not commence prior to an environmental authorisation being granted by the Department.

Yours sincerely

Mr Dumisani Mthembu
Chief Director: Environmental Impact Management (Acting)
Department of Environmental Affairs
Letter signed by: Ms Hilda Bezuidenhout
Designation: Assistant Director: Environmental Impact Evaluation
Date: 13/04/2011

AM01/Let_Apr11

15 April 2011

Dear Sir/Madam

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST (REF NO. 12/12/20/2254): NOTICE OF AVAILABILITY OF DRAFT BASIC ASSESSMENT REPORT FOR COMMENT

De Beers Consolidated Mines Ltd (De Beers) is the current Prospecting Rights holder for the sea areas: 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c.

AuruMar (Pty) Ltd (AuruMar) has been formed to act as the operator to undertake Marine Prospecting Activities in these sea areas. The proposed prospecting activities include the identification of heavy minerals, platinum group metals, gold and sapphire (gemstones).

Notice is hereby given in terms of the National Environmental Management Act (No. 107 of 1998) that a Draft BAR is available for public review and comment. Copies of the Draft BAR will be available at the following locations from **Monday, 18 April 2011**:

1. Offices of CCA Environmental (Pty) Ltd (Cape Town); and
2. On the CCA Environmental website (www.ccaenvironmental.co.za).

The Draft BAR has been made available for a 40-day comment period (plus 5 days to cover public holidays). Interested and Affected Parties who would like to submit comments on the Draft BAR should submit them to CCA Environmental **no later than 1 June 2011** for inclusion in the Final BAR. Comments should be sent to our Tamryn Heydenrych (tamryn@ccaenvironmental.co.za) or to CCA (details below).

A copy of the Executive Summary of the Draft BAR is enclosed for your reference.

Should you have any queries on the above, or require any further information, please do not hesitate to contact us.

Yours sincerely

Jonathan Crowther Pr.Sci.Nat., CEAPSA
CCA ENVIRONMENTAL (PTY) LTD

Encl.

AM01PR/Corr/I&APs /Let I&AP DBAR notification – April 2011

CCA ENVIRONMENTAL (Pty) Ltd • Consulting Services
Unit 35 Roeland Square 30 Drury Lane Cape Town 8001 • PO Box 10145 Caledon Square 7905
Tel +27 (21) 461 1118/9 • Fax +27 (21) 461 1120 • email: info@ccaenvironmental.co.za • website: www.ccaenvironmental.co.za
Directors: J Crowther F Fredericks • Reg No 2003/019026/07

APPENDIX 3

MARINE BENTHIC INPUT

SPECIALIST STATEMENT

Marine Specialist Statement on the potential benthic impacts of proposed sampling for heavy minerals in De Beers Consolidated Mines' Prospecting Right Areas off the west coast of South Africa

PREPARED FOR

AuruMar (Pty) Ltd

on behalf of

CCA Environmental (Pty) Ltd

April 2011

By

Pisces Environmental Services (Pty) Ltd

Contact Details:
Dr A. Pulfrich
P O Box 31228, Tokai 7966, South Africa
Tel & Fax: 27 21-7829553
Email: apulfrich@pisces.co.za

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EXPERTISE AND DECLARATION OF INDEPENDENCE

This report was prepared by Dr Andrea Pulfrich of Pisces Environmental Services (Pty) Ltd. Andrea has a BSc (Hons) and MSc degree in Zoology from the University of Cape Town and a PhD in Fisheries Biology from the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany.

As Director of Pisces since 1998, Andrea has considerable experience in undertaking specialist environmental impact assessments, baseline and monitoring studies, and Environmental Management Programmes relating to marine diamond mining and dredging, hydrocarbon exploration and thermal/hypersaline effluents. She is a registered Environmental Assessment Practitioner and member of the South African Council for Natural Scientific Professions, South African Institute of Ecologists and Environmental Scientists, and International Association of Impact Assessment (South Africa).

This specialist report was compiled as a desktop study on behalf of CCA Environmental (Pty) Ltd, 35 Roeland Square, 30 Drury Lane, Cape Town, 8001 for their use in preparing a Basic Assessment Report and developing an Environmental Management Plan for a proposed heavy minerals sampling campaign off the South African West Coast. The compilation followed a review process of published (peer reviewed) and unpublished literature and the assessment of potential impacts based on proposed activities and identification of impacts (and their mitigation) within the available literature.

I do hereby declare that Pisces Environmental Services (Pty) Ltd is financially and otherwise independent of the Applicants and CCA Environmental.

Andrea Pulfrich

Dr Andrea Pulfrich

The specific terms of reference received from CCA Environmental for the marine specialist assessment were:

1 Provide a general description of the marine biodiversity in the identified prospecting areas.
2 Review the information provided in the EMPs for the identified prospecting areas and update, if required.
3 Assess the impact of taking core samples from the seabed on the benthic communities.
4 Assess the impact of the temporary placement of a 6 m x 6 m frame on the seabed during coring (approximately 1.5 hours per core).
5 Identify practicable mitigation measures to reduce negative impacts and indicate how these can be implemented in the sampling phase and management of the proposed project.
6 Comply with DEA&DP's guidelines on specialist study requirements for EIAs.

1. PROJECT DESCRIPTION

1.1 Overview

AuruMar is a joint venture company created by De Beers Group Exploration Holdings Limited and AngloGold Ashanti Marine Exploration Limited to develop offshore gold placer deposits. The company is planning a sampling campaign in De Beers Consolidated Mines' Heavy Mineral Prospecting Right Areas off the west coast of South Africa. The Prospecting Right Concessions are located in both the Northern and Western Cape and include:

- Northern Cape - 1c, inshore portions of 2c, 3c, 4c and 5c, and 6c, 7c, 8c, 9c and 10c
- Western Cape - 12c, 14c, 15c, 16c, 17c, 18c and 20c.

The prospecting activities would be conducted in a phased approach, with each phase dependant on the results of the previous phase. The two phases planned are as follows and it is proposed that they would run from October 2010 to November 2013:

- Phase I: Initial Deposit Assessment Programme
- Phase II: Resource Delineation Programme

It should be noted that AuruMar has already undertaken a desktop study and developed a geological model and an associated mineralisation model, based on existing information. The desktop study included the review of published geophysical, geotechnical and sampling data as well as the review of data that De Beers has collected from existing and adjacent concession areas. Geophysical surveys and follow up ground-truthing was also undertaken in areas highlighted as potential targets by the desktop studies and where there was insufficient detail to guide further exploration.

1.1.1 Exploration Sampling

The proposed prospecting activities would utilise AuruMar's Sonic VibroCorer (SVC) in order to collect the required samples. The system utilises a vibratory head, which has been adapted from land based technology, where the vibration energy is transferred into the drill string and enables the drill-string to penetrate into the seabed down to 10 m with a radius of 75 mm. The system can penetrate through most unconsolidated seabed lithologies, to produce a discrete high integrity core, which can then be analysed in detail. The sampling system is mounted in a frame, which is lowered to the seabed from a purpose built Launch and Recovery System (LARS) on a suitable vessel of opportunity.

SVC core samples would be logged and stored onboard the vessel and transferred ashore at regular intervals for further analysis. Once the cores are logged they would then be analysed onshore for heavy mineral content. This would entail initial sizing, screening and sub-sampling, followed by an evaluation of a sub-sample at an appropriately accredited onshore laboratory. Results from the sample treatment and the evaluation process would provide inputs into the geological model.

1.2 Initial Deposit Assessment

The aim of Initial Deposit Assessment Programme would be to groundtruth the geological model compiled during the desktop study and to identify the possible presence of mineralisation for further resource delineation (i.e. Phase II).

It is proposed that approximately 300 cores would be collected within identified areas in the prospecting rights areas. Up to 60 target areas would be selected over the 27 600 km² prospecting area based on the results of an ongoing desktop study. Clusters of up to five cores would be collected in each target area with individual core spacing of approximately 70 metres. The 300 core sampling activities would result in a total disturbance area of 53 m³. The Initial Deposit Assessment Programme would extend for approximately 80 days.

Total disturbance for Deposit Assessment Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
300	5	1.8×10^{-8}	53
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2			

1.3 Resource Delineation

Once the detailed geophysical surveying has been completed and the results further analysed, it is assumed that these results would yield at least one deposit that would justify further sampling in the Resource Delineation Programme. The proposed method of sampling would be the same as the process undertaken in Phase I. Phase II is intended to increase the level of confidence regarding the presence of a mineral resource in the deposit area. This confidence level would ultimately determine whether it is viable to apply for commercial mining rights.

It is assumed that the potential deposit area to be sampled would be approximately 56 km² in extent. It is estimated that up to 4 500 core samples would be required within this deposit area. The core spacings would be between 50 and 200 m apart. The total volume of disturbance would be approximately 799 m³.

Total disturbance for Resource Delineation Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
4500	80	$2.9 \times e^{-7}$	799
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10 m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2.			

2. DESCRIPTION OF THE MARINE ENVIRONMENT

This section summarises the important features and processes of the region based on the relevant description of the offshore marine environment documented in Chapter 1 of Volume III (Description of the Environmental Baseline) of the Generic EMPR for Marine Diamond Mining (Lane and Carter 1999). It is supplemented by more recent information from other EIAs and EMPs compiled for the area (e.g. Pulfrich 1999; CCA Environmental 2005, 2007a, 2007b) and the BCLME Report on cumulative effects of diamond mining in the Benguela Region (Penney *et al.* 2007).

2.1 Meteorology

The meteorological processes of the South African West Coast have been described by Andrews and Hutchings (1980), Heydorn and Tinley (1980), Nelson and Hutchings (1983), Shannon (1985), Shannon and Nelson (1996), and Shillington (1998).

Wind and weather patterns along the West Coast are primarily due to the South Atlantic high-pressure cell and the eastward movement of mid-latitude cyclones (which originate within the westerly wind belt between 35° to 45°S), south of the subcontinent.

The South Atlantic high-pressure cell is perennial, but strongest during austral summer when it attains its southernmost extension to the south and south-west (approximately 30°S, 05°E) of the subcontinent. Linked to this high-pressure in summer is a low-pressure cell that forms over the subcontinent due to strong heating over land. The pressure differential of these two systems induces moderate to strong south-easterly (SE) winds near the shore during summer. Furthermore, the southern location of the South Atlantic high-pressure cell limits the impact that mid-latitude cyclones have on summer weather patterns so that, at best, the mid-latitude cyclones cause a slackening of the SE winds. During the austral winter both the weakening and north-ward migration of the South Atlantic high-pressure cell (to approximately 26°S, 10°E) and the increase in atmospheric pressure over the subcontinent result in the eastward moving mid-latitude cyclones advancing closer to the coast.
Strong north-westerly (NW) to south-westerly (SW) winds result from mid-latitude cyclones passing the southern Cape at a frequency of 3 to 6 days. Associated with the approach of mid-latitude cyclones is the appearance of low-pressure cells, which originate from near Lüderitz on the Namibian coast and quickly travel around the subcontinent (Reason and Jury 1990; Jury *et al.* 1990).

A second important wind type that occurs along the West Coast are catabatic 'berg' winds during the formation of a high-pressure system (lasting a few days) over, or just south of, the south-eastern part of the subcontinent. This results in the movement of dry adiabatically heated air offshore (typically at 15 m/s). At times, such winds may blow along a large proportion of the West Coast north of Cape Point and can be intensified by local topography. Aeolian transport of fine sand and dust may occur up to 150 km offshore.

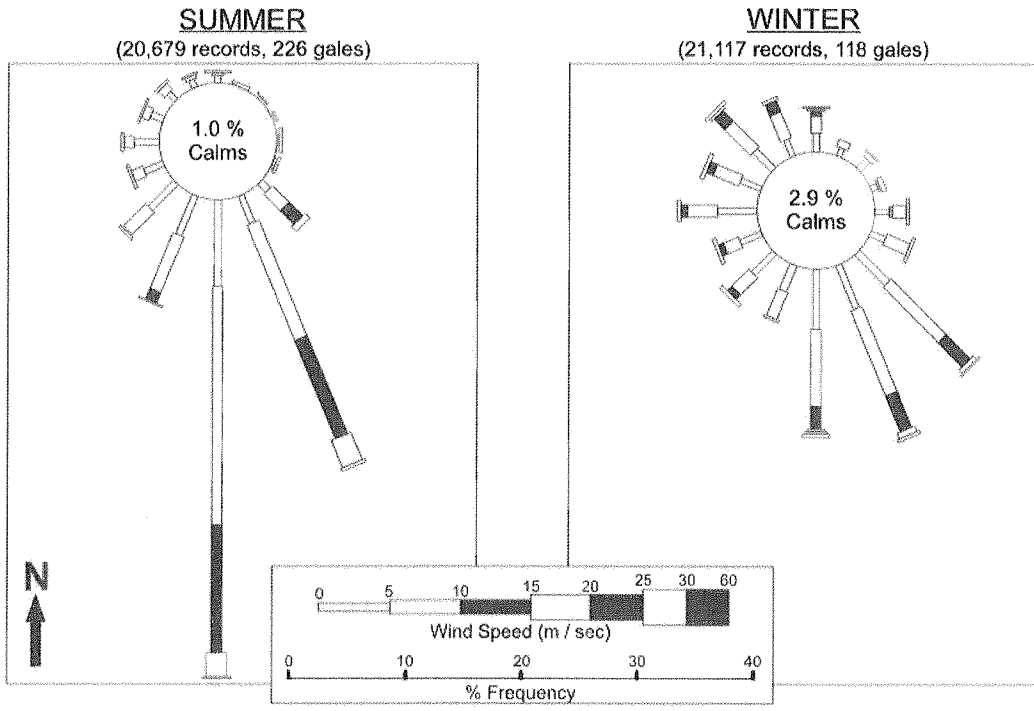

Figure 1: Rose-plots of the distribution of wind strength and direction along the South African west coast between Alexander Bay (29°S) and Saldanha Bay (33° S) during the summer and winter seasons over the period 1960 - 1997. (Redrawn from Lane and Carter 1999. Data from the SA Data Centre for Oceanography.)

2.2 Physical Oceanography

2.2.1 Topography

The bathymetry and topography of the West Coast offshore region have been described by Nelson and Hutchings 1983, Shannon 1985, Shannon and Nelson 1996, and Dingle *et al.* 1987.

The continental shelf along the West Coast is generally wide and deep, although large variations in both depth and width occur. The shelf maintains a general north-north-west (NNW) trend north of Cape Point, being narrowest in the south between Cape Columbine and Cape Point (40 km) and widening to the north of Cape Columbine to its widest of the Orange River (180 km). The nature of the shelf break varies off the South African West Coast. Between Cape Columbine and the Orange River, there is usually a double shelf break, with the distinct inner and outer slopes, separated by a gently sloping ledge.

The immediate nearshore area consists mainly of a narrow (to ~8 km wide) rugged rocky zone, which initially slopes steeply seawards to a depth of about 30 m and then gradually to about 80 m. The middle and outer shelf normally lack relief and slope gently seawards reaching the shelf break at a depth of approximately 500 m. Banks on the continental shelf include the Orange Bank (Shelf or Cone), a shallow (160 - 190 m) zone that reaches maximal widths (180 km) offshore of the Orange

River, and Childs Bank, situated ~150 km offshore at about 31°S. A number of submarine canyons cut into the shelf between 31° and 35°S, the most prominent being the Cape Canyon and the Cape Point Valley.

The proposed prospecting activities would be undertaken within a 27,600 km^2 area in water depths of between 50 m to 200 m.

2.2.2 Sediments

Figure 2 illustrates the distribution of seabed surface sediment types off the South African west coast. As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. An almost 500 km long mud belt (of up to 40 km wide, and of 15 m average thickness) is situated over the outer edge of the middle shelf between the Orange River and St Helena Bay (Birch *et al.* 1976). Within the broad study area, sediment is dominated by muddy sands, sandy muds, mud and some sand.

Present day sedimentation is limited to input from the Orange River. This sediment is generally transported northward. Most of the sediment in the area is therefore considered to be relict deposits by now ephemeral rivers active during wetter climates in the past. The Orange River, when in flood, still contributes largely to the mud belt as suspended sediment is carried southward by poleward flow. In this context, the absence of large sediment bodies on the inner shelf reflects on the paucity of terrigenous sediment being introduced by the few rivers that presently drain the South African West Coast coastal plain.

Nearshore sediments are subject to suspension by waves and longshore transport. This effect penetrates to 90 m. Natural turbidity levels range from 3 and 12 mg/l with significantly higher concentrations associated with storm waves and floods.

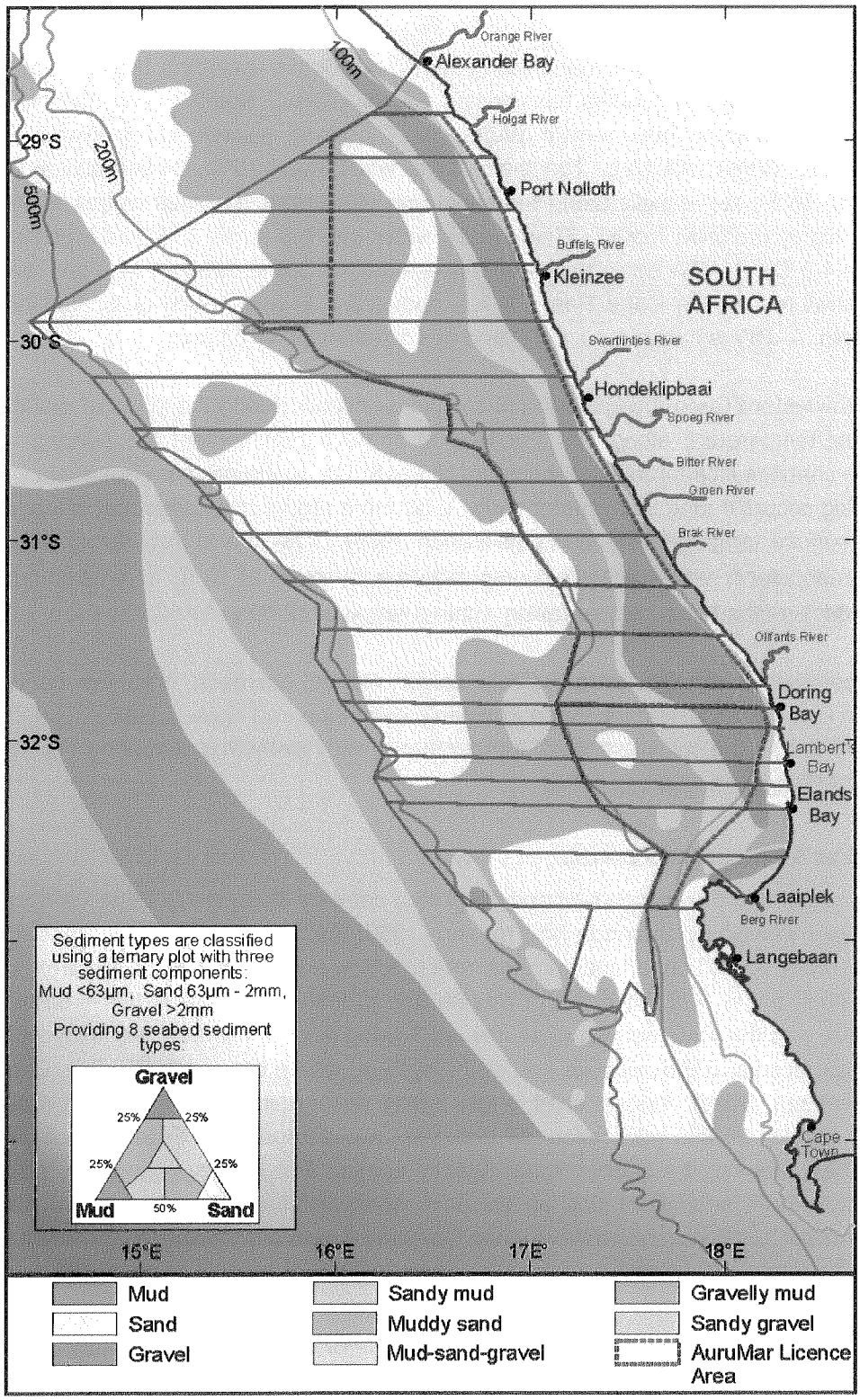

Figure 2: Map of the distribution of seabed surface sediment types off the South African west coast (redrawn from Lane and Carter 1999).

2.2.3 Water masses and sea surface temperatures

A number of water masses are found along the West Coast, including tropical and sub-tropical surface waters, thermocline waters (comprising South Atlantic, South Indian and tropical Atlantic Central Water), Antarctic Intermediate Water (AAIW), North Atlantic Deep Water (NADW) and Antarctic Bottom Water (AABW). The thermocline water mass (6°C, 34.5 Practical Salinity Units (psu) – 16°C, 35.5 psu) upwells along the coast and constitutes the shelf waters of the Benguela, although in highly modified forms. Thermocline water overlies AAIW (34.2-34.5 psu with potential temperature 4-5°C). NADW has a potential temperature <3°C and salinity >34.8 psu, and lies below the AAIW stratum. In the Cape Basin, it lies above the AABW, which is located beyond about 3,800 m depth. AABW is cooler than 1.4°C and has a salinity of 34.82 psu.

Off the south-western Cape the upwelling of cool water occurs during the summer months stabilising the seawater temperature along this coastline to some extent so that the average sea surface temperature changes little throughout the year (13 to 15 °C). In the northern Benguela system where cool upwelling occurs during the winter months, a far more pronounced seasonal difference (12 to 17 °C) in sea surface temperatures occurs (Shannon 1985). The sea surface temperature along the coast of Namaqualand near Port Nolloth ranges from a minimum of 10 °C to a maximum of just over 20 °C, with 84 % of the temperatures falling within a range of 12 °C to 17 °C.

Over the continental margin, progressively colder waters encroach onto the continental shelf between the Orange River and the Cape Peninsula (Shannon and Nelson 1996). The area between 31°S and 33°S has the minimum shelf temperatures, with isotherms retreating into deeper water south of 34°S (Dingle and Nelson 1993).

2.2.4 Currents & Circulation Patterns

The major coastal and oceanic current and circulation patterns along the Southern African west coast have been overviewed by Shannon and Nelson (1996) (Figure 3). Typical current speeds in the region range from 10 - 50 cm/s, and currents tend to follow major topographic features, particular the continental shelf edge. Off the coast of Angola, the prominent feature is the circular gyre on the Angola Dome, and the resultant warm, southward flowing Angola Current. Another dominant, warm current feature occurs at the opposite end of the system, where the strong Agulhas Current, flowing down the eastern South African shelf edge, along the Agulhas Bank to past Cape Agulhas, periodically results in the generation of massive, warm 'Agulhas Rings', which can result in substantial heat flux into the central South Atlantic ocean. The Agulhas Current is also capable of rounding Cape Point and generating an episodic, northward-flowing current, which can split near Cape Columbine (33°S) into the offshore Cape Canyon jet, and a northward longshore flow.

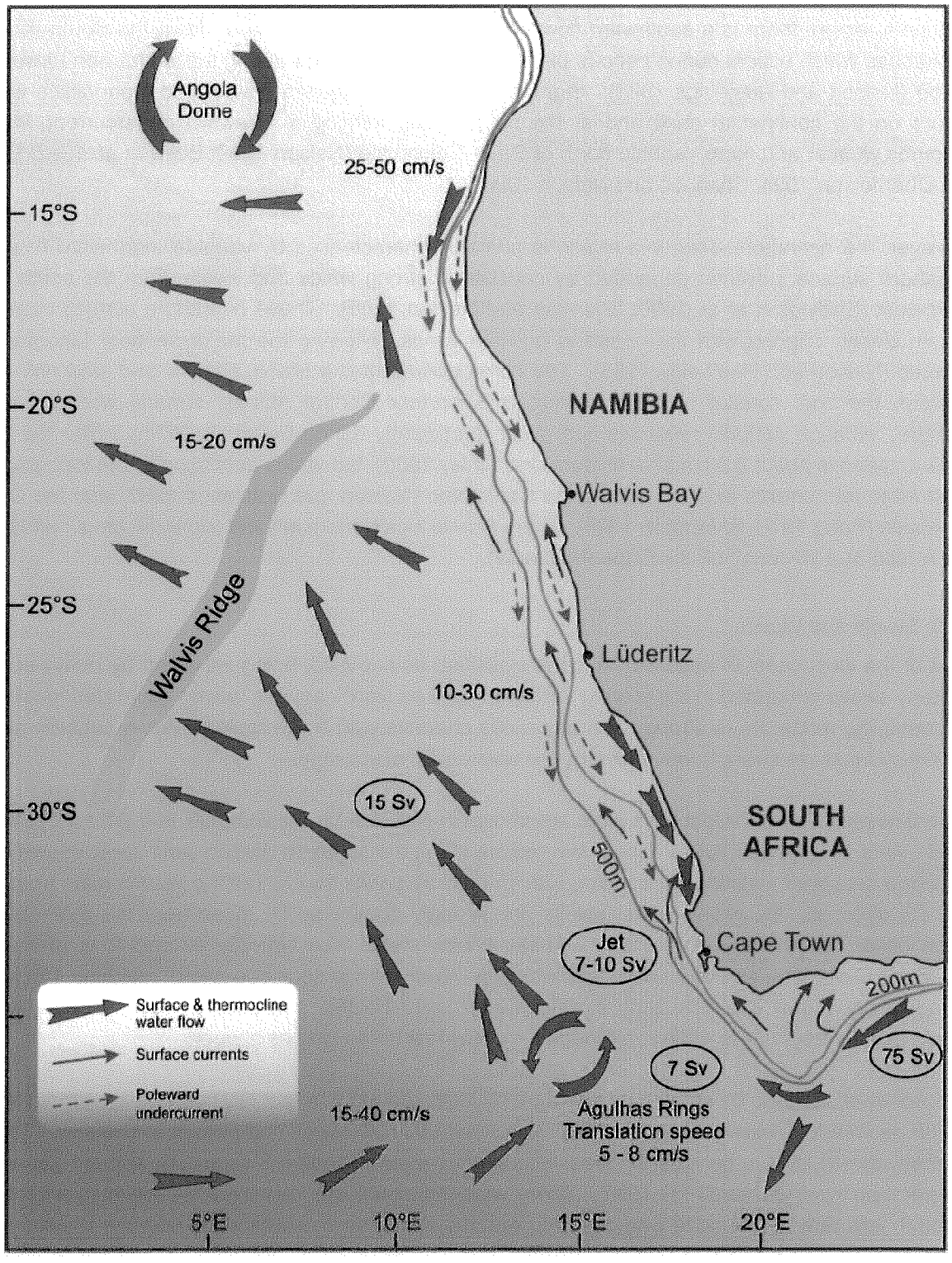

Figure 3: Circulation and volume flows of the Benguela current (after Shannon and Nelson 1996).

Between these two warm features, the Benguela west coast region is dominated more by wind-driven upwelling and swell events, than by consistent current flows. Close inshore over the southern Benguela region, there is a southward flow of cold water near the surface, down the South African west coast, which occurs during periods of barotropic reversals, and during the winter non-upwelling period (Nelson and Hutchings 1983). Significant southerly poleward flow of sub-thermocline water occurs on the continental shelf and at the shelf break, forming a poleward undercurrent, which becomes weaker and more variable north of Cape Columbine (Nelson 1989; Boyd *et al.* 1992; Boyd and Oberholster 1994; Shannon and Nelson 1996).

However, the nearshore Benguela region is primarily characterised by variable, northward flowing, longshore surface currents, generated by consistent, strong winds and swells from the south and southwest (Shillington *et al.* 1990; Shannon and Nelson 1996). These nearshore surface currents remain closely aligned with the coastline and the winds, following the major seafloor topographic features (Nelson and Hutchings 1983). The current constitutes a broad, shallow and slow NW flow between the cool coastal upwelled waters and warmer Central Atlantic surface waters further offshore, although periodic reversals can occur, particularly during Benguela Niños.. The average current speed is about 2.5 $cm.s^{-1}$ (Heydorn and Tinley 1980), but varies according to the topography. Shelf edge jet currents exist off both Cape Columbine (Nelson and Hutchings 1983) and the Cape Peninsula (Bang 1970; Shillington 1998), where flow is locally more intense (up to 50 $cm.s^{-1}$ off Cape Columbine and 70 $cm.s^{-1}$ off the Cape Peninsula).

2.2.5 Swells and Waves

Most of the west coast of southern Africa is classified as exposed, being impacted by heavy south-westerly swells generated in the roaring forties, as well as significant sea waves generated locally by the prevailing moderate to strong southerly winds characteristic of the region. Wave patterns along the West Coast are strongly influenced by the seasonal meteorology.

Typical seasonal swell-height rose-plots are shown in Figure 4 for the Summer and Winter of March 1998 - April 1999 (CSIR 2000). The wave regime along the southern African west coast shows only moderate seasonal variation in direction, with virtually all swells throughout the year coming from the SW - S direction. However, winter swells are strongly dominated by those from the SW - SSW, which occur almost 80% of the time. These winter swells also typically exceed 2 m in height, averaging about 3 m, and often attaining over 5 m. With wind speeds capable of reaching 100 km/h during heavy winter south-westerly storms, winter swell heights can exceed 10 m. Large wave events usually last for 2 to 4 days, although they may last for as long as a week.

Summer swells tend to be smaller on average, typically around 2 m, not reaching the maximum swell heights of winter. There is also a more pronounced southerly swell component in summer. These southerly swells tend to be wind-induced, with shorter wave periods (~8 seconds), and are generally steeper than swell waves (CSIR 1996). These wind-induced southerly waves are relatively local and, although less powerful, tend to work together with the strong southerly winds of summer to cause the northward-flowing nearshore surface currents, and result in substantial nearshore sediment mobilisation, and northwards transport, by the combined action of currents, wind and waves.

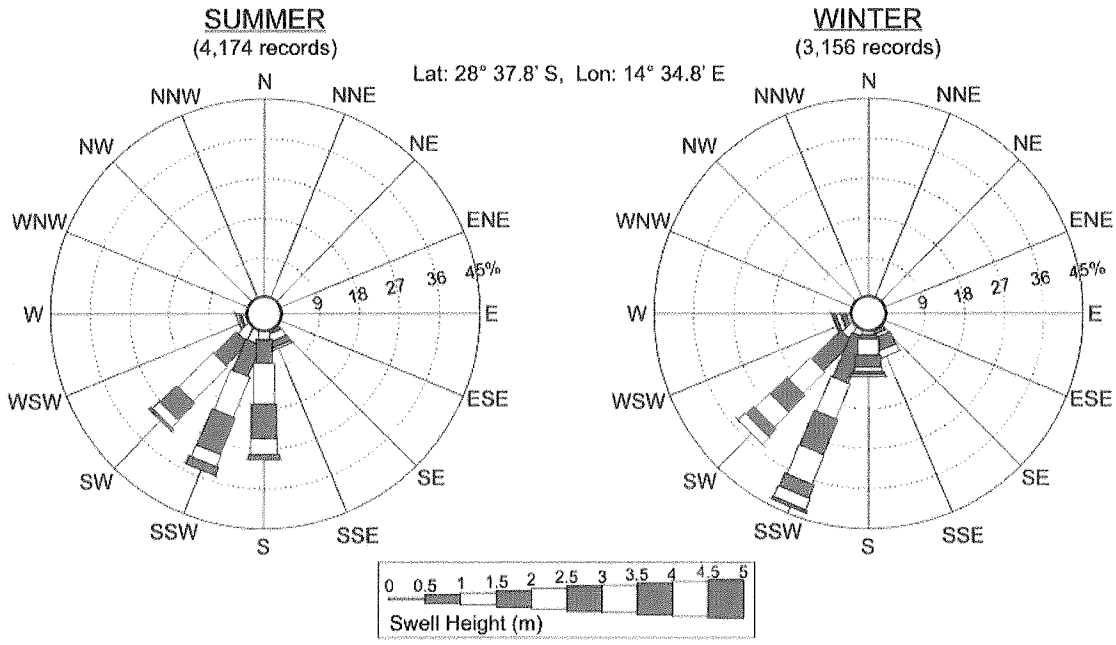

Figure 4: Rose-plots of the distribution of swell height and direction measured in 175 m water depth, 180 km offshore, west of the Orange River mouth, over the summer and winter seasons during March 1998 - April 1999 (redrawn from CSIR 2000).

2.2.5 Tides

Tides along the West Coast are semi-diurnal, with a mean tidal range along the Namaqualand coast of about 1.57 m (at least 50% of the time in the nearshore area), with spring tides as much as 2.24 m and neap tides in the order of 1 m. Tides arrive almost simultaneously (within 5 to 10 minutes) along the whole of the West Coast. Other than in the presence of constrictive topography, e.g. an entrance to enclosed bay or estuary, tidal currents are weak.

2.2.6 Upwelling

The Benguela region is one of the world's major coastal upwelling systems, the majority of which are found off the west coasts of continents (e.g. off Chile and Peru, California and West Africa). This upwelling dominates the oceanography of the West Coast of South Africa (Andrews and Hutchings 1980; Nelson and Hutchings 1983). Upwelling is characterised by pulsed input of cold, nutrient rich water into the euphotic zone, and in the Benguela region results from the wind-driven offshore movement of surface waters. The surface waters are replaced by cold nutrient-rich water that upwells from depth through Ekman transport. Once upwelled, this water warms and stabilises, and moves offshore where a thermocline usually develops. Nutrient rich upwelled water enhances primary production, and the West Coast region consequently supports substantial pelagic fisheries (Heydorn and Tinley 1980; Shillington 1998).

Upwelling occurs along the West Coast from Cape Agulhas to northern Namibia. The principle upwelling centre on the West Coast lies off Lüderitz and this upwelling cell effectively divides the

Benguela Upwelling system into a northern and southern region, which are meteorologically distinct (Pitcher *et al.* 1992). In the south upwelling-favourable SE winds are most prevalent during spring and summer, and upwelling occurs mostly between September and March. Upwelling in the southern Benguela area is highly variable on macro, meso and micro scales. Both continental shelf bathymetry and upwelling winds drive upwelling in the southern Benguela which is further influenced by local topography and meteorology (Shannon 1985), resulting in centres of enhanced upwelling off Namaqualand (30°S), Cape Columbine (33°S) and Cape Peninsula (34°S) (Figure 5).

The Namaqualand upwelling zone (or Hondeklipbaai Cell) is a cool wedge-shaped zone lying between Hondeklip Bay and the Orange Bight, where the narrow shelf to the south-west of Hondeklip Bay results in enhanced upwelling. Both bathymetry and orography control upwelling at Cape Columbine. Two fronts separate a divergence zone off the Columbine Peninsula, an oceanic front at the shelf edge and a shallower inshore front.

Although the upwelling process is active within 10 to 20 km of the shore, the influence of cold upwelled water extends approximately 150 km (Shannon and Nelson 1996). However, distinctive cold water filaments can extend 200 km offshore perpendicular to the coast, some being more than 1,000 km long (Shannon and Nelson 1996; Shillington *et al.* 1992).

2.2.7 Nutrient distribution

The cold, upwelled water is rich in inorganic nutrients, the major contributors being various forms of nitrates, phosphates and silicates (Chapman and Shannon 1985). During upwelling the comparatively nutrient-poor surface waters are displaced by enriched deep water, supporting substantial seasonal primary phytoplankton production. This, in turn, serves as the basis for a rich food chain up through zooplankton, pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (hake and snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). High phytoplankton productivity in the upper layers again depletes the nutrients in these surface waters. This results in a wind-related cycle of plankton production, mortality, sinking of plankton detritus and eventual nutrient re-enrichment occurring below the thermocline as the phytoplankton decays.

2.2.8 Oxygen concentrations

The natural annual input of many millions of tons of organic material onto the seabed off the southern African west coast has a substantial effect on ecosystems of the Benguela region. This organic input provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area. However, most of the organic detritus is not directly consumed, and so enters a seabed decomposition cycle. This aerobic decomposition process is capable of depleting deep water oxygen levels, resulting in the substantial seasonal formation of deep, low-oxygen water masses off this coast. Subsequent upwelling processes can move this low-oxygen water up onto the shelf, and into nearshore waters, often with devastating effects on marine communities. In some years (the most recent being 1993-1994), depletion of oxygen in shelf waters has had severe impacts on nearshore resources.

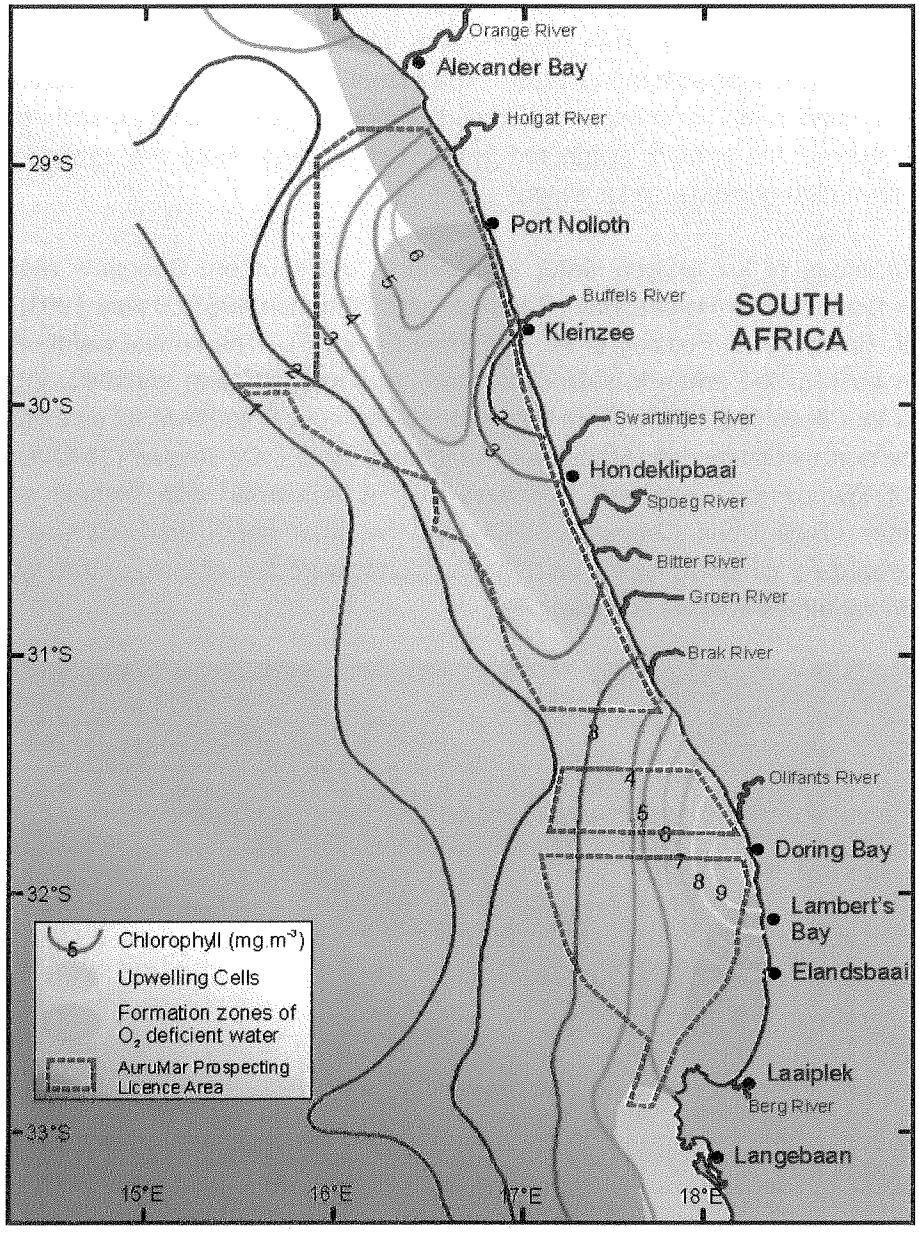

Figure 5: Map of the main upwelling areas, contours of resultant mean phytoplankton production (measured as $mg.m^{-3}$ of chlorophyll-a and areas of subsequent natural formation of low oxygen water off the South African west coast (modified from Brown *et al.* 1991).

Large scale hypoxic or anoxic conditions appear to result primarily from changes in wind patterns, which result in strong upwelling and increased nearshore plankton production, followed by calm seas, proliferation of the bloom and depletion of nutrients, followed by death, deposition and decay of vast quantities of organic material and resultant depletion of oxygen in shelf-seabed water masses (Shannon and O'Toole 2003). Subsequent upwelling can drive this low oxygen water ashore,

causing mass displacements, or even direct mortality, of seabed-associated species. As a result, the continental shelf waters of the Benguela system are characterised by low seabed oxygen concentrations (Chapman and Shannon 1985). The rate of oxygen depletion is dependent on the net organic accumulation in the sediments, and so carbon-rich biogenic mud deposits play an important role. As the mud on the shelf is distributed in discrete patches, there are corresponding primary areas for the formation of oxygen-poor water.

The two main areas of low-oxygen water formation in the southern Benguela region are in the Orange River Bight and St Helena Bay (Chapman and Shannon 1985; Bailey 1991; Shannon and O'Toole 1998; Bailey 1999; Fossing *et al.* 2000)(see Figure 5). The spatial distribution of oxygen-poor water in each of the areas is subject to short- and medium-term variability in the volume of hypoxic water that develops. Water from these zones can advect southwards as compensation flow for the surface north-westerly drift (Nelson and Hutchings 1983). De Decker (1970) showed that the occurrence of low oxygen water off Lambert's Bay is seasonal, with highest development in summer/autumn. Bailey and Chapman (1991), on the other hand, demonstrated that in the St Helena Bay area daily variability exists as a result of downward flux of oxygen through thermoclines and short-term variations in upwelling intensity.

Figure 6: The mass stranding, or 'walk-out' of rock lobsters that occurred at Elands Bay in February 2002 (Photo from http://www.waterencyclopedia.com).

Oxygen-deficient water affects the marine biota in the Benguela region at two levels. It can have sub-lethal effects, such as reduced growth and feeding, localised migrations and increased inter-moult period in rock-lobster populations (Beyers *et al.* 1994). On a larger scale, periodic low-oxygen events in the nearshore region can have catastrophic effects on the marine communities (Diaz and

Rosenberg 1995). Advancing hypoxic water associated with massive 'red-tide' blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of white mussels, rocky shore biota and fish (see Section 2.3.1). Such mass 'walk-outs' of rock lobsters have resulted in the death of up to 3 million lobsters per time (Newman and Pollock 1974; Matthews and Pitcher 1996; Pitcher 1998; Cockcroft 2000; Cockcroft *et al.* 2001) (Figure 6).

2.2.9 Turbidity

Inputs of sediments into the marine environment from terrigenous sources, together with organic inputs due to the high primary productivity characterising the Benguela region, results in naturally turbid coastal waters, particularly in the nearshore areas where waves and currents keep particulate matter in suspension. Total Suspended Particulate Matter (TSPM) consists of Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. Off Namaqualand, the PIM loading in nearshore waters is strongly related to natural inputs from the Orange River or from 'berg' wind events. On the other hand, seasonal phytoplankton production associated with upwelling events also plays an important role in determining the concentrations of POM in coastal waters.

Concentrations of suspended particulate matter in shallow coastal waters vary spatially and temporally, typically ranging from a few mg/ℓ to several tens of mg/ℓ (Bricelj and Malouf 1984; Berg and Newell 1986; Fegley *et al.* 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/ℓ, showing significant long-shore variation (Zoutendyk 1995). Considerably higher concentrations of PIM have, however, been reported from southern African west coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions. During storm events, concentrations near the seabed may even reach up to 10,000 mg/ℓ (Miller and Sternberg 1988). In the vicinity of the Orange River mouth, where river outflow strongly influences the turbidity of coastal waters, measured concentrations ranged from 14.3 mg/ℓ at Alexander Bay just south of the mouth (Zoutendyk 1995) to peak values of 7,400 mg/ℓ immediately upstream of the river mouth during the 1988 Orange River flood (Bremner *et al.* 1990). Field measurements of TSPM and PIM concentrations in the southern Benguela are summarized in Table 1.

The current velocities typical of the Benguela (10-30 cm/s) are capable of re-suspending and transporting considerable quantities of sediment northwards. Under calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow southward-flowing poleward undercurrent (Shillington *et al.* 1990; Rogers and Bremner 1991).

Table 1 Mean concentrations of total suspended particulate matter (TSPM) and particulate inorganic matter (PIM) expresses as mg/ℓ from coastal waters in the Benguela.

Region	TSPM	PIM	Source
Dalebrook (RSA)	1.5		Cliff (1982)
Olifantsbos (RSA)		1	Zoutendyk (1995)
Oudekraal (RSA)	1.6		Stuart (1982), Stuart *et al.* (1982)
Melkbosstrand (RSA)		~4.5	Zoutendyk (1995)
Saldanha Bay (RSA)		<4	Carter and Coles (1998)
Groenrivier (RSA)		8.8 2	Bustamante (1994) Zoutendyk (1995)
Port Nolloth (RSA)		~2.75	Zoutendyk (1995)
Alexander Bay (RSA)		14.3	Zoutendyk (1995)
Orange River	9		Emery *et al.* (1973)
Orange River 1988 flood		7,400	Bremner *et al.* (1990)

On the inner and middle continental shelf, the ambient currents are insufficient to transport coarse sediments typical of those depths, and re-suspension and shoreward movement of these by wave-induced currents occur primarily under storm conditions (see also Drake *et al.* 1985; Ward 1985). Data from a Waverider buoy at Port Nolloth have indicated that 2-m waves are capable of re-suspending medium sands (200 µm diameter) at ~10 m depth, whilst 6-m waves achieve this at ~42 m depth. Low-amplitude, long-period waves will, however, penetrate even deeper. Most of the sediment shallower than 90 m can therefore be subject to re-suspension and transport by heavy swells (Lane and Carter 1999).

Mean sediment deposition is naturally higher near the seafloor due to constant re-suspension of coarse and fine PIM by tides and wind-induced waves. Aggregation or flocculation of small particles into larger aggregates occurs as a result of cohesive properties of some fine sediments in saline waters. The combination of re-suspension of seabed sediments by heavy swells, and the faster settling rates of larger inorganic particles, typically causes higher sediment concentrations near the seabed. Significant re-suspension of sediments can also occur up into the water column under stronger wave conditions associated with high tides and storms. Re-suspension can result in dramatic increases in PIM concentrations within a few hours (Sheng *et al.* 1994). Wind speed and direction have also been found to influence the amount of material re-suspended (Ward 1985).

Although natural turbidity of seawater is a global phenomenon, there has been a worldwide increase of water turbidity and sediment load in coastal areas as a consequence of anthropogenic activities. These include dredging associated with the construction of harbours and coastal installations, beach replenishment, accelerated runoff of eroded soils as a result of deforestation or poor agricultural practices, and discharges from terrestrial, coastal and marine mining operations (Airoldi 2003). Such increase of sediment loads has been recognised as a major threat to marine biodiversity at a global scale (UNEP 1995).

2.3 Biological Oceanography

Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). Described here are the marine communities 'typical' of the region, focusing only on dominant, commercially important and conspicuous species.

2.3.1 Plankton

Plankton comprises three components, namely phytoplankton, zooplankton and ichthyoplankton.

(a) Phytoplankton

Phytoplankton forms the base of the marine food chain, and ultimately sustains the large pelagic and demersal fish stocks that support the major commercial fisheries on the southern African west coast. During periods of upwelling the phytoplankton communities are dominated by large-celled diatoms (Andrews and Hutchings 1980; Olivieri 1983) (Figure 7), whereas during periods of water column stability, they are replaced by a small-celled community dominated by flagellates (Chapman and Shannon 1985; Pitcher *et al.* 1991). Red tides (dinoflagellate and/or ciliate blooms) are also common features in certain areas in the Benguela system, particularly in the Lamberts Bay to St Helena Bay region (Shannon and Pillar 1985; Pitcher 1998) during relaxation of upwelling cells in late summer to autumn. Red tides can reach very large proportions with sometimes spectacular effects such as the large-scale rock-lobster 'walkout' of 1997 (Cockcroft *et al.* 2000; Cockcroft 2001)(Figure 6) and the so-called 'black tide' that occurred between Cape Columbine and the Berg River mouth in 1994 (Matthews and Pitcher 1996). Most of these red-tide events occur quite close inshore although Hutchings *et al.* (1983) have recorded red-tides 30 km offshore.

As would be expected from the short- and long-term variability of the winds that induce upwelling, phytoplankton productivity in the Benguela region is variable, with short-term variability being linked to the frequency and strength of seasonal upwelling and the development and migration of oceanic temperature fronts (Shannon and Pillar 1985). Seasonal variability is also affected by sunlight and water column stability, with production being highest in the austral summer, and lowest in July/August. In the south, upwelling is also pulsed, lasting for 3-7 days and alternating with periods of relaxation or even reversal. The average distribution of phytoplankton (measured as chlorophyll-a) along the southern African West Coast (see Figure 5), reveals high-productivity areas off the Olifants River mouth and off Port Nolloth.

Phytoplankton production is directly linked to nutrient supply, seeding by existing phytoplankton or spores, and water-column stability (Brown 1986). Ideal conditions occur on the South African West Coast continental shelf, but there is longshore variation in water column stability. Boyd (1987) related variation in thermocline depth (an index of water column stability) to local variations in wind strength and shelf topography. As a result, the perennial Namaqua upwelling cell is characterised by deep mixing, whereas areas such as St Helena Bay have well-developed, shallow thermoclines. Phytoplankton production and biomass is high in the latter area but generally low in the former.

Monteiro (1997) modelled the estimated total carbon flux resulting from primary production in the Benguela upwelling system. The Lüderitz upwelling cell effectively forms an environmental boundary, dividing the region into separate northern and southern Benguela sub-systems (Shannon and Nelson 1996). The southern sub-system, with an area 10,400 km^2, supports 6.45 g C/m^2 (or 670 x 103 tons C), with the total annual carbon production estimated at 76.4 x 106 tons C/year.

(b) Zooplankton

Zooplankton biomass varies with phytoplankton production and so seasonal minima occur in winter (Andrews and Hutchings 1980). As with phytoplankton, more intense variation occurs in association with the upwelling cycle, with newly upwelled water supporting low zooplankton biomass due to initial scarcity of food, while high biomasses develop in aged upwelled water after significant phytoplankton blooms. As zooplankton blooms lag phytoplankton blooms they occur even further offshore, with zooplankton biomass being maximal 40 to 100 km offshore in summer. During winter (when no upwelling occurs in the southern Benguela region) maximal zooplankton biomass is observed close inshore, values being low offshore.

Zooplankton comprises mesozooplankton (>200 µm) and macrozooplankton (>1,600 µm). Copepods dominate the mesozooplankton (Andrews and Hutchings 1980; Hutchings *et al.* 1991), and most are found in the phytoplankton-rich upper mixed layer of the water column. Mesozooplankton standing stock estimates in the southern Benguela range from 0.237 to 2.520 $gC.m^{-2}$ and generally increase from south (~0.5 to ~1.0 $gC.m^{-2}$ between Cape Point and Cape Columbine) to north (~0.5 to ~2.5 $gC.m^{-2}$ to the north of Cape Columbine); the higher northern biomass attributed to the region being downstream of two major upwelling cells.

The macro-zooplankton (>1,600 µm) is dominated by 18 species of euphausiids (Pillar 1986; Pillar *et al.* 1992). Other important groups contributing to the southern Benguela macrozooplankton community are chaetognaths (24 species), hyperiid amphipods (over 70 species within the southern and northern Benguela) and tunicates (42 species) (Figure 7). Macrozooplankton standing stocks are greatest north of Cape Columbine (0.5 $gC.m^{-2}$) and decline southwards and eastwards to 0.1 $gC.m^{-2}$ at the eastern boundary of the West Coast.

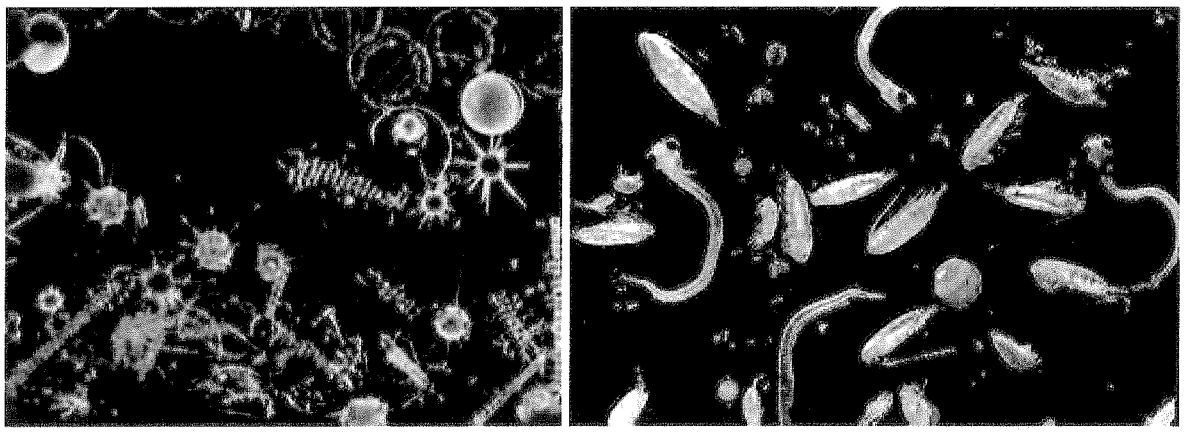

Figure 7: Phytoplankton (left, photo: hymagazine.com) and zooplankton (right, photo: mysciencebox.org) is associated with upwelling cells on the shelf.

(c) Ichthyoplankton

Ichthyoplankton comprises both fish eggs and larvae, and despite contributing only a small component to the overall plankton, is important due to the commercial fisheries of the Benguela region.

Most of the clupeoid pelagic species exhibit similar life history patterns involving seasonal migrations between the west and south coasts. Apart from round herring which spawn offshore of the shelf break on the West Coast, the spawning areas for pilchard (*Sardinops sagax*) and anchovy (*Engraulis japonicus*) are distributed on the continental shelf extending from south of St Helena Bay to Mossel Bay on the south coast (Shannon and Pillar 1986). Spawning areas are generally located downstream of the major upwelling centres and on the Western Agulhas Bank (Shannon and Pillar 1986), but spawning off St Helena Bay declined to negligible levels by 1966, possibly due to overfishing (Crawford 1980). Spawning activity takes place over a protracted period during spring and summer, with frequency of spawning being dependent on food concentration (copepod biomass). The eggs and larvae are subsequently carried around Cape Point to find their way back up the West Coast in northward flowing surface waters.

Of the demersal species, the two hake species (*Merluccius capensis* and *M. paradoxus*) spawn on the continental shelf off St Helena Bay and the western Agulhas Bank. Hake spawning occurs in spring and early summer, with a secondary spawning peak in autumn. Kingklip (*Genypterus capensis*) spawning occurs along the southern African West Coast from Cape Point northwards (Payne 1977). Eggs and/or larvae of snoek (*Thyrsites atun*), jacopever (*Helicolenus dactylopterus*), dragonet (*Paracallionymus costatus*) and saury (*Scomberesox saurus scomberoides*) have also been reported in the southern Benguela.

2.3.2 Benthic Macrofauna

The seabed is home to many benthic (meaning bottom-dwelling) macro-invertebrate communities that live on (epifauna) or burrow within (infauna) the seabed sediments, usually to a depth of ~30 cm (Figure 8). Benthic organisms are differentiated by size: macrobenthos consists of those organisms retained by a 1 mm mesh sieve, whilst those passing through comprise the meio- (0.1 - 1 mm) and microbenthos (<0.1 mm).

These organisms influence major ecological processes (e.g. remineralisation and flux of organic matter deposited on the sea floor, pollutant metabolism, sediment stability) and serve as important food source for commercially valuable fish species and other higher order consumers. As a result of their comparatively limited mobility and permanence over seasons, these animals provide an indication of historical environmental conditions and provide useful indices to evaluate the status of marine ecosystems in monitoring for long-term responses and site-specific impacts (Salas *et al.* 2006). Being considered good indicators with which to measure environmental impacts (Gray 1974; Warwick 1993; Salas *et al.* 2006), numerous studies have been conducted on the southern African west-coast continental-shelf benthos, focussing primarily on mining or pollution impacts (Christie and Moldan 1977; Moldan 1978; Jackson and McGibbon 1991; Environmental Evaluation Unit 1996;

Parkins and Field 1997, 1998; Pulfrich and Penney 1999; Goosen *et al.* 2000; Steffani and Pulfrich 2004, 2007; Steffani 2007a, 2007b 2009a, 2009b, 2010a, 2010b, 2010c).

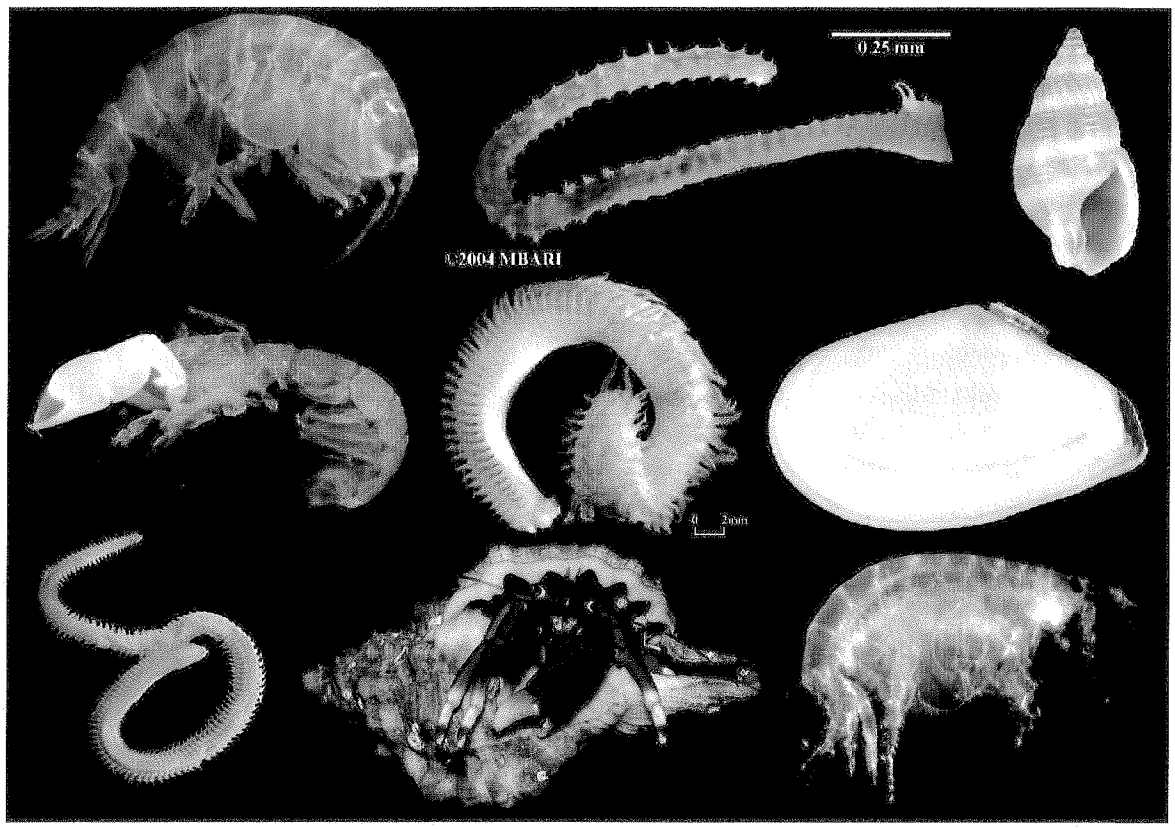

Figure 8: Benthic macrofaunal genera commonly found in nearshore sediments include: (top: left to right) *Ampelisca*, *Prionospio*, *Nassarius*; (middle: left to right) *Callianassa*, *Orbinia*, *Tellina*; (bottom: left to right) *Nephtys*, hermit crab, *Bathyporeia*.

The only systematic study to date to specifically investigate change in macrobenthic community distributions across the continental shelf has been that conducted by Christie (1974, 1976) off Lamberts Bay, South Africa, and the description below is drawn from that study. It must be noted, however, that the sediment characteristics of the mudbelt, and the impact of environmental stressors (such as low oxygen events) off Lambert's Bay are likely to differ from those in other deepwater areas along this coast. As the composition and structure of benthic communities is largely determined by these physical factors, the mid-shelf benthic communities in other areas are likely to differ from those described by Christie (1974).

Biomass distribution off Lambert's Bay shows four clear regions across the continental shelf. From the shore to 80 m deep, biomass ranges from 3.62 g/m^2 dry weight to 16.2 g/m^2. This comparatively low biomass reflects the high depositional environment on the inner continental shelf, with sediments emanating from the Orange River, or re-mobilised and transported in seabed turbulence within depths affected by swells, constantly smothering the area in freshly deposited sediment. Fine sands

almost exclusively dominate sediment texture at these depths, and molluscs, polychaete worms and cnidarians dominate the biota. In contrast, the mid-shelf mudbelt (70-120 m depth) is a particularly rich benthic habitat, and biomass attains 60.3 g/m^2. Clays, silts and very fine sands dominate the sediment texture in the mudbelt, and scavenging and carnivorous polychaete worms, together with cnidarians, dominate the fauna. The comparatively high benthic biomass in this region represents a food resource to carnivores such as the mantis shrimp, cephalopods and demersal fish species (Lane and Carter 1999). Below this mid-depth zone, very fine sands dominate the sediment texture, and biomass declines to 4.9 g/m^2 at 200 m depth and remains consistently low (<3 g/m^2) on the outer shelf, from 200 m - 500 m depth. However, crustaceans increase in relative importance in the biota, with amphipods comprising the major component at these deeper depths.

The structure of benthic communities (e.g. their species composition, diversity, abundance and biomass) within a specific biogeographic region is primarily controlled by water depth, sediment particle size and texture, and its associated biogeochemistry (e.g. Christie 1974; Gray 1974; Warwick *et al.* 1991). Long-term or permanent changes in sediment properties (e.g. grain size) affect other factors like organic content, pore-water chemistry and microbial composition (Snelgrove & Butman 1994), which in turn influence the macrofaunal composition. Recent studies have found that benthic communities can also be highly variable in space and time, on scales of hundreds of metres or less (Kenny *et al.* 1998; Kendall and Widdicombe 1999; van Dalfsen *et al.* 2000; Zajac *et al.* 2000; Parry *et al.* 2003), with evidence of mass mortalities and substantial recruitments (Steffani and Pulfrich 2004). Although a number of empirical studies have also related benthic community structure to sediment composition (Christie 1974; Warwick *et al.* 1991; Yates *et al.* 1993; Desprez 2000; Van Dalfsen *et al.* 2000), it is likely that the distribution of benthic marine communities is controlled by complex interactions between physical and biological factors at the seabed, rather than just by sediment particle size (Snelgrove and Butman 1994; Seiderer and Newell 1999).

There are clearly other natural processes operating in the deepwater shelf areas that can over-ride the suitability of sediments in determining benthic community structure, and it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro and van der Plas 2006; Pulfrich *et al.* 2006). In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure.

An important aim of the Offshore Biodiversity Initiative (a joint project by SANBI, WWF and M&CM) is to identify and map Vulnerable Marine Ecosystems (VMEs) for consideration during the identification of areas/ecosystems that are to receive protection. On the West Coast continental shelf vulnerable ecosystems include cold water coral reefs, sponge beds, high profile reefs and sea pen aggregations (Sink and Samaai 2010). These are all ecosystems that are easily disturbed by human activities and are slow to recover, or which may never recover. Apart from an initiative by De Beers Marine to map rocky outcrop features in their mining licence areas, data on the distribution and biodiversity of VMEs on the West Coast is limited.

2.3.3 Jellyfish

The hydrozoan jellyfish *Chrysaora lyosulla* and *Aequorea aquorea* have been observed to congregate in large densities on the shelf between Lüderitz and Port Nolloth in late summer. The centre of distribution for both species is Lüderitz to Walvis Bay and populations decrease southwards and northwards. Preferred depth ranges coincide with the mid-shelf (100 – 200 m) with decreasing densities towards the coast and offshore. Jellyfish 'swarms' have been observed off Port Nolloth, although the reasons for this aggregation and their temporal variability are presently unknown (M. Gibbons, UWC, pers. comm.).

2.3.4 Cephalopods

The major cephalopod resource in the southern Benguela, are sepiods/cuttlefish (Lipinski 1992; Augustyn *et al.* 1995). Experimental catches on the northern West Coast were dominated by *Sepia australis* and *S. hieronis*, with *Rossia enigmatica* being more common further south towards Cape Columbine. Most of the resource is distributed on the mid-shelf, *S. australis* being most abundant at depths between 60 - 190 m, whereas *S. hieronis* densities were higher in 110 – 250 m. Both species are tolerant of cold, oxygen poor waters. *Rossia enigmatica* occurs more commonly on the edge of the shelf to depths of 500 m. Biomass of these species was generally higher in the summer than in winter.

Although common in survey catches these species are not commercially exploited at present. North of the Orange River, however, *Todarodes angolensis* forms an important bycatch with landings fluctuating from 2,600 - 15,000 tons between 1980 and 1988 (Lipinski 1992). In the southern Benguela the fishery is dominated by *Loligo v. reynaudii* at levels similar to those for *T. angolensis* in the north.

Cuttlefish are largely epi-benthic and occur on mud and fine sediments in association with their major prey item; mantis shrimps (Augustyn *et al.* 1995).

2.3.5 Fishes

(a) Pelagic species

Fish commonly found in pelagic areas off the South African West Coast comprise several species, including anchovy *Engraulis capensis*, pilchard *Sardinops sagax*, round herring/red-eye *Etrumeus whiteheadi*, chub mackerel *Scomber japonicus* and horse mackerel *Trachurus trachurus* (Figure 9) These species typically occur in mixed shoals of various sizes, the bulk of which are made up of anchovy and pilchards (Crawford *et al.* 1987).

At the start of winter every year, juveniles recruit into coastal waters in large numbers between the Orange River and Cape Columbine, particularly in the areas between the upwelling centres. They recruit across broad stretches of the shelf, to utilise the shallow shelf region as nursery grounds before gradually moving southwards in the inshore southerly flowing surface current, towards the major spawning grounds on the Agulhas Bank. Following spawning in Spring and early Summer, the adults then migrate back up the West Coast. Although the mechanisms are not well understood, it appears that recruitment success relies on the interaction of oceanographic events. Recruitment is

thus subject to spatial and temporal variability, and consequently the abundance of adults and juveniles of these short lived (1-3 years) small pelagic fish is highly variable both within and between species.

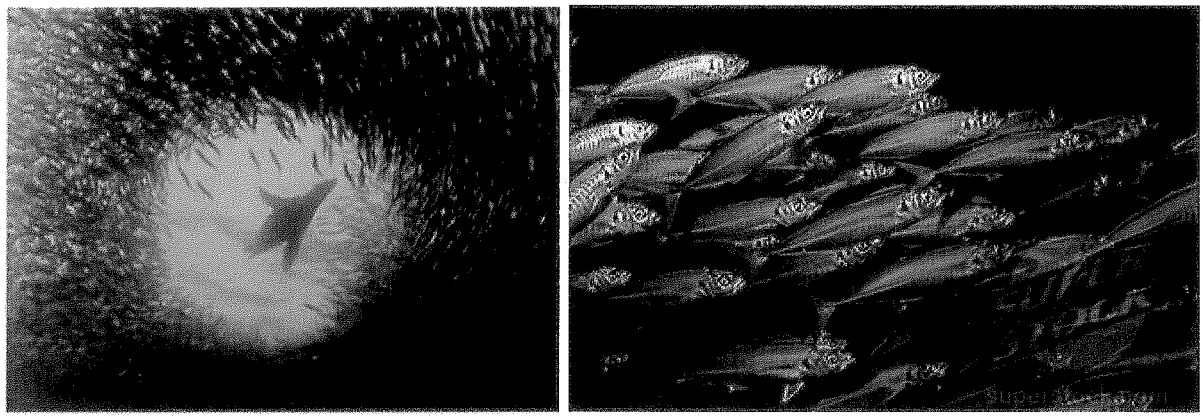

Figure 9: Cape fur seal preying on a shoal of pilchards (left). School of horse mackerel (right) (photos: www.underwatervideo.co.za; www.delivery.superstock.com).

Snoek and chub mackerel are landed mainly within the zone west of Cape Agulhas to 15°S. Both species occur in the northern Benguela region during spring and summer, move south inshore during autumn and winter, and back north offshore in spring. Their migration is related to prey availability. Snoek spawn offshore between the Western Cape and Namibia (July to October), while chub mackerel spawn and recruit inshore, moving offshore as they age.

Yellowtail is an inshore pelagic species encountered seasonally west of Cape Point, with maximum abundance between Cape Point and Cape Agulhas. It spawns along the southern Cape coast, although its recruitment areas are not well known. Adults are abundant on shallow banks inshore.

Tunas and billfish are migratory pelagic fish moving between surface waters and depths exceeding 300 m (Figure 10). Species occurring off western southern Africa include the albacore/longfin tuna *Thunnus alalunga*, yellowfin *T. albacares*, bigeye *T. obesus*, and skipjack *Katsuwonus pelamis tunas*, as well as the Atlantic blue marlin *Makaira nigricans*, the white marlin *Tetrapturus albidus* and the broadbill swordfish *Xiphias gladius* (Payne and Crawford 1989).

The distributions of these species is dependent on food availability in the mixed boundary layer between the Benguela and warm central Atlantic waters. Concentrations of large pelagic species are also known to occur associated with underwater feature such as canyons and seamounts as well as meteorologically induced oceanic fronts (Penney *et al.* 1992). Their occurrence in the Benguela is highly seasonal.

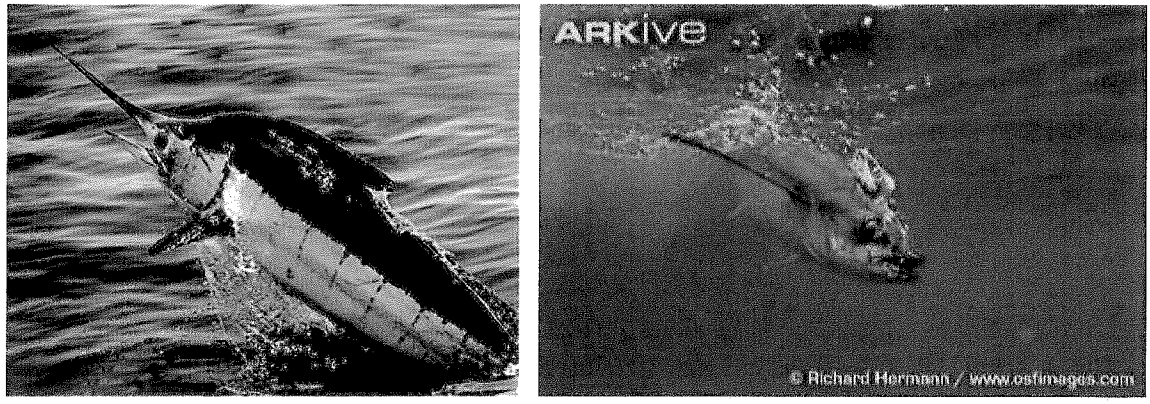

Figure 10: Large migratory pelagic fish such as blue marlin (left) and longfin tuna (right) occur in offshore waters (photos: www.samathatours.com; www.arkive.org).

A number of species of pelagic sharks are also known to occur on the West Coast, including blue *Prionace glauca*, mako *Isurus oxyrinchus* and oceanic whitetip sharks *Carcharhinus longimanus*. Common throughout the world in warm temperate waters, these species are usually found further offshore on the West Coast, although they have been caught in <100 m depth (M. Kroese, SFRI, pers. comm.).

(b) Demersal species

Roel (1987) describes the demersal communities on the continental shelf of the West Coast. As many as 116 species of bony fish, cartilaginous fish and cephalopods were identified during research trawls, and these can be split into two main groups which are primarily influenced by depth. The first group is dominated by the deepwater hake *Merluccius paradoxus* and those species normally found in depths exceeding 380 m, including monkfish *Lophius vomerinus*, kingklip *Genypterus capensis* and various squalid shark species. The second group is a less diverse shelf community (<380 m) dominated by the Cape hake *M. capensis*, and includes jacopever *Helicolenus dactylopterus*, white squid *Loligo vulgaris reynaudii*, and the catshark *Holohalaelurus regani*.

Both species of hake appear to recruit north of Cape Colombine with concentrations of juveniles of both species being found inshore on the West Coast in the bays. Kingklip inhabit predominantly hard or rocky substrates but are also found on soft muddy substrates. Juveniles are mostly found inshore, and are reported to migrate into deeper water as they age.

The deep-sea community was found to be homogenous both spatially and temporally, whereas the shelf communities showed seasonal variations in their distribution ranges. The diversity and distribution of demersal cartilagenous fishes on the West Coast is discussed by Compagno *et al.* (1991).

2.3.6 Sea Birds

Large numbers of pelagic seabirds exploit the pelagic fish stocks of the Benguela system. Duffy *et al.* (1987) listed 49 species of seabirds that occur in the Benguela region, 14 of which were defined as resident, 10 visitors from the northern hemisphere and 25 migrants from the southern Ocean. In the overall region, Cape Agulhas to northern Namibia, the area between Cape Point and the Orange River supports 38% and 33% of the overall population of pelagic seabirds in winter and summer, respectively. Most of the species in the region reach highest densities offshore of the shelf break (200 – 500 m depth) with highest population levels during their non-breeding season (winter). Pintado petrels and Prion spp. show the most marked variation here. Of the migrant pelagic seabird species the Blackbrowed Albatross, Yellownosed Albatross and Southern Giant Petrel are listed in the South African Red Data Book as "Near threatened".

Fourteen Species of seabirds breed in southern Africa; Cape Gannet, African Penguin, four species of Cormorant, White Pelican, three Gull and four Tern species. Although breeding areas are distributed along the whole coast, islands are especially important, particularly those between Dyer Island and Lambert's Bay. The number of successfully breeding birds at the particular breeding sites varies with food abundance. This is most evident for Cape Gannets whose numbers reduced on the West Coast but increased on the south coast, Algoa Bay, in response to changed abundances in pilchard (Crawford *et al.* 1991).

Cape Gannets breed only on islands (Figure 11), with Bird Island in Lamberts Bay and Malgas Island supporting important colonies. Cape cormorants breed mainly on offshore islands (Dyer, Jutten, Seal, Dassen, Bird (Lamberts Bay), Malgas and Vondeling Islands), although the large colonies may associate with estuaries, lagoons or sewerage works. The bank and crowned cormorants are endemic to the Benguela system and both breed between Namibia and just to the west of Cape Agulhas. Although white-breasted cormorants occur between northern Namibia and the eastern Cape in southern Africa, the majority of the population is concentrated between Swakopmund and Cape Agulhas.

Most of the resident seabird species feed on fish (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). Feeding strategies can be grouped into surface plunging (gannets and terns), pursuit diving (cormorants and penguins) and scavenging and surface seizing (gulls and pelicans). All these species feed relatively close inshore, although gannets and kelp gulls may feed some distance offshore.

Within the broader study area African penguin colonies (*Spheniscus demersus*) occur at 4 localities, namely Bird Island in Lamberts Bay, Marcus and Malgas Islands at Saldanha Bay and on Dassen Isalnd (Figure 11). The species forages at sea with most birds being found within 20 km of their colonies. African penguin distribution at sea is consistent with that of the pelagic shoaling fish, which generally occur within the 200 m isobath.

The African Penguin, Cape Gannet and Bank Cormorant are listed in the South African Red Data Book as "Vulnerable". The Caspian Term, Cape Cormorant and Crowned Cormorant are listed in the South African Red Data Book as ""Near-threatened". The Damara Tern is listed as "Endangered".

The decline in the African Penguin population is ascribed primarily to the removal of the accumulated guano from the islands during the Nineteenth Century. Penguins used to breed in burrows in the guano and are now forced to nest in the open, thereby being exposed to much greater predation and thermal stress.

The Cape Gannet, a plunge diver feeding on epipelagic fish, is thought to have declined as a result of the collapse of the pilchard, whereas the Cape Cormorant was able to shift its diet to pelagic goby. Furthermore, the recent increase in the seal population has resulted in seals competing for island space to the detriment of the breeding success of both gannets and penguins.

Figure 11: Cape Gannets *Morus capensis* (left) (Photo: NACOMA) and African Penguins *Spheniscus demersus* (right) (Photo: Klaus Jost) breed primarily on offshore Islands.

2.3.7 Marine Mammals

The marine mammal fauna of the West Coast comprises between 28 and 31 species of cetaceans (whales and dolphins) and one seal species, the Cape fur seal (*Arctocephalus pusillus*). The range of cetacean species reflects largely taxonomic uncertainty at species and sub-species level, rather than uncertainty of occurrence or distribution patterns (Findlay *et al.* 1992).

(a) Cetaceans

The majority of migratory cetaceans in South African waters are large baleen whales. Populations of large baleen whales in South African waters were decimated by historical whaling and are presently a fraction of their pre-exploitation densities.

Blue (*Balaenoptera musculus*), fin (*B. physalus*), sei (*B. borealis*), minke (*B acutorostrata / B bonaerensis*) and humpback whales (*Megaptera novaeangliae*) make winter migrations through the West Coast region *en route* from Antarctic summer feeding grounds to winter breeding grounds. While blue, fin and sei whales migrate off or along the continental shelf edge (and are thus distributed in deeper waters), humpback whales migrate over the continental shelf and along the coast.

Two types of Bryde's whales are recorded from South African waters - a smaller neritic form (of which the taxonomic status is uncertain) and a larger pelagic form described as *Balaenoptera brydei*. While the smaller neritic form is resident (particularly over the Agulhas Bank) the larger offshore form is migratory along the African west coast, being found off Saldanha Bay in winter. Southern right whales (*Eubalaena australis*) (Figure 12) migrate into the extreme near-shore region of the West Coast (mainly south of Lamberts Bay) between June and January each year (animals may be sighted as early as April and as late as February). This population is increasing at approximately 7% per annum, yet is still probably around 10% of the pre-exploitation abundance (Best 2000).

Killer whales are found year round in the waters of the West Coast, although the seasonality of sightings within the whaling grounds (in September and October) suggests that some killer whales are highly migratory. The pygmy right whale (*Caperea marginata*) shows a strong summer seasonality in water depths of less than 50 m along the coast between Algoa Bay in the east and Walvis Bay, Namibia. Arnoux's beaked whale (*Berardius arnuxii*) has been recorded along the West Coasts to the east of 18° E during summer. Layard's beaked whale (*Mesoplodon layardii*) is distributed throughout the West Coast pelagic waters in summer and early autumn.

Four faunal provinces define the distribution of resident cetaceans within the West Coast region (after Findlay *et al.* 1992; Peddemors 1999). These include:

- *Agulhas Bank to Lamberts Bay (inshore)* - Two species, the long beaked common dolphin (*Delphinus delphis*) and the resident smaller inshore Bryde's whale appear to be strongly associated with the Agulhas Bank region and the West Coast inshore region as far north as Lambert's Bay. Although these species will be found elsewhere in southern African waters (a common dolphin species is recorded from strandings on the Namibian coast) the majority of records are from the Agulhas Bank region.
- *West Coast Inshore* – Two species, the Benguela dolphin (*Cephalorhynchus heavisidii)* (Figure 12) and the dusky dolphin (*Lagenorhynchus obscurus)* are resident over the shelf with the Benguela (Heaviside's) dolphin found inshore to the north of Cape Point and dusky dolphin found inshore west of False Bay.
- *West Coast Offshore* - Two pelagic species of cetacean, True's beaked whale (*Mesoplodon mirus*) and the dwarf sperm whale (*Kogia sima*) appear to be limited to offshore region between Cape Columbine and the Eastern Cape. A further two species, Gray's beaked whale (*Mesoplodon grayii*) and the long finned pilot whale (*Globicephala melas*) appear to be limited to the offshore region between Namibia and the Eastern Cape. These species are found in deep waters elsewhere in the world and apart from the pilot whale are recorded only as strandings on the South African coast. A localised distribution of southern right-whale dolphins is recorded off the coast of southern Namibia and may range into the northern waters of the South African West Coast region.
- *Cosmopolitan* - Killer whales (*Orcinus orca*) and minke whales (possibly *Balaenoptera acutorostrata*) are found in both continental shelf and offshore waters of the West Coast. Cuvier's beaked whale (*Ziphius cavirostris*), pygmy sperm whales (*Kogia breviceps*), False killer whales (*Pseudorca crassidens*), pygmy killer whales (*Feresa attenuata*), Risso's dolphins (*Grampus griseus*), and sperm whales (*Physeter macrocephalus*) are found throughout the

offshore waters of the West Coast. A second common dolphin species occurs in the offshore region of the West Coast.

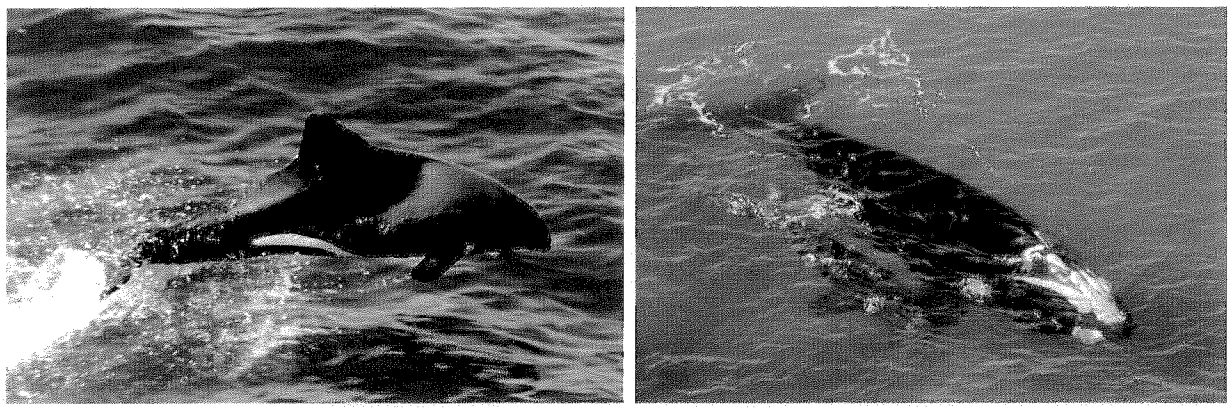

Figure 12: The endemic Benguela Dolphin *Cephalorhynchus heavisidii* (left) (Photo: De Beers Marine Namibia), and Southern Right whale *Eubalaena australis* (right) (Photo: www.divephotoguide.com; www.aad.gov.au.

(b) Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) (Figure 13) congregates in four breeding and three non-breeding colonies between the Orange River mouth and Saldanha Bay. Five other seal species may occasionally be found as vagrants along the West Coast.

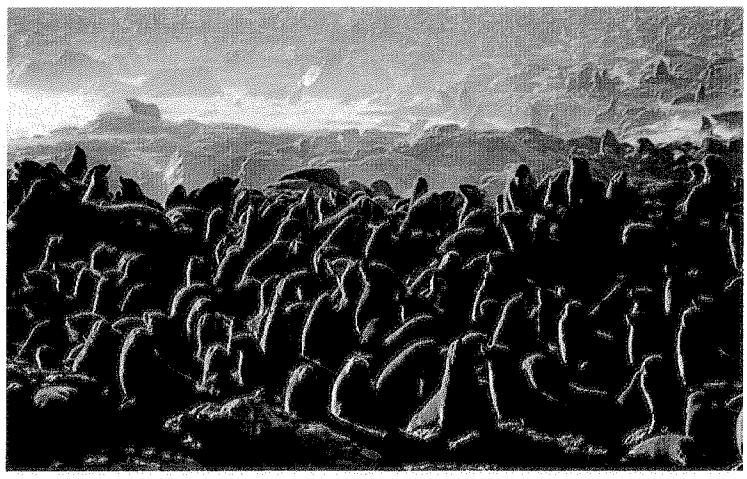

Figure 13: Colony of Cape fur seals *Arctocephalus pusillus pusillus* (Photo: Dirk Heinrich).

The largest breeding colony on the South African coast is located at Robeiland near Kleinzee. The colony at Buchu Twins, formerly a non-breeding colony, has also attained breeding status (M. Meyer, SFRI, pers. comm.). Further breeding colonies are located at Paternoster Rocks and Jacob's Reef at Cape Columbine. Non-breeding colonies occur south of Hondeklip Bay at Strandfontein Point and on Bird Island at Lamberts Bay, with the McDougalls Bay islands and Wedge Point being haul-out sites only and not permanently occupied by seals. All have important conservation value since they are largely undisturbed at present.

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles offshore (Shaughnessy 1979). Although the main feeding grounds are south of Lamberts Bay, a northward movement between colonies, particularly among juveniles, is known to occur. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991).

3. ASSESSMENT OF IMPACTS ON MARINE FAUNA

3.1 Assessment Procedure

The following convention was used to determine significance ratings in the assessment:

Rating	Definition of Rating
Extent *– defines the physical extent or spatial scale of the impact*	
Local	Extending only as far as the activity, limited to the site and its immediate surroundings
Regional	Limited to the Western Cape
National	Limited to the coastline of South Africa
International	Extending beyond the borders of South Africa
Duration *– the time frame over which the impact will be experienced*	
Short-term	0 – 5 years
Medium-term	6 – 15 years
Long-term	Where the impact would cease after the operational life of the activity, either because of natural processes or by human intervention
Permanent	Where mitigation either by natural processes or by human intervention would not occur in such a way or in such time span that the impact can be considered transient

Rating	Definition of Rating
Intensity *– establishes whether the magnitude of the impact is destructive or benign in relation to the sensitivity of the receiving environment*	
Zero to Very Low	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected.
Low	Where the impact affects the environment in such a way that natural, cultural and social functions and processes continue, albeit in a slightly modified way.
Medium	Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way
High	Where environmental functions and processes are altered to the extent that they temporarily or permanently cease
Loss of Resources *- the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable*	
Low	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
Medium	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
High	Where the activity results in an irreplaceable loss of a resource.
Status of the Impact *– describes whether the impact would have a negative, positive or zero effect on the affected environment*	
Positive	The impact benefits the environment
Negative	The impact results in a cost to the environment
Neutral	The impact has no effect
Probability *– the likelihood of the impact occurring*	
Improbable	Possibility very low either because of design or historic experience
Probable	Distinct possibility
Highly Probable	Most likely
Definite	Impact will occur regardless of preventive measures
Degree of confidence in predictions *– in terms of basing the assessment on available information and specialist knowledge*	
Low	Less than 35% sure of impact prediction.
Medium	Between 35% and 70% sure of impact prediction.
High	Greater than 70% sure of impact prediction

Using the core criteria above, the significance of the impact is determined:

Significance *– attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity*	
VERY HIGH	Impacts could be EITHER: of high intensity at a regional level and endure in the long term; OR of high intensity at a national level in the medium term; OR of medium intensity at a national level in the long term.
HIGH	Impacts could be EITHER: of high intensity at a regional level enduring in the medium term; OR of high intensity at a national level in the short term; OR of medium intensity at a national level in the medium term; OR of low intensity at a national level in the long term; OR of high intensity at a local level in the long term; OR of medium intensity at a regional level in the long term.

Significance *– attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity*	
MEDIUM	Impacts could be EITHER: of high intensity at a local level and endure in the medium term; OR of medium intensity at a regional level in the medium term; OR of high intensity at a regional level in the short term; OR of medium intensity at a national level in the short term; OR of medium intensity at a local level in the long term; OR of low intensity at a national level in the medium term; OR of low intensity at a regional level in the long term.
LOW	Impacts could be EITHER of low intensity at a regional level, enduring in the medium term; OR of low intensity at a national level in the short term; OR of high intensity at a local level and endure in the short term; OR of medium intensity at a regional level in the short term; OR of low intensity at a local level in the long term; OR of medium intensity at a local level, enduring in the medium term.
VERY LOW	Impacts could be EITHER of low intensity at a local level and endure in the medium term; OR of low intensity at a regional level and endure in the short term; OR of low to medium intensity at a local level, enduring in the short term.
INSIGNIFICANT	Impacts with: Zero intensity with any combination of extent and duration.
UNKNOWN	Where it is not possible to determine the significance of an impact.

Additional criteria to be considered, which could "increase" the significance rating are:

- Permanent / irreversible impacts (as distinct from long-term, reversible impacts);
- Potentially substantial cumulative effects; and
- High level of risk or uncertainty, with potentially substantial negative consequences.

Additional criteria to be considered, which could "decrease" the significance rating are:

- Improbable impact, where confidence level in prediction is high.

The relationship between the significance ratings after mitigation and decision-making can be broadly defined as follows:

Significance after Mitigation *- considering changes in intensity, extent and duration after mitigation and assuming effective implementation of mitigation measures*	
Very Low; Low	Will not have an influence on the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented.
Medium	Should influence the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented.
High; Very High	Would strongly influence the decision to proceed with the proposed project.

Furthermore, the degree to which an impact can be mitigated or enhanced, and reversed is defined as follows.

Degree to which impact can be mitigated *– indicates the degree to which an impact can be reduced or enhanced*	
None	No change in impact after mitigation.
Very low	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
Low	Where the significance rating drops by one level, after mitigation.
Medium	Where the significance rating drops by two to three levels, after mitigation.
High	Where the significance rating drops by more than three levels, after mitigation.

Reversibility of an Impact *- refers to the degree to which an impact can be reversed*	
Irreversible	Where the impact is permanent.
Partially reversible	Where the impact can be partially reversed.
Fully reversible	Where the impact can be completely reversed.

3.2 Assessment of Impacts

3.2.1 Noise and Vibrations

Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 db re 1 µPa at 1 m (NRC 2003). Especially at low frequencies between 5 to 100 Hz, vessel traffic is a major contributor to noise in the world's oceans and very large geographic areas are affected. Studies have shown that the noise radiating from a prospecting/mining vessel in operation is broadband (140 – 170 db re 1 µPa at 1 m) and essentially has the same noise level as that from a merchant vessel (~170 db re 1 µPa at 1 m) (Coley 1994, 1995; NRC 2003; Pidcock *et al.* 2003). The main difference is that a prospecting vessel is more or less stationary and is producing noise at a constant level, whereas a merchant vessel is moving. On the other hand, prospecting operations are conducted in comparatively shallow water, which restricts the propagation of low frequencies (>10°Hz, the spectrum that potentially propagates for long distances) to within a few kilometres. In contrast, under the right conditions, the low frequencies radiating from merchant vessels can propagate 100s of kilometres.

The potential effects of anthropogenic sounds on marine organisms include disturbance of normal behaviour resulting in possible displacement from areas, restricted detection of natural sounds (auditory "masking"), and temporary or permanent reductions in hearing sensitivity. Exposure to intense sounds for even a short period of time may result in permanent hearing loss, while lower sound levels often result in temporary or transient loss of hearing that may last for minutes, hours, or even days. Hearing, however, ultimately returns to the pre-exposure level.

Despite the large volume of international literature concerned with the description of various impacts of noise upon marine mammals (reviewed in Richardson *et al.* 1995; McCauley 1994), issues regarding the effects of long-term anthropogenic sound on individuals and populations, remain unanswered. It has to be kept in mind, however, that the ocean is a naturally noisy place and that normal physical sea noise may commonly overshadow the influence of any distant, low-level anthropogenic sounds. Findlay (1996) evaluated the potential effects of diamond mining on the marine mammals community in southern Namibia and concluded that the significance of the impact is likely to be minimal based on the assumption that the radius of elevated noise level will be restricted to ~20 km around the mining/prospecting vessel.

During sampling activities, noise and vibrations from the Sonic Vibrocorer may have an impact on macrobenthic communities, fishes and marine mammals in the area. Marine mammals and fish are known to be particularly susceptible to the sound levels associated with, for example, pile driving (Anderson 1990; Reyff 2004; Carstensen *et al.* 2006; David 2006; Carlson and Weiland 2007). Studies conducted during the construction of offshore wind-farms in Europe have indicated that the behaviour of marine mammals and fish could be influenced several kilometres away from the construction site, with avoidance distances ranging between 1.4 km for salmon and harbour porpoises, 4.6 km and 5.5 km for Bottlenose dolphins and cod, respectively (www.wind-energy-the-facts.org). Injurious levels of noise (e.g. greater than 220 dB), however, only occur with impact hammering, which generates impulsive shock characterised by a rapid build-up to a peak followed by decay. In contrast, pile driving using vibrating columns is classified as continuous or intermittent vibration, which may only last a few seconds but is characterised by a build-up to a level that is maintained for a considerable number of cycles. Consequently, sound levels for vibratory piling rigs are generally much lower than those generated by impact pile driving (Parnum 2009).

The comparatively small core-width of the Sonic Vibrocorer suggests that the noise and vibrations generated during coring are unlikely to be injurious or reach lethal amplitudes, even at the source. Any mobile marine fauna particularly sensitive to noise (e.g. dolphins, penguins and finfish species) are expected to avoid the target area once sampling activities commence and as such no direct impacts to these biota are expected during vibrocoring. There may be some temporary disturbance of benthic invertebrates in response to the vibrations, but this is likely to be at sublethal levels. Furthermore, the maximum radius over which the noise may influence is very small compared to the population distribution ranges of the potentially sensitive species.

The impact of noise generated by vibrocoring into the seabed sediments will therefore be highly localised and last only for the ~1.5 hour duration required per core.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term (1.5 hours per site over ~ 80 days)	Short-term
Intensity	Low	Low

Status of Impact	Negative	Negative
Probability	Improbable	Improbable
Confidence	High	High
Significance	VERY LOW	VERY LOW
Cumulative impact	None	None
Nature of Cumulative impact	Due to the sound impact lasting for only 1.5 hours per target site any form of cumulative impact is highly unlikely.	
Degree to which impact can be reversed	Fully reversible - any disturbance of behaviour, auditory "masking" or reductions in hearing sensitivity that may occur as a result of ships noise or vibrations from the vibrocorer will be temporary only due to low sound levels at the source.	
Degree to which impact may cause irreplaceable loss of resources	Negligible	
Degree to which impact can be mitigated	None – no mitigation measures possible or necessary.	

3.2.2 Sediment Removal

The samples taken during the deposit assessment and resource delineation operations remove a core of sediment from the seabed. Each sample has a surface area of ~0.02 m^2. Benthic fauna typically inhabit only the top 20 - 30 cm of sediment, and removal of the sediment cores will thus completely eliminate the benthic infaunal and epifaunal biota in the core footprints resulting in a reduction in benthic biodiversity.

The high-intensity negative impact of sediment removal is unavoidable, but as it will be site specific (*i.e.* confined to the core footprints) the impact can confidently be rated as having a very low overall significance. No mitigation measures are possible, or considered necessary for the direct loss of macrobenthos due to core sampling.

Depending on the texture of the sediments at the target sites, slumping of adjacent unconsolidated sediments into the excavation can be expected over the very short-term. Although this may result in localised disturbance of macrofauna associated with these sediments and alteration of sediment structure, it also serves as a means of natural recovery of the excavations. Studies have shown that some mobile benthic animals are capable of actively migrating vertically through overlying sediment thereby significantly affecting the recolonization of impacted areas and the subsequent recovery of sites disturbed by deposited sediments (Maurer *et al.* 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger *et al.* 2000; but see Harvey *et al.* 1998; Blanchard and Feder 2003).

Natural rehabilitation of the seabed following mining operations, through a process involving influx of sediments and recruitment of invertebrates, has been demonstrated on the southern African continental shelf (Penney and Pulfrich 2004; Steffani 2007b, 2009a, 2009b, 2010a, 2010c). Studies on the impacts of diamond mining on benthic communities suggest that the effects can persist for at least five years (Savage 1996; van der Merwe 1996; Winckler 1999; Parkins & Field 1997,1998; Pulfrich & Penney 1999; Savage *et al.* 2001). Recovery rates of the impacted communities are variable, however, and appear to be dependent on the mining approach, sediment influx rates and the influence of natural disturbances on succession communities. The structure of the recovering communities is also highly spatially and temporally variable confirming the high natural variability in benthic communities in the region. The community developing after a mining impact depends on (1) the nature of the impacted substrate, (2) differential re-settlement of larvae in different areas, and (3) environmental factors such as near-bottom dissolved oxygen concentrations. Indications of significant recruitments and natural mortalities in recovering succession communities has provided evidence of natural disturbances, possibly related to low-oxygen events (Pulfrich and Penney 1999). Savage *et al.* (2001) noted similarities in apparent levels of disturbance between mined and unmined areas off the southern African west coast, and areas of the Oslofjord in the NE Atlantic Ocean, which is known to be subject to periodic low oxygen events. They concluded that the lack of clear separation of mined from unmined samples suggests that short-term physical disturbance resulting from mining is no more stressful than regular anoxic events typical of the West Coast continental shelf area.

However, relative to mining, sampling causes disturbance at a significantly smaller scale and in scattered pockets. Accelerated recovery of disturbed sediments and the associated benthic communities can therefore be expected.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Status of Impact	Negative	Negative
Probability	Definite	Definite
Confidence	High	High
Significance	VERY LOW	VERY LOW
Cumulative impact	None during the sampling campaign	None during the sampling campaign
Nature of Cumulative impact	Total area impacted by sediment removal during sampling campaign will not have cumulative effects.	
Degree to which impact can be reversed	Removal of sediments and associated macrofaunal communities is irreversible. Recovery of excavations through sediment influx, and	

	recolonisation will occur over the short-term through recruitment and immigration from adjacent areas.
Degree to which impact may cause irreplaceable loss of resources	Negligible considering total surface area of seabed affected.
Degree to which impact can be mitigated	None – no mitigation measures possible or necessary.

3.2.3 Crushing

Some disturbance or loss of adjacent benthic biota can also be expected as a result of the placement on the seabed of the 6 x 6 m frame into which the sampling tool is mounted. Epifauna and infauna beneath the footprint of the frame may be smothered or crushed resulting in a reduction in benthic biodiversity. Crushing is likely to primarily affect soft-bodied species as some molluscs and crustaceans may be robust enough to survive (see for example Savage *et al.* 2001). The impacts are highly localised, and temporary as recolonization will occur over the short-term from adjacent undisturbed sediments.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term (1.5 hours per site)	Short-term
Intensity	Low	Low
Status of Impact	Negative	Negative
Probability	Highly probable	Highly probable
Confidence	High	High
Significance	VERY LOW	VERY LOW
Cumulative impact	None	None
Nature of Cumulative impact	Total area impacted by frame during sampling campaign will not have cumulative effects.	
Degree to which impact can be reversed	Loss through crushing is irreversible. Recovery of impacted biota will occur over the short-term through recruitment and immigration from adjacent areas.	
Degree to which impact may cause irreplaceable loss of resources	Negligible considering total surface area of seabed affected.	
Degree to which impact can be mitigated	None – no mitigation measures possible or necessary.	

4. CONCLUSIONS AND RECOMMENDATIONS

If all environmental guidelines and appropriate mitigation measures advanced in the Basic Assessment Report for the proposed project, are implemented, there is no reason why the proposed sampling campaigns should not proceed. The macrofaunal communities on the continental shelf are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone, and no rare or endangered species have been identified in unconsolidated sediments. Furthermore, as they are frequently exposed to natural disturbances (e.g. low oxygen events, sediment inputs) the marine biota of the Benguela system are inherently robust and recovery of benthic macrofaunal communities to sustainable ecological succession can occur within 1-5 years (Ellis 2001, Newell *et al.* 1998). However, as the structure of mature soft-sediment benthic communities is naturally highly variable, it is difficult to measure when 'equilibrium' has been attained. As a result, it would not be expected that the composition and structure of 'recovered' communities will be identical to the pre-sampling state, which may differ somewhat in physical characteristics. When seen in context against the high degree of natural disturbance, the inherent high variability of benthic communities, and the extremely localised area of seabed affected by core-sampling, the significance of the impacts of the sampling campaign on the benthic macrofauna, both through sediment removal and potential crushing, can be considered negligible.

Reactions to sound by marine fauna depend on a multitude of factors including species, state of maturity, experience, current activity, reproductive state, time of day (Wartzok *et al.* 2004; Southall *et al.* 2007). If a marine animal does react briefly to an underwater sound by changing its behaviour or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the population as a whole (NRC 2005). Noise and vibration effects on marine fauna as a result of the sampling campaign can therefore be considered negligible.

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APPENDIX 4

FISHING INPUT

CAPRICORN FISHERIES MONITORING cc
Reg. No. CK 99 / 24441 / 23
Unit 15 Foregate Square, Table Bay Boulevard, Cape Town, South Africa.
P.O. Box 50035, Waterfront, Cape Town 8002
Tel : (021) 425 1994 Fax: (021) 425 6226 Cell: 082 – 788 6737

14th April 2011

CCA Environmental
Unit 35 Roeland Square
Cnr Roeland Street and Drury Lane
Cape Town
8001
R.S.A

Dear Sir/Madam

Project Reference: Proposed prospecting activities within sea areas 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c (De Beers Consolidated Mines Ltd).

Please find herewith attached an assessment of the commercial fisheries active on the west coast of South Africa in relation to proposed marine prospecting activities within the prospecting rights areas held by De Beers Consolidated Mines Ltd.

This report was compiled on behalf of CCA Environmental (Pty) Ltd for their use in undertaking an Environmental Impact Assessment for the proposed prospecting activities to be undertaken by AuruMar (Pty) Ltd, the operator. We do hereby declare that we are financially and otherwise independent of the applicant and CCA Environmental

Kind Regards,

CapFish cc
Vat no: 4960195479
Reg. no: CK 99/24441/23

Sarah Wilkinon

FISHERIES AND OTHER HARVESTING

The South African fishing industry consists of approximately 20 commercial sectors operating with the 200 nautical mile Exclusive Economic Zone (EEZ)[1]. The western coastal shelf is a highly productive upwelling ecosystem (Benguela current) and supports a number of fisheries.

The largest and most economically valuable of these are the demersal trawl and long-line fisheries, targeting the cape hakes *Merluccius paradoxus* and *M. capensis*, and the pelagic purse-seine fishery targeting pilchard (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus*) and round herring (*Etrumeus whitheadii*). Secondary commercial species in the hake-directed fisheries include an assemblage of demersal (bottom-dwelling) fish of which monk fish (*Lophius vomerinus*) and snoek (*Thyrsites atun*) are the most important commercial species. Other fisheries active on the West Coast are the pelagic long-line fishery for tunas and swordfish and the tuna pole and traditional linefish sectors. West Coast rock lobster (*Jasus lalandi*) is an important trap fishery exploited close to the shoreline (waters shallower than 100 m) including the intertidal zone and kelp beds off the West Coast. The main commercial sectors operating in the vicinity of the study area are discussed below:

(a) Demersal longline

The target species of this fishery is hake (*M. capensis* and *M. paradoxus*) with a small non-targeted commercial bycatch species that includes kingklip. The hake long-line fishery is a relatively new fishery in South Africa. Currently 64 vessels are active within this sector and operate from all major fishing harbours. The fishery is directed both in inshore and offshore areas. Inshore hake long-lining is restricted in the number of hooks that may be set per line (a maximum of 5 000 hooks per day), while offshore long-lining may only take place in water deeper than 110 m and is restricted to a maximum of 20 000 hooks per line.

Bottom-set long-line gear is robust and comprises two lines as well as dropper lines with subsurface floats attached. Lines are set over mostly rocky bottoms adjacent to demersal trawling grounds. Demersal long-lines are anchored at either end and marked by an array of large buoys. Boats "stand by" their gear and are also restricted in their movements when hauling and shooting. Hooks are spaced about one fathom apart and lines can be up to 20 km long.

On the West Coast, demersal long-liners operate in well-defined offshore areas extending along the shelf break from Port Nolloth to Cape Agulhas where they may be found working between the 200 and 750 m bathycontours. Well the predominant areas of operation lie well to the west of the study area, isolated fishing events have been recorded in the study area.

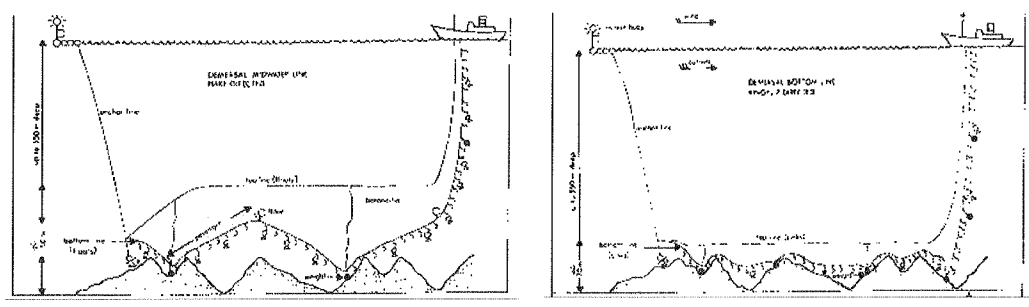
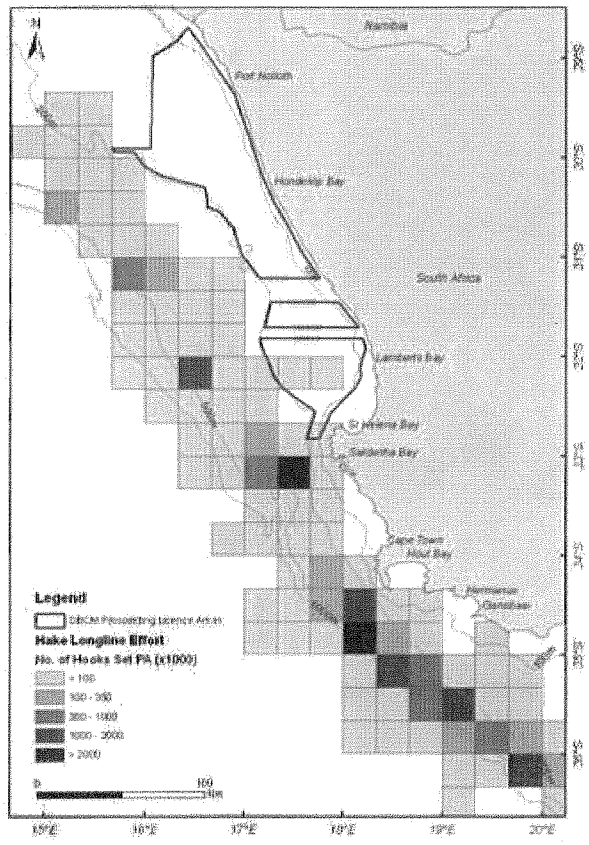


Figure 4.17: Diagram illustrating typical fishing gear deployed when fishing for demersal (bottom dwelling) species (gear for hake on left and kingklip on right).

[1] The Exclusive Economic Zone is the zone extending from the coastline out to a distance of 200 nautical miles within which South Africa holds exclusive economic rights.

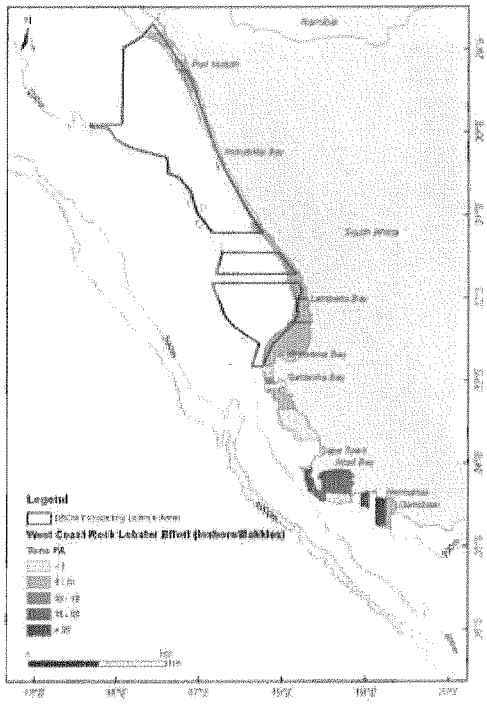


Distribution of effort within the demersal hake-directed long-line fishery.

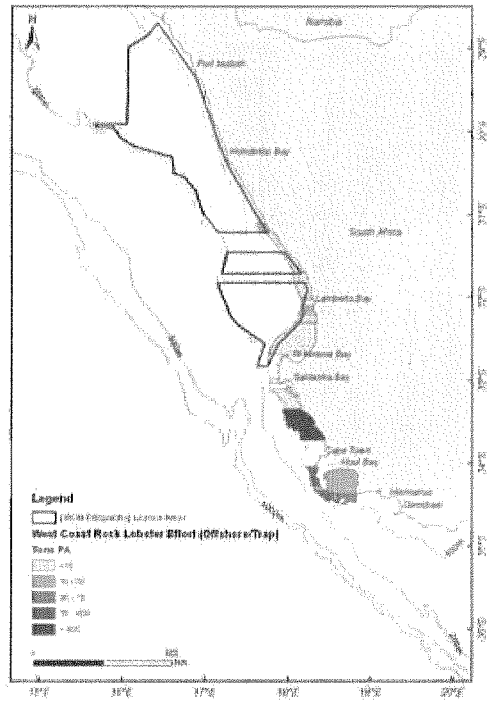
(b) West Coast Rock lobster trap fishery

This fishery targets the West Coast rock lobster (*Jasus lalandii*) along the West Coast. The fishery is divided into an inshore and offshore fishery which makes use of hoop-nets and traps respectively. The inshore fishery operates from the coast up to one nautical mile offshore (predominantly waters shallower than 15 m) while the offshore trap fishery operates up to a depth of 100 m. Catch and effort figures are recorded according to management zone and prospecting licence areas coincide with zones A,B and C. Effort is seasonal (1st November to 20th June) and small boats operate from the shore and coastal harbours.

Activity within Zone A (extending from the Namibia/RSA border up to 31° 6' S is currently solely restricted to the hoop-net fishery and therefore is unlikely to coincide with the prospecting licence area North of this point.



Distribution of catch within the inshore West Coast rock lobster fishery.



Distribution of catch within the offshore West Coast rock lobster fishery.

(c) Pelagic purse-seine

The small pelagic purse-seine fishery targets pilchard (*Sardinops sagax*) and anchovy (*Engraulis encrasicolus*) and is the second most economically valuable commercial fishery in South Africa. Approximately 100 vessels operate within this fishery, predominantly along the West Coast from the harbours St Helena, Saldanha, Cape Town and Hout Bay. As the targeted species are coastal, fishing effort is not displaced more than 50 nm from harbours. Typically a vessel will fish overnight and return the following day to the harbour to offload their catch. A schematic diagram of the typical gear configuration of a pelagic purse-seiner is shown below.

The prospecting area overlaps with the pelagic fishery. The concentration of pelagic purse-seine effort is the greatest inshore of the 100 m isobath, with effort increasing significantly towards the shallower portions of the study area.

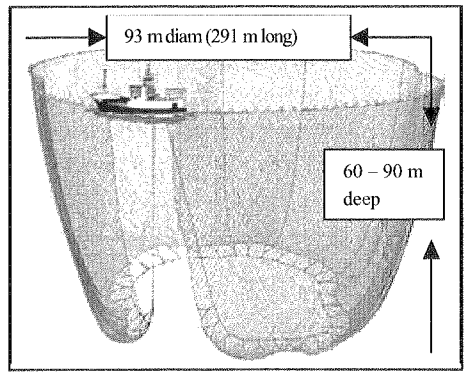
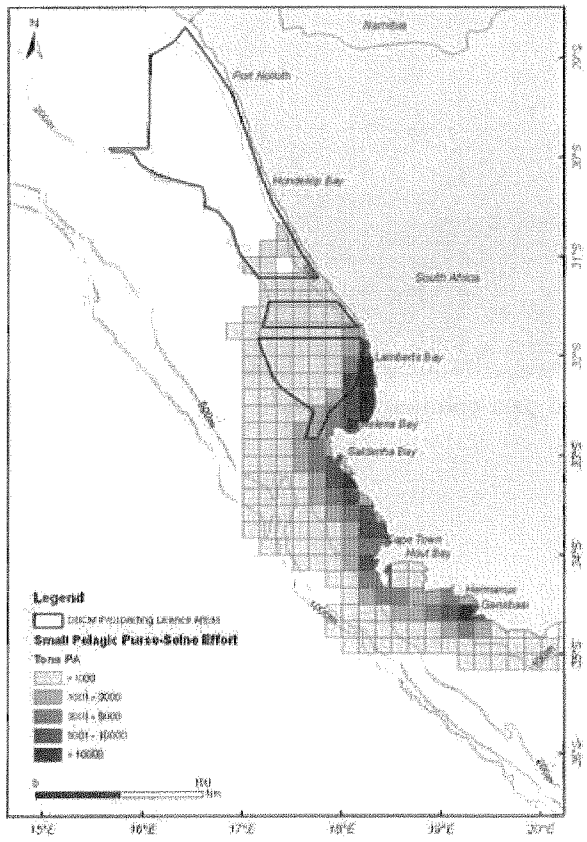


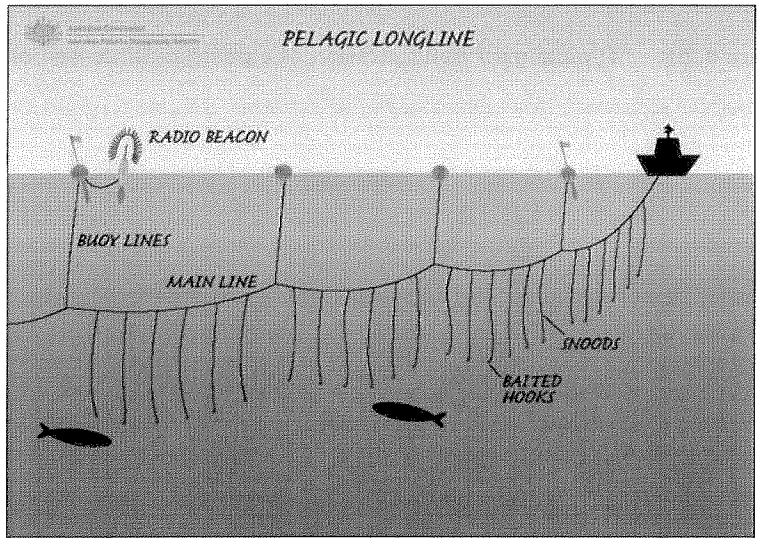
Figure 4.20: Typical gear configuration of a pelagic purse-seiner.



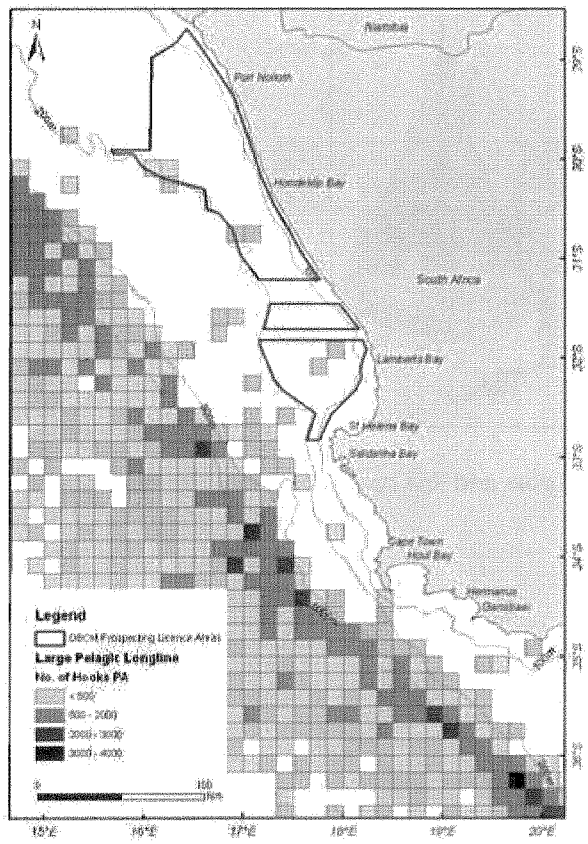
Distribution of catch within the pelagic purse-seine fishery.

(d) Pelagic long-lining (large pelagic species)

The pelagic tuna long-line fishery is another fishery that occurs extensively off the West Coast of South Africa. The fishery targets tunas (including bluefin *Thunnus thynnus*, yellowfin *T. albacares*, bigeye *T. obsesus* and longfin or albacore *T. alalunga*), shark and broadbill swordfish (*Xiphias gladius).* Long-lining is carried out both by local and foreign vessels that fish around the entire South African coast. Approximately 30 vessels (17 tuna-directed and 14 swordfish-directed) are presently operational within this sector with activity predominantly centred along the continental shelf break and offshore. Occasional fishing events have been recorded closer inshore in the vicinity of the prospecting licence areas. The figure below shows the annual distribution of long-line tuna effort on the West Coast.



Typical pelagic longline gear configuration (tuna, swordfish and shark).

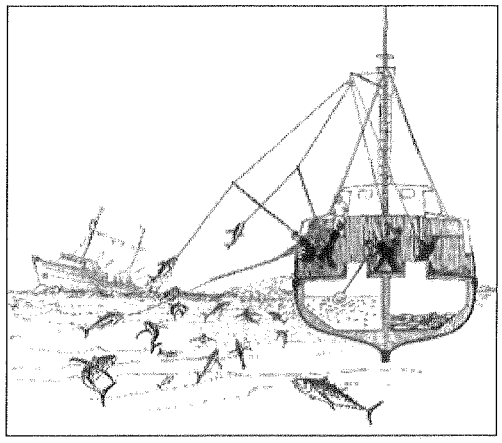


Distribution of catch within the pelagic long-line fishery.

(e) Tuna Pole (large pelagic species)

The tuna pole fishery is conducted using handline, pole, rod and real fishing gear. Tuna species, predominantly yellowfin tuna (*Thunnus albacares*) and albacore (*Thunnus alalunga*), are targeted while other species caught include snoek, angel fish, oil fish, escolar, dorado, wahoo, yellowtail and squid. The fishery operates on the West Coast and sees an average annual catch of 3500 tons.

The tuna pole fleet comprises up to 200 vessels (and a maximum of 3600 crew) operating predominantly from Cape Town harbour. The fishery is seasonal with most of the effort conducted from October to early May. Vessels work from the 100m bathycontour offshore and particularly along the shelf break at 500m. These vessels drift whilst attracting and catching shoals of pelagic tunas. Once a shoal of tuna is located, water is sprayed alongside the vessel to attract fish to the surface, at which point they are caught with baited hooks and gaffed on board.



Schematic diagram of pole and line operation (www.fao.org/fishery).

APPENDIX 5

CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS

CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS

Specialists will consider ten rating scales when assessing potential impacts. These include:

- Extent of impact;
- Duration of impact;
- Intensity of impact;
- Status of impact;
- Probability of impact occurring;
- Degree of confidence of assessment;
- Significance of impact;
- Degree to which a resource is lost;
- Degree to which impact can be mitigated; and
- Reversibility of impact

In assigning significance ratings to potential impacts before and after mitigation specialists are instructed to follow the approach presented below:

1. The core criteria for determining significance ratings are "extent" (Section 1.1), "duration" (Section 1.2) and "intensity" (Section 1.3). The preliminary significance ratings for combinations of these three criteria are given in Section 1.8.

2. Additional criteria to be considered, which could "increase" the significance rating if deemed justified by the specialist, with motivation, are the following:
   - Permanent / irreversible impacts (as distinct from long-term, reversible impacts);
   - Potentially substantial cumulative effects (see Item 9 below); and
   - High level of risk or uncertainty, with potentially substantial negative consequences.

3. Additional criteria to be considered, which could "decrease" the significance rating if deemed justified by the specialist, with motivation, is the following:
   - Improbable impact, where confidence level in prediction is high.

4. The status of an impact is used to describe whether the impact will have a negative, positive or neutral effect on the surrounding environment. An impact may therefore be negative, positive (or referred to as a benefit) or neutral (Section 1.5).

5. Describe the degree to which a resource is impacted (Section 1.4).

6. Describe the impact in terms of the probability of the impact occurring (Section 1.6) and the degree of confidence in the impact predictions, based on the availability of information and specialist knowledge (Section 1.7).

7. When assigning significance ratings to impacts *after mitigation*, the specialist needs to:
   - First, consider probable changes in intensity, extent and duration of the impact after mitigation, assuming effective implementation of mitigation measures, leading to a revised significance rating; and
   - Then moderate the significance rating after taking into account the likelihood of proposed mitigation measures being effectively implemented. Consider:
     - Any potentially significant risks or uncertainties associated with the effectiveness of mitigation measures;
     - The technical and financial ability of the proponent to implement the measure; and
     - The commitment of the proponent to implementing the measure, or guarantee over time that the measures would be implemented.

8. Describe the degree to which an impact can be mitigated or enhanced (Section 1.9) and reversed (Section 1.10).

9. The cumulative impacts of a project should also be considered. "Cumulative impacts" refer to the impact of an activity that may become significant when added to the existing activities currently taking place within the surrounding environment.

10. Where applicable, assess the degree to which an impact may cause irreplaceable loss of a resource. A resource assists in the functioning of human or natural systems, i.e. specific vegetation, minerals, water, agricultural land, etc.

The significance ratings are based on largely objective criteria and inform decision-making at a project level as opposed to a local community level. In some instances, therefore, whilst the significance rating of potential impacts might be "low" or "very low", the importance of these impacts to local communities or individuals might be extremely high. The importance which I&APs attach to impacts must be taken into consideration, and recommendations should be made as to ways of avoiding or minimising these negative impacts through project design, selection of appropriate alternatives and / or management.

The relationship between the significance ratings after mitigation and decision-making can be broadly defined as follows (see overleaf): substance

Significance rating	Effect on decision-making
VERY LOW; LOW	Will not have an influence on the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented.
MEDIUM	Should influence the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented.
HIGH; VERY HIGH	Would strongly influence the decision to proceed with the proposed project.

1.1 EXTENT

"Extent" defines the physical extent or spatial scale of the impact.

Rating	Description
LOCAL	Extending only as far as the activity, limited to the site and its immediate surroundings. Specialist studies to specify extent.
REGIONAL	Western Cape. Specialist studies to specify extent.
NATIONAL	South Africa
INTERNATIONAL	

1.2 DURATION

"Duration" gives an indication of how long the impact would occur.

Rating	Description
SHORT TERM	0 - 5 years
MEDIUM TERM	5 - 15 years
LONG TERM	Where the impact will cease after the operational life of the activity, either because of natural processes or by human intervention.
PERMANENT	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such time span that the impact can be considered transient.

6.1.3 INTENSITY

"Intensity" establishes whether the impact would be destructive or benign.

Rating	Description
ZERO TO VERY LOW	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected.
LOW	Where the impact affects the environment in such a way that natural, cultural and social functions and processes continue, albeit in a slightly modified way.
MEDIUM	Where the affected environment is altered, but natural, cultural and social functions and processes continue, albeit in a modified way.
HIGH	Where natural, cultural and social functions or processes are altered to the extent that it will temporarily or permanently cease.

1.4 LOSS OF RESOURCES

"Loss of resource" refers to the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable.

Rating	Description
LOW	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
MEDIUM	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
HIGH	Where the activity results in an irreplaceable loss of a resource.

1.5 STATUS OF IMPACT

The status of an impact is used to describe whether the impact would have a negative, positive or zero effect on the affected environment. An impact may therefore be negative, positive (or referred to as a benefit) or neutral.

1.6 PROBABILITY

"Probability" describes the likelihood of the impact occurring.

Rating	Description
IMPROBABLE	Where the possibility of the impact to materialise is very low either because of design or historic experience.
PROBABLE	Where there is a distinct possibility that the impact will occur.
HIGHLY PROBABLE	Where it is most likely that the impact will occur.
DEFINITE	Where the impact will occur regardless of any prevention measures.

1.7 DEGREE OF CONFIDENCE

This indicates the degree of confidence in the impact predictions, based on the availability of information and specialist knowledge.

Rating	Description
HIGH	Greater than 70% sure of impact prediction.
MEDIUM	Between 35% and 70% sure of impact prediction.
LOW	Less than 35% sure of impact prediction.

1.8 SIGNIFICANCE

"Significance" attempts to evaluate the importance of a particular impact, and in doing so incorporates the above three scales (i.e. extent, duration and intensity).

Rating	Description
VERY HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***long term***; OR of ***high intensity*** at a ***national level*** in the ***medium term***; OR of ***medium intensity*** at a ***national level*** in the ***long term.***
HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***high intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***national level*** in the ***long term***; OR of ***high intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***regional level*** in the ***long term.***
MEDIUM	Impacts could be EITHER: of ***high intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***medium intensity*** at a ***regional level*** in the ***medium term***; OR of ***high intensity*** at a ***regional level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***local level*** in the ***long term***; OR of ***low intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***regional level*** in the ***long term.***
LOW	Impacts could be EITHER of ***low intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***national level*** in the ***short term***; OR of ***high intensity*** at a ***local level*** and endure in the ***short term***; OR of ***medium intensity*** at a ***regional level*** in the ***short term***; OR of ***low intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.***
VERY LOW	Impacts could be EITHER of ***low intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***; OR of ***low to medium intensity*** at a ***local level*** and endure in the ***short term.***
INSIGNIFICANT	Impacts with: Zero to very low intensity with any combination of extent and duration.
UNKNOWN	In certain cases it may not be possible to determine the significance of an impact.

1.9 DEGREE TO WHICH IMPACT CAN BE MITIGATED

This indicates the degree to which an impact can be reduced / enhanced.

Rating	Description
NONE	No change in impact after mitigation.
VERY LOW	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
LOW	Where the significance rating drops by one level, after mitigation.
MEDIUM	Where the significance rating drops by two to three levels, after mitigation.
HIGH	Where the significance rating drops by more than three levels, after mitigation.

1.10 REVERSIBILITY OF AN IMPACT

This refers to the degree to which an impact can be reversed.

Rating	Description
IRREVERSIBLE	Where the impact is permanent.
PARTIALLY REVERSIBLE	Where the impact can be partially reversed.
FULLY REVERSIBLE	Where the impact can be completely reversed.

APPENDIX 6

I&AP DATABASE

Alexcor Bpk

Mr G Davies (Geoff)
Mine Manager Alexcor Bpk
Private Bag X5 ALEXANDER BAY 8290
Work 027 831 1330 Fax 027 831 1364 Email geoffd@alexkor.co.za

Anschutz (South Africa) (Pty) Ltd

Mr T Weller (Ted)
Vice President - International Anschutz (South Africa) (Pty) Ltd
2402 Anaconda Tower 555 Seventeeth Street Denver, Colorado 80202 USA
Work 1303 299 1418 Email tedwell@tac-denver.com

Association of Small Hake Industries

Mr A Kaye (Andrew)
Chairman Association of Small Hake Industries
P O Box 6259 ROGGEBAAI 8012
Work 021 421 2472 Fax 021 425 2716 Email andrew@kaytrad.co.za

AuruMar (Pty) Ltd

Mr N Fraser (Neil)
AuruMar (Pty) Ltd
DBM Gardens, Golf Park 2 Raapenberg Road PINELANDS
Work 021 658 3213 Fax 021 658 3355 Cell 083 388 3733 Email neil.fraser@aurumar.co.za

BHP Billiton

Mr D Biggs (David)
Vice President: Land and Upstreem Agreements BHP Billiton
1360 Post Oak Boulervard Suite 150 Houston Texas 77056 USA
Work +171 3499 5615 Email david.biggs@bhpbilliton.com

BHP Billiton Petroleum (Americas) Inc.

Mr R Silverman (Robert)
BHP Billiton Petroleum (Americas) Inc.
1360 Post Oak Boulevard Suite 150 Houston, Texas 77056 3020 USA
Email robert.j.silverman@bhpbilliton.com

BHP Billiton Petroleum Great Britain Ltd

Mr S Sanders (Scott)
BHP Billiton Petroleum Great Britain Ltd
1360 Post Oak Boulevard Suite 150 Houston, Texas 77056 3020 USA
Work +17139618420 Email scott.s.sanders@bhpbilliton.com

Capricorn Fisheries Monitoring cc (CAPFISH)

Mr D Japp (Dave)
Capricorn Fisheries Monitoring cc (CAPFISH)
P O Box 50035 WATERFRONT 8002
Work 021 425 2161 Fax 021 425 1994 Cell 082 788 6737 Home 021 780 1101 Email jappy@iafrica.com
NOTE: Home tel = also fax. Physical address: Unit 15 Foregate Square, Table Bay Boulevard, Cape Town.

De Beers Marine (Pty) Ltd

Ms L Roos (Lesley)
Environmental Manager De Beers Marine (Pty) Ltd
P O Box 87 CAPE TOWN 8000
Work 021 658 3194 Fax 021 658 3355 Email lesley.roos@debeersgroup.com

Dr P Wickens (Patti)
Environmental Principal De Beers Marine (Pty) Ltd
P O Box 87 CAPE TOWN 8000
Work 021 658 3325 Cell 083 448 2279 Email patti.wickens@debeersgroup.com

De Beers South Africa

Mr S Ngcobo (Sakhile)
Executive Head of External & Corporate Affairs De Beers South Africa
Private Bag X01 SOUTHDALE 2135
Work 011 374 7974 Cell 082 806 1394 Email sakhile.ngcobo@debeersgroup.com

Department of Agriculture Forestry and Fisheries

Dr J Augustyn (Johan)
Chief Director: Marine Resource Management Department of Agriculture Forestry and Fisheries
Private Bag X2 ROGGEBAAI 8012
Work 021 402 3102 Fax 021 419 3639 Cell 082 829 3911 Email JohannAU@daff.gov.za

Mr AM Gordon (Mike)
Directorate: Social Economic Development Department of Agriculture Forestry and Fisheries
P O Box 139 LAMBERTS BAY 9130
Work 027 432 1631 Cell 082 829 3908
NOTE: (Direct Line) 027 432 1920

Department of Economic Affairs Northern Cape

Mr P Mokubung (Percival)
Manager: Economic Sector Research Department of Economic Affairs Northern Cape
Metlife Towers, Floor 11, Market Square Private Bag X6108 KIMBERLEY 8300
Work 053 839 4079 Email pmokubung@met.ncape.gov.za

Department of Env. Affairs & Development Planning

Mr P Hardcastle (Paul)
Deputy Director Department of Env. Affairs & Development Planning
Environmental Impact Management Unit Private Bag X9086 CAPE TOWN 8000
Work 021 483 5687 Fax 021 483 4372 Cell 082 889 9065 Email phardcas@pgwc.gov.za
NOTE: 1 Dorp Street, 1st Floor Property Building, Cape Town

Department of Env. Affairs & Nature Conservation

Mr J J Mutyorauta (Julius)
Director: Environmental Management Department of Env. Affairs & Nature Conservation
Private Bag X6102 KIMBERLEY 8300
Work 053 807 7430 Fax 053 831 3530 Cell 083 285 2373 Email jmutyorauta@half.ncape.gov.za
NOTE: Gen.(053) 807 4800. Secretary: Ann Jacobs. Phy.Add: 90 Long Street, Sasko Building, Kimberley 8300

Department of Environmental Affairs

Mr J Geeringh (John)
Department of Environmental Affairs
Private Bag X447 PRETORIA 0001
Work 012 310 3491 Fax 012 320 7539 Cell 083 632 7663 Email jgeeringh@environment.gov.za

Mr A Johnson (Ashley)
Directorate: Oceans and Coastal Research Department of Environmental Affairs
Private Bag X2 ROGGEBAAI 8012
Work 021 402 3569 Email Ajohnson@environment.gov.za

Dr M Mayekiso (Monde)
Deputy Director: Oceans and Coast Department of Environmental Affairs
Private Bag X2 ROGGEBAAI 8012
Work 021 819 2410 Email mmayekiso@environment.gov.za

Dr R Omar (Razeena)
Chief Director: Integrated Coastal Management Department of Environmental Affairs
PO Box 52126 CAPE TOWN 8002
Work 021 819 2432/0 Email romar@environment.gov.za
NOTE: Physical address: 2 East Pier Shed, East Pier Road, V&A Waterfront, Cape Town. Oceans & Coasts Bran

Department of Mineral Resources

Mr JH Briers (Jan)
Deputy Director : Environment Department of Mineral Resources
Private Bag X9 ROGGEBAAI 8012
Work 021 427 1000/51 Cell 083 280 0776 Email jan.briers@dmr.gov.za
NOTE: Physical Address: 9th Flr, No.9 Atterbury House, Cnr Lower Burg & Riebeek Streets, Cape Town 8001

Ms M Ledingwane ()
Director: Mineral Development Department of Mineral Resources
Private Bag X6093 KIMBERLEY 8300
Work 053 830 0800 Fax 053 832 5631
NOTE: Physical Address: 1st Floor, Standard Bank Building, 43 Chapel Street, Kimberley 8301. Northen cape

Dolphin Action & Protection Group

Ms N Rice (Nan)
Secretary Dolphin Action & Protection Group
P O Box 22227 FISH HOEK 7974
Fax 021 782 6223 Home 021 782 5845 Email mwdapg@mweb.co.za

Forest Exploration International (SA) (Pty) Ltd

Ms A Friedrichs (Anschen)
Forest Exploration International (SA) (Pty) Ltd
Suite 1B, Nautica The Waterclub, Beach Road GRANGER BAY 8005
Work 021 401 4140 Email ajfriedrichs@forestoil.co.za

Mammal Institute / Iziko Museum

Dr P Best (Peter)
Mammal Institute / Iziko Museum
P O Box 61 CAPE TOWN 8000
Work 021 481 3800 Email pbest@iziko.org.za

Matzikama Municipality

Mr L Phillips (Lionel)
Matzikama Municipality
P O Box 37 VREDENDAL 8160
Work 027 201 3346 Fax 086 6543 232 Cell 082 329 0166 Email lionelp@matzikamamun.co.za

Namagroen Prospecting

Mrs I Visser (I)
Namagroen Prospecting
P O Box 6141 Erinvale Estate SOMERSET WEST 7130
Work 021 847 1566 Cell 082 896 0781 Email namagroen@telkomsa.net
NOTE: CEO of Namagroen

Namaqua Diamond Fund Trust

Ms M Williams (Margaret)
Namaqua Diamond Fund Trust
P O Box 814 SPRINGBOK 8240
Work 027 718 1060 Fax 027 718 1062 Cell 082 852 4875 Email marg@ndft.org
NOTE: alt tel 027 718 1061/3

National Ports Authority

()
The Port Manager National Ports Authority
P O Box 30 PORT NOLLOTH 8280

OPASA

Mr J Langhus (John)
OPASA
Suite 1B, Nautica The Waterclub, Beach Road GRANGER BAY 8005
Work 021 401 4140 Fax 021 401 4198 Cell 083 412 9876 Email jllanghus@forestoil.co.za

Panda Marine

Mr K Pansegrouw (Kobus)
Panda Marine
P O Box 35630 NORTHCLIFF 2115
Work 011 672 1652 Fax 086 652 7670 Email pandanet@global.co.za

Petroleum Agency SA

Mr S Mills (Stephen)
Commercial Manager Petroleum Agency SA
P O Box 5111 TYGERVALLEY 7536
Work 021 938 3500 Fax 021 938 3520 Email millss@petroleumagencysa.com
NOTE: physical address: Tygerpoort Building, 7 Mispel Road, Bellville 7530

PetroSA (Pty) Ltd

Ms J Courtoreille (Jessica)
PetroSA (Pty) Ltd
Private Bag X5 PAROW 7955
Work 021 929 3216 Fax 021 929 3018 Cell 083 253 6614 Email jessica.courtoreille@petrosa.co.za
NOTE: 151 Frans Conradie Drive, Parow 7500

PetroSA (Pty) Ltd

Ms V Singh (Varsha)
Asset Manager: Exploration Projects PetroSA (Pty) Ltd
Private Bag X5 PAROW 7499
Fax 021 929 3104 Cell 083 551 2441 Home 021 929 3452 Email varsha.singh@petrosa.co.za

Prospect 35 (Pty) Ltd

Mr M Hirs (Martin)
Prospect 35 (Pty) Ltd
P O Box 12460 MILL STREET CAPE TOWN 8010
Work 021 462 0715 Fax 021 462 0716
NOTE: he is also with Astarte (Pty) Ltd

Richtersveld Municipality

Mr MS Ahjum ()
Richtersveld Municipality
Private Bag X113 PORT NOLLOTH 8280
Work 027 851 8229 Fax 027 851 8366 Email port@lantic.net

Mr A Delie (Allen)
Richtersveld Municipality
P O Box 128 ALEXANDER BAY 8290
Fax 027 831 1457 Cell 072 1903 752

S A Navy Hydrographic Office

Mr M Nelson (Malcolm)
S A Navy Hydrographic Office
Private Bag X1 TOKAI 7966
Work 021 787 2408 Fax 021 787 2233 Email hydrosan@iafrica.com

SA Pelagic Fishing Industry Association

Mr D de Villiers (Dan)
SA Pelagic Fishing Industry Association
P O Box 2066 CAPE TOWN 8000
Work 021 425 2727 Fax 021 425 4734 Email safish@new.co.za
NOTE: dan@new.co.za

SA Pelegic Fish Industry Association

Mr P Foley (Peter)
SA Pelegic Fish Industry Association
P O Box 2066 CAPE TOWN 8000
Work 021 425 2727 Fax 021 425 4734 Email safish@new.co.za
NOTE: Secretary of West Coast Rock Lobster Industry Association

SA Squid Management Industrial Association

Dr E van Niekerk ()
SA Squid Management Industrial Association
P O Box 13130 Suite 196 HUMEWOOD 6013
Work 041 582 1615

SA Tuna Longline Association

Mr R Ball (Richard)
Secretary SA Tuna Longline Association
P O Box 3277 CAPE TOWN 8000
Email rball@iafrica.com

Sasol Petroleum International (Pty) Ltd

Mr P Dekker (Peter)
Manager: Exploration Sasol Petroleum International (Pty) Ltd
P O Box 5486 JOHANNESBURG 2000
Work 011 344 0795 Fax 011 441 3923 Email peter.dekker@sasol.com

Shark Longline Association

Mr H Gomez (Horatio)
Chairman Shark Longline Association
20 Woodhead Drive EDGEMEAD 7441
Work 021 425 2161 Fax 021 589 739

Simco Petroleum Limited

Mr P Mikkelsen (Peter)
Technical Advisor Simco Petroleum Limited
Work +44 020 8780212 Fax +44 02088780270
NOTE: Advisor to Thombo Petroleum. Simco Petroleum Industry Management and consultancy Services

South African Commercial Line Fishing Association

()
South African Commercial Line Fishing Association
P O Box 383 YZERFONTEIN 7351
Email boating@ telkomsa.net

South African Deep Sea Trawling Association

Mr R Bross (Roy)
The Secretary South African Deep Sea Trawling Association
P O Box 2066 CAPE TOWN 8000
Work 021 425 2727 Fax 021 425 4734 Email deepsea@iafrica.com
NOTE: Note: Send corr. via email

South African Heritage Resources Agency (SAHRA)

()
The Provincial Manager South African Heritage Resources Agency (SAHRA)
P O Box 2771 CAPE TOWN 8000
Work 021 424 5046 Fax 021 424 5047 Email bcrouts-knipe@wc.sahra.org.za

South African Maritime Safety Authority (SAMSA)

Mr D Colley (Dave)
Western Regional Manager South African Maritime Safety Authority (SAMSA)
Private Bag X7025 ROGGEBAAI 8012
Work 021 421 6170 Email dcolley@samsa.org.za
NOTE: 2 Long Street, 19th Floor, Cape Town, 8001

South African National Biodiversity Institute

Dr K Sink (Kerry)
Marine Program Manager South African National Biodiversity Institute
Kirstenbosch Research Centre Private Bag X7 CLAREMONT 7735
Work 021 799 8855 Cell 082 831 0536 Email k.sink@sanbi.org.za

Thombo Petroleum

Mr T Ridley (Trevor)
Managing Director Thombo Petroleum
1c Barnes High Street London UNITED KINGDOM SW13 9LB
Work +44 207 8344919 Email trevor@thombopetroleum.co.za
NOTE: formerly QVD South Africa

Trans Hex Group Limited

Ms B Fatyi (Babalwa)
Trans Hex Group Limited
P O Box 13972 Voma Valley MIDRAND 1686
Work 011 403 2275 Fax 011403 2363 Email babalwa@myezo.co.za
NOTE: Myezo Environmental Management

Mr V Madlela (Vincent)
Trans Hex Group Limited
P O Box 723 PAROW 7499
Work 021 937 2000
NOTE: in charge of environmental division

Mr C Neethling (Carel)
Group Operations Manager Marine Trans Hex Group Limited
P O Box 723 PAROW 7499
Cell 082 451 5760 Email careln@transhex.co.za

Mr G Zecharias (George)
Company Secretary Trans Hex Group Limited
P O Box 723 PAROW 7499
Email georgez@transhex.co.za

Tuna Hake Association

Ms Moniz (Antoinette)
Tuna Hake Association
20th Floor Metropolitan Building Coen Coen Steytler Avenue CAPE TOWN 8001
Cell 083 461 4753 Email antoinette@tunahake.co.za
NOTE: send info via email

Tuna Longline Association

Mr D Lucas (Don)
Tuna Longline Association
P O Box 3277 CAPE TOWN 8000
Work 021 510 7924 Fax 021 696 1327 Cell 083 456 2592 Email comfish@mweb.co.za
NOTE: 021 511 6590

Wealth 4 U (Bagger (Pty) Ltd)

Mr D Gadd-Clayton (Dan)
Wealth 4 U (Bagger (Pty) Ltd)
Private Bag X13 TYGER VALLEY 7536
Work 021 914 7215 Fax 021 914 6476 Email dan@w4u.co.za

WESSA

Mr P Dowling (Patrick)
WESSA
P O Box 30145 TOKAI 7966
Work 021 701 1397 Fax 021 701 1399 Email patrick@wessa.co.za

Prof RA Hasty (Robert)
Conservation Portfolio WESSA
P O Box 316 KIMBERLEY 8300
Email robert.h@absamail.co.za

60 names listed

APPENDIX 7

ADVERTISEMENTS

PUBLIC PARTICIPATION PROCESS

PROPOSED MARINE PROSPECTING ACTIVITIES IN VARIOUS AREAS OFF THE WEST COAST OF SOUTH AFRICA

Notice No: AM01PR-01/2011 DEA Ref No. 12/12/20/2254

Notice is hereby given of a public participation process in terms of the NEMA Environmental Impact Assessment Regulations 2010.

Applicant: De Beers Consolidated Mines Ltd. (Operations would be undertaken by AuruMar (Pty) Ltd.)

Description: The proposed Marine Prospecting Activities include the sourcing of heavy minerals, platinum group metals, gold and sapphire (gemstones) within sea areas: 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c off the west coast of South Africa.

Location: Off the west coast of South Africa, between St Helena Bay and Alexander Bay, in water depths between 90 m and 200 m.

Environmental Assessment Practitioner: CCA Environmental (Pty) Ltd (CCA)

Application for environmental authorisation to undertake the following activities:
The proposed project includes the following activities in terms of the EIA regulations 2010 as listed in Government Notice No. R.544: 16(vi) and 18(ii).

Opportunity to participate:
A Draft Basic Assessment Report (BAR) is available for a 40-day review and comment period. Note that the five public holidays that fall within this comment period have been added to the 40-day time period. Copies of the Draft BAR will be available at the following locations from **Monday 18 April 2011**:

1. Offices of CCA Environmental (Pty) Ltd; and
2. On the CCA Environmental website (www.ccaenvironmental.co.za).

Interested and Affected Parties (I&APs) are invited to submit comments on the Draft BAR and/or to register as I&APs. Comments should reach CCA **no later than Wednesday, 1 June 2011** for inclusion in the Final BAR. A copy of the Executive Summary of the Draft BAR is available on request.

CCA Environmental (Pty) Ltd contact details:
Unit 35 Roeland Square, Drury Lane, Cape Town,
PO Box 10145, Caledon Square, 7905
Tel: (021) 461 1118 Fax: (021) 461 1120
E-mail: tamryn@ccaenvironmental.co.za
www.ccaenvironmental.co.za

cca ENVIRONMENTAL

Date of advertisement: 18 April 2011

PUBLIEKE DEELNAMEPROSES

VOORGESTELDE MARIENE PROSPEKTERINGSAKTIWITEITE IN VERSKEIE AREAS LANGS DIE WESKUS VAN SUID AFRIKA

Kennis No: AM01PR-01/2011 DEA Verw No. 12/12/20/2254

Hiermee kennisgewing van 'n publieke deelnameproses in terme van die NEMA Omgewingsimpakbepaling (OIB) Regulasies 2010.

Aansoeker: De Beers Gekonsolideerde Myne Bpk. (Projek sal onderneem word deur Aurumar (Edms) Bpk)

Beskrywing: Die voorgestelde Mariene Prospekteringsaktiwiteite sluit die ondersoek na swaar metale, platinum groep metale, goud en saffier (halfedelstene) in, binne see areas: 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c en 20c langs die weskus van Suid Afrika.

Ligging: Langs die weskus van Suid Afrika, tussen St Helenabaai en Alexanderbaai, in waterdieptes tussen 90 m en 200 m.

Omgewingskonsultant: CCA Environmental (Edms) Bpk (CCA)

Aansoek vir omgewingsgoedkeuring om die volgende aktiwiteite te onderneem:
Die voorgestelde projek sluit die volgende aktiwiteite in terme van die OIB Regulasies 2010 in, soos gelys in Staatskennisgewing No. R.544: 16(vi) en 18(ii).

Geleentheid om deel te neem:
'n Konsep Basiese Evalueringsverslag (BEV) is beskikbaar vir 'n 40-dae oorsig en kommentaarperiode. Neem kennis dat die vyf openbare vakansiedae wat binne hierdie kommentaarperiode val by die 40-dae periode bygevoeg is. Kopieë van die Konsep BEV sal **vanaf Maandag 18 April 2011** by die volgende plekke beskikbaar wees:

3. Kantore van CCA Environmental (Edms) Bpk; en
4. Op die CCA Environmental webblad (www.ccaenvironmental.co.za).

Belanghebbende Persone word uitgenooi om kommentaar te lewer op die Konsep BEV en/of te registreer as Belanghebbende Persone. Kommentaar moet CCA **teen Woensdag, 1 Junie 2011** bereik vir insluiting by die Finale BEV. 'n Kopie van die Bestuursoorsig van die Konsep BEV is beskikbaar op aanvraag.

CCA Environmental (Edms) Bpk kontakbesonderhede:
Eenheid 35 Roelandplein, 30Drurylaan, Kaapstad, 8001
Posbus 10145, Caledonplein, 7905
Tel: (021) 461 1118 Faks(021) 461 1120
E-pos: tamryn@ccaenvironmental.co.za
www.ccaenvironmental.co.za

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APPENDIX 8

PREVIOUS HERITAGE ASSESSMENT

Desktop Study for De Beers Marine assessing the significance of Maritime Heritage in concession areas 12(c), 14(c), 15(c), 16(c), 17(c), 18(c) and 20(c)

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J.J. Boshoff

Iziko Museums of Cape Town

Introduction

This desktop study was commissioned by De Beers Marine to assess the significance of the Maritime Heritage i.e. shipwrecks, in the concession areas 12(c), 14(c), 15(c), 16(c), 17(c), 18(c) and 20(c). The relevant legislation that applies is the Act no. 25 of 1999: The National Heritage Resources Act. The act defines wrecks older than 60 years in the waters of South Africa, as defined in the Maritime Zones Act of 1994, as "archaeological" (Section 2.ii.c). Archaeological remains are defined as part of the National Estate (Section 3.2.f) and are therefore protected under this act. As such De Beers Marine is compelled to report any discovery of Archaeological remains (in this case shipwreck remains) under Section 35.3. This desktop study then is part of the process to identify the possibility of finding remains.

The Resource

Although the concession area extend from a boundary 5km from the high water mark to the 200m depth contour and therefore does not include the shoreline or inter tidal zone, one cannot asses the significance of the Maritime Heritage without looking at the area as a whole.

It is unlikely however to find pre-colonial remains in the concession area as the distance from the shore (ca. 5km) is too far away for sea level changes to be significant. In fact from about 2000 years before the present the coastline conditions have remained relatively stable (Heydorn & Tinley 1980). Although this period of 2000 years encompasses mainly the Later Stone Age there is no likelihood of artefacts from the Early or Middle Stone Age to be found in the concession areas mainly due to the location of the boundaries as mentioned above. What could be significant is the Fossil Record. This is however the precept of Palaeontology and the author is not qualified to comment on this matter. I do however suggest that a separate impact assessment is done by a qualified Palaeontologist to assess this significance.

The greatest potential impact for Maritime Heritage comes therefore from the colonial period or period of European expansion that dates from the 15th century to the first half of the 20th century. As can be seen from Table 1 (SAHRA National Shipwreck Database) the known wrecks in the area dates from 1693. Table 2 (SAHRA National Shipwreck Database) is a list of wrecks not impacted by the National Heritage resources Act and is included for the sake of being comprehensive as possible.

Table 1. Shipwrecks older than 60 years close to concession areas

Name	Location	Type	Date
Bantam	Paternoster	Wooden Sailing Vessel	1693/02/08
De Gouden Buys	8 km (miles?) north of Berg River Mouth	Wooden Sailing Vessel	1693/10/19
Meteren	North of (30km north of)	Wooden Sailing Vessel	1723/11/07

Huis te Vlotter	St Helena Bay	Wooden Sailing Vessel	1731/02/01
Elizabeth	Mietjie Frans se Baai	Wooden Sailing Vessel	1818/01/01
Britannia	Surf at eastern end of Britannia Bay	Wooden Sailing Vessel	1826/10/22
Columbine	Lighthouse (1.5km north of)	Wooden Sailing Vessel	1829/03/31
Friends Goodwill	Paternoster (?)	Wooden Sailing Vessel	1840/02/06
Australia	17.7 km north of Oliphant's River Mouth	Wooden Sailing Vessel	1840/12/27
Alicia Jane	Paternoster Island	Wooden Sailing Vessel	1845/05/16
Eve	Paternoster Island	Wooden Sailing Vessel	1845/05/17
Reflector	St Helena Bay (on reef)	Wooden Sailing Vessel	1851/04/17
Antoinette	Lamberts Bay		1854/07/01
Lamberts Bay Packet	Lamberts Bay	Sailing Vessel	1859/03/01
Rosebud	Lamberts Bay	Wooden Sailing Vessel	1859/06/25
Perimede	Dwarskersbos - 11km north of Berg River	Wooden Sailing Vessel	1860/08/04
Barbara	Berg River Mouth	Sailing Vessel	1868/06/16
St Lawrence	Groot Paternoster Point / Soldiers Reef	Iron Sail Steamship	1876/11/08
Bulli	Seal Island (most westerly point)	Steel Screw Steamship	1884/05/05
Columbus	Berg River Mouth (near)	Sailing Vessel	1885/06/19
Hopefield Packet	Paternoster Bay	Sailing Vessel	1888/09/05
Lingfield	Groot Paternoster	Steel Steamship	1891/12/05
Resolution	Jacobs Bay (off) / Hoedjies Bay?	Steamship	1898/12/18
Sybille	Grootrif near Steenboksfontein	Twin Screw Steel Motor Vessel	1901/01/16
King Cerrig	Cape Columbine Lighthouse (north of)		1903/01/01
Good Hope	St Helena Bay	Sailing Vessel	1910/01/01
Lisboa	Soldiers Reef	Twin Screw Steel Steamship	1910/10/23
Eros	Near	Steamship	1918/05/26
Malmesbury	Jacobs Reef	Steel Steamship	1930/09/09

Haleric	Paternoster Point Reef	Steel Screw Steamship	1933/04/04
Langebaan	Stompneus Point	Motor Vessel	9/11/1933
Columbine	Lighthouse (40.2km / 25 miles from)	Steamship	1944/06/16
Chub	3 km south of Cape St Martin / Kalkoond	Steamship	1945/11/02
The highlighted rows indicate shipwrecks with an uncertain location			

Table 2. Shipwrecks not covered by the Heritage Legislation			
Name	**Location**	**Type**	**Date**
Shamrock	Lamberts Bay	Motor Vessel	1958/01/01
Blue Bird	Elands Bay	Motor Vessel	1960/11/01
Pilar Cousido	Stumpnose Bay	Motor Vessel	1/1/1966
Dorita	Paternoster (off)	Motor Vessel	1970/02/03
Girl Devon	Doring Bay	Sailing Vessel	1971/01/14
Seatrader	Cape St Martin Lighthouse (north of)	Motor Vessel	1971/06/03
Zulu Coast II	11,3 km south of	Motor Vessel	1971/07/07
Breerivier	Cape St Martin	Motor Vessel	1972/03/15
Oceana Point	St Helena Bay	Motor Vessel	1974/01/01
Boy Francis	St Helena Bay	Motor Vessel	1974/01/01
Bella Theresa	28.8 km west of St Helena Bay	Motor Vessel	1977/02/01
Boy Donald	Lamberts Bay (off)	Motor Vessel	1983/03/22
St Gerard	off Columbine / 48.3km west of Dassen	Motor Vessel	1983/11/26
Stormgans	Laaiplek	Motor Vessel	1987/08/19

In Table 1 above there are only two 17th and two 18th Century shipwrecks with the bulk in the 19th Century (19 shipwrecks) and some in the first half of the 20th Century. As recording of shipwrecks were better in the 19th Century and later, it gives us a more accurate view of where the different from this period wrecks are positioned. Of the earlier shipwrecks the *Meteren*'s (1707) position is known as material was recovered from the site as late as 2001 (SAHRA National Shipwreck Database). Of the other earlier wrecks the *Bantam* (1693) is listed as being grounded as was the *Huis te Vlotter* (1731) and *De Gouden Buys* (1693).
Some of the other wrecks in Table 1 has been located and include the *Britannia* (1822), *St Lawrence* (1879), *Sybille* (1901) and the *Lisboa* (1910). If we plot the positions and

supposed positions of the wrecks in Table 1 we see that none of the fall within the concession area (Figure 1).

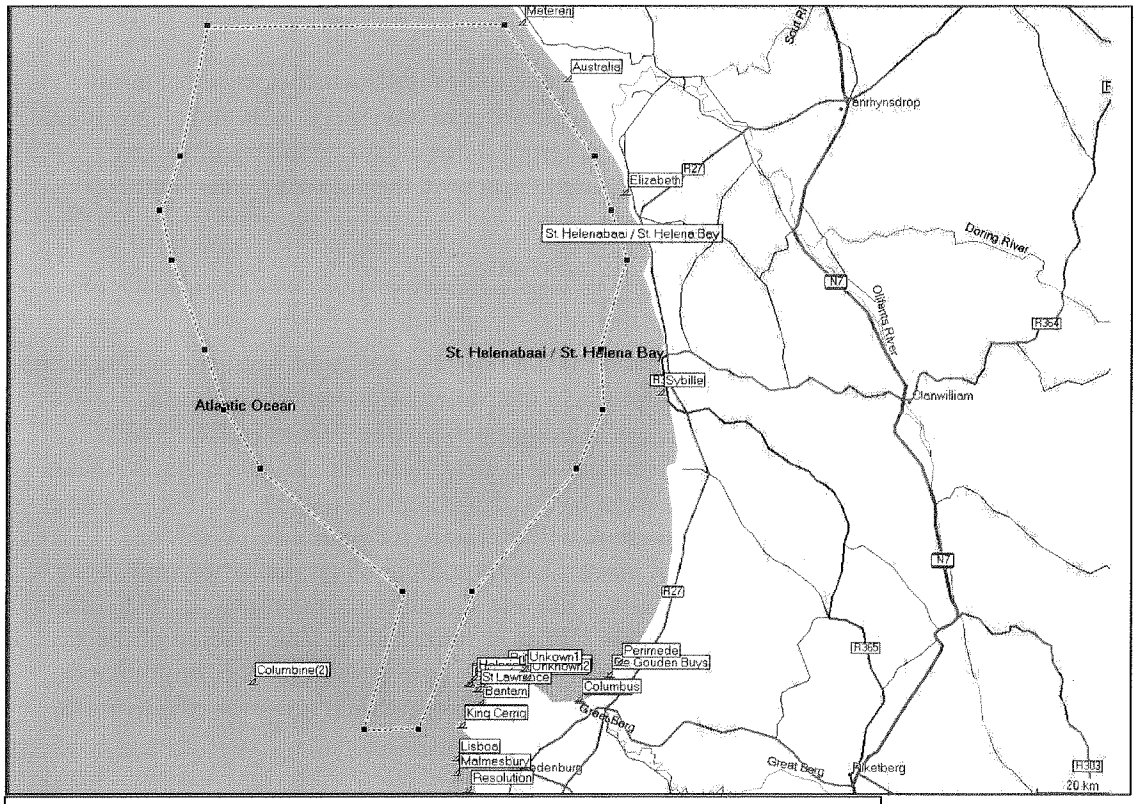

Figure 1. Shipwrecks older than 60 years plotted. Concession area marked in yellow

This however does not preclude the possibility of unknown shipwrecks being in the area. The region has seen quite a lot of maritime activity over the years especially ship based whaling probably from the early 17th century onwards as it is known that whale ships frequented the Cape. This activity has not been well recorded and it is possible that ships were lost further out at sea and consequently in the concession area. From 1734 at different times the Dutch East India Company had an outpost in St Helena Bay (Sleigh 1993) mainly due to threats of war with other European powers. The Dutch reported an increase in activity of American, British and French whale ships in the bay in the late 18th Century and it seems that this was probably the heyday of ship based whaling in the area. The only other records we have of whaling activity is in surviving ships logs of some of the whale ships (Best 2006). As not all the logs have been preserved and we do not know how many whaling voyages were undertaken to this area, we cannot say with certainty that there are no whale ship wrecks in the concession area especially in the Northern section where the concession area comes sometimes within 3km of the coastline.

Other periods likely to produce shipwrecks are during war times for example during the First and Second World wars. The only wreck that seemed to have been produced during

both World Wars in this area was the *Columbine* (1944) that was sunk by the German U-boat *U-198* (Gordon-Cumming et al, 1961). The official coordinates for this tragedy puts the vessel outside of the concession area in fact about 27km East of the closest point in the concession area.

It would therefore seem that there is a low probability for shipwreck remains in the concession area but as stated above not all shipwrecks have been recorded. To mitigate this situation it is important that the results from the standard geophysical survey proposed by De Beers Marine be scrutinised especially the side scan sonar and magnetometer readings.

Geophysical Survey

According to the background document for the Prospecting Right Application, De Beers will be deploying a full array of geophysical instrumentation including Swath bathymetry, Shallow (2 to 10 KHz) and medium penetration (0.5 to 2Khz) "Chirp" seismic systems, 100Khz side scan sonar, and a magnetometer. Of these the side scan sonar and magnetometer will be of most use in detecting shipwrecks. As the side scan sonar projects a sonar image a shipwreck will be easily recognisable. With the magnetometer it is more a matter of correct interpretation. A typical shipwreck, even a wooden one with iron fittings, will give a di-pole signature more or less aligned with the earths' magnetic field (Gearheart 2004). What is critical is the lane spacing of the magnetometer surveys. This should ideally be 20m or less although this might not be possible as the concession area is quite large. De Beers should however endeavour to make the lane spacing as narrow as possible.

Conclusion

This desktop study indicates that there is a low probability of finding historical shipwrecks in the concession area. This does not rule out the possibility of unknown wrecks in the area. The existence of unknown wrecks should be brought to light by the geophysical survey. The author of this report does however request that the results of especially the side scan sonar and magnetometer surveys be made available for his perusal before the sampling and coring of the area commence in order to rule out any possible occurrence of cultural material.

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iziko
museums of cape town

16 March 2009

Ms. Lesley Roos
Environmental Manager
De Beers Marine
PO Box 87
Cape Town 8000

Dear Ms. Roos

PROSPECTING AREAS 7C TO 10C

Our previous desktop study for the Hondeklip Bay area covers the above mentioned areas and you therefore do not need another Heritage Impact Assessment. As you are going to deploy a sufficient array of Geophysical equipment over the area, you should be able to pick up any unknown sites. In the eventuality that this does happen I would urge you that you make contact with me as soon as possible.

Yours truly,

J.J. Boshoff
Maritime Archaeologist