CaseID: 1984

1st June

cca ENVIRONMENTAL

AM01/Let April11

18 April 2011

South African Heritage Resources Agency
Provincial Manager
PO Box 2771
Cape Town
8000

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. Please find enclosed one copy of the Draft BAR. The report will also be placed on our website, www.ccaenvironmental.co.za from **Monday, 18 April 2011**:

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).

Please do not hesitate to contact our Tamryn Heydenrych or the undersigned if you have any queries.

Yours sincerely

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

Encl.

Am01pr\Correspondence\I&APs\Let submission of Draft BAR - April 2011_SAHRA.doc

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Directors: J Crowther F Fredericks • Associate: J Blood • Reg No 2003/019026/07

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

DRAFT BASIC ASSESSMENT REPORT

Prepared for:
Department of Environmental Affairs

On behalf of:
De Beers Consolidated Mines Ltd

Prepared by:
CCA Environmental (Pty) Ltd

cca ENVIRONMENTAL

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

DRAFT BASIC ASSESSMENT REPORT

Prepared for:
Department of Environmental Affairs
Private Bag X447
PRETORIA, 0001
Reference No: 12/12/20/2254

On behalf of:
De Beers Consolidated Mines Ltd
PO Box 616
KIMBERLEY, 8300

Prepared by:
CCA Environmental (Pty) Ltd
Unit 35 Roeland Square, Drury Lane
CAPE TOWN, 8001
Tel: (021) 461 1118 / 9 Fax (021) 461 1120
E-mail: tamryn@ccaenvironmental.co.za

cca ENVIRONMENTAL

PROJECT INFORMATION

TITLE	Draft Basic Assessment Report for Marine Prospecting Activities in various areas off the west coast of South Africa
APPLICANT	De Beers Consolidated Mines Ltd
ENVIRONMENTAL CONSULTANTS	CCA Environmental (Pty) Ltd
REPORT REFERENCE	AM01PR/DBAR
DEA REFERENCE	12/12/20/2254
REPORT DATE	15 April 2011

REPORT COMPILED BY: Tamryn Heydenrych

.....

Tamryn Heydenrych
Environmental Scientist

REPORT REVIEW BY: Jonathan Crowther

.....

Jonathan Crowther (Pr.Sci.Nat.; CEAPSA)
Managing Director

EXPERTISE OF ENVIRONMENTAL ASSESSMENT PRACTITIONER

NAME	Jonathan Crowther
RESPONSIBILITY ON PROJECT	Project leader and quality control.
QUALIFICATIONS	B.Sc. Hons (Geol.), M.Sc. (Env. Sci.)
PROFESSIONAL REGISTRATION	Pr.Sci.Nat., CEAPSA
EXPERIENCE IN YEARS	22
EXPERIENCE	Jonathan Crowther has been involved in environmental consulting since 1988 and is currently the Managing Director of CCA Environmental (Pty) Ltd. He has expertise in a wide range of environmental disciplines, including Environmental Impact Assessments (EIA), Environmental Management Plans / Programmes, Environmental Planning & Review, Environmental Auditing & Monitoring, Environmental Control Officer, Public Consultation & Facilitation. He has project managed a number of offshore oil and gas EIAs for various exploration and production activities in South Africa and Namibia. He also has extensive experience in projects related to roads, property developments and waste landfill sites.

NAME	Tamryn Heydenrych
RESPONSIBILITY ON PROJECT	Project consultant and report writing.
DEGREE	B.Sc. (Env. & Geo. Sci.), B.Sc. Hons (Physical Geography.)
PROFESSIONAL REGISTRATION	-
EXPERIENCE IN YEARS	4
EXPERIENCE	Tamryn Heydenrych has worked as an environmental assessment practitioner since the beginning of 2007 and has been involved in a number of small-scale projects covering a range of environmental disciplines, including Basic Assessments (BA), Environmental Management Plans (EMP), Environmental Impact Assessments and Environmental Control Work. She has been exposed to a range of projects relating to infrastructure projects (e.g. bulk sewer pipelines, roads, bulk stormwater), and housing developments.

EXECUTIVE SUMMARY

1 INTRODUCTION

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), a joint venture entity created by De Beers Group Exploration Holdings Limited and AngloGold Ashanti Marine Exploration Limited, has been formed to act as the operator to undertake Marine Prospecting Activities in these sea areas (refer to Figure 1). The proposed prospecting activities include the identification of heavy minerals, platinum group metals, gold and sapphire (gemstones).

In terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA), De Beers submitted four Environmental Management Plans (now Programmes) (EMP's) to the Department of Mineral Resources (DMR) for the above-mentioned sea areas between December 2008 and February 2010. DMR subsequently approved these EMP's on the following dates: 8 October 2009 for portions 2c to 5c and 7c to 10c; 10 September 2009 for portions 12c, 14c to 20c and 1 March 2011 for portions 1c and 6c.

At the time that these EMP's were submitted to DMR, the proposed project did not trigger any listed activities in terms of the National Environmental Management Act (107 of 1998) (NEMA). However, with the amendment to the Environmental Impact Assessment (EIA) Regulations in 2010 the proposed project now triggers listed activities in terms of Government Notice (GN) R 544. Thus a Basic Assessment Process is required to be undertaken in terms of GN R 543 and Environmental Authorisation obtained from the Department of Environmental Affairs (DEA) before the project can proceed.

AuruMar has appointed CCA Environmental (Pty) Ltd (CCA) as the independent Environmental Assessment Practitioner to undertake a Basic Assessment process for the proposed Marine Prospecting Activities in accordance with the requirements of NEMA and the EIA Regulations 2010.

This Draft Basic Assessment Report (BAR) summarises the process followed to date and provides a description of the proposed project and affected environment. It also provides an assessment of the impacts of the proposed project. It should be noted that DEA's standard BAR template has also been completed as an Appendix.

1.1 ASSUMPTIONS AND LIMITATIONS

The study assumptions and limitations are listed below:

- The study assumes that CCA has been provided with all relevant project description information by AuruMar and that it was correct and valid at the time it was provided;
- There will be no significant changes to the project description or surrounding environment between the completion of the report and implementation of the proposed project that could substantially influence findings, recommendations with respect to mitigation and management, etc;
- Certain details regarding the proposed Marine Prospecting Activities were not available at the time of report writing, e.g. the actual specific locations of the sample sites, vessels to be used, etc.); and
- The study assumes that all mitigatory measures incorporated into the project description would be implemented as proposed.

1.2 COMMENT ON THE DRAFT BAR

This Draft BAR has been distributed for a 40-day comment period from **18 April 2011 to 1 June 2011.** Copies of the full report have been made available at the following locations:

1. Offices of CCA; and
2. On the CCA website www.ccaenvironmental.co.za.

Electronic copies (disk) of the report can be requested from CCA, at the contact details provided below.

Any comments should be forwarded to CCA at the address, telephone/fax numbers or e-mail address shown below. For comments to be included in the Final BAR, comments should reach CCA **no later than Wednesday 1 June 2011**.

Tamryn Heydenrych
CCA Environmental (Pty) Ltd
Unit 35 Roeland Square, 30 Drury Lane, Cape Town, 8001
PO Box 10145, Caledon Square, 7905

Tel: (021) 461 1118 / 9 Fax: (021) 461 1120
E-mail: tamryn@ccaenvironmental.co.za

2 BASIC ASSESSMENT PROCESS

2.1 KEY LEGISLATION

Key legislative requirements that the proposed prospecting activities must comply with, include the following:

- National Environmental Management Act (No. 107 of 1998); and
- Minerals and Petroleum Resources Development Act (No. 28 of 2002).

2.2 PROCESS FOLLOWED TO DATE

The Basic Assessment process undertaken to date is summarised below.

- An Application Form and Declaration of Interest were submitted to DEA on 31 March 2011).
- Specialist input was provided on the likely impact on the benthic environment and fishing industry by the proposed prospecting activities.
- The specialist input and other relevant information have been integrated into this Draft BAR.
- A preliminary interested and affected party (I&AP) database has been compiled. To date 59 I&APs have been registered on the project database.

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); 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.

2.3 WAY FORWARD

The following steps will be undertaken in the remainder of the Basic Assessment process:

- After closure of the comment period, the Draft BAR will be updated into a Final BAR. Comments received on the Draft BAR will be incorporated into a Comments and Responses Report that will be appended to the Final BAR;
- The Final BAR will be released for a further 21-day comment period. All I&APs on the project database will be notified of the availability of the Final BAR for comment;
- The Final BAR and any comments received from I&APs on the Final BAR, will be submitted to DEA for consideration and decision-making.
- After DEA has reached a decision, all I&APs on the project database will be notified of the outcome of the application and the reasons for the decision; and
- A statutory appeal period in terms of Chapter 7 of the EIA Regulations 2010 will follow the issuing of the decision.

3 PROJECT DESCRIPTION

3.1 GENERAL INFORMATION

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. The proposed prospecting activities include the sourcing of heavy minerals, platinum group metals, gold and sapphire (gemstones). 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 km² 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.

3.2 NEED AND DESIRABILITY

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.

3.3 MARINE PROSPECTING OVERVIEW

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

3.3.1.1 Exploration sampling

The proposed prospecting activities would utilise AuruMar's Sonic VibroCorer (SVC) in order to collect the required samples. The system deploys 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.

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.

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.

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.

Resource Delineation Programme

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

Geophysical Surveying

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. Sound levels from the acoustic equipment would range from 190 to 220 dB re 1 µPa at 1m.

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 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 km^2 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 m^3.

3.4 NO-GO ALTERNATIVE

The No-Go alternative is the non-occurrence of the proposed project. The negative implications of not going ahead with the proposed project are as follows:

- Loss of opportunity to establish whether 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.

4 EMISSIONS AND DISCHARGES

The types of emissions and discharges that are expected from prospecting activities include the following:

- Discharges such as deck drainage, machinery space wastewater, sewage, etc; and
- Disposal of solid waste such as foodwaste.

5 AFFECTED ENVIRONMENT

The proposed prospecting activities fall within the offshore area of the west coast region of South Africa. It lies within the southern zone of the Benguela Current region and is characterised by the cool Benguela upwelling system. The description of the offshore environment in the Draft BAR contains a general overview of the oceanography and ecology of the west coast offshore region with specific reference to the prospecting area. The human utilisation, such as fishing, marine diamond mining / prospecting and petroleum exploration, of the area is also described.

6 ENVIRONMENTAL IMPACT ASSESSMENT

Table 1 (overleaf) provides a summary of the significance ratings assigned to each potential impact of prospecting.

Table 6.1: Summary of the significance of the potential impacts associated with the proposed prospecting activities and No-Go Alternative.

Potential impact		Significance	
		Without mitigation	With mitigation
Vessels and helicopter operation:			
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 surveying		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

7 CONCLUSIONS

All of the impacts associated with the prospecting activities would occur in the immediate vicinity of the vessel, 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.

8 RECOMMENDATIONS

8.1 GENERAL

8.1.1 Compliance with the Environmental Management Programme

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

8.1.2 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.

8.1.3 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.

8.1.4 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.

8.1.5 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.

9 ENVIRONMENTAL MANAGEMENT PROGRAMME

The EMP has been compiled for prospecting activities, which consolidates management activities required to address the issues and mitigation measures identified in the Draft Basic Assessment Report.

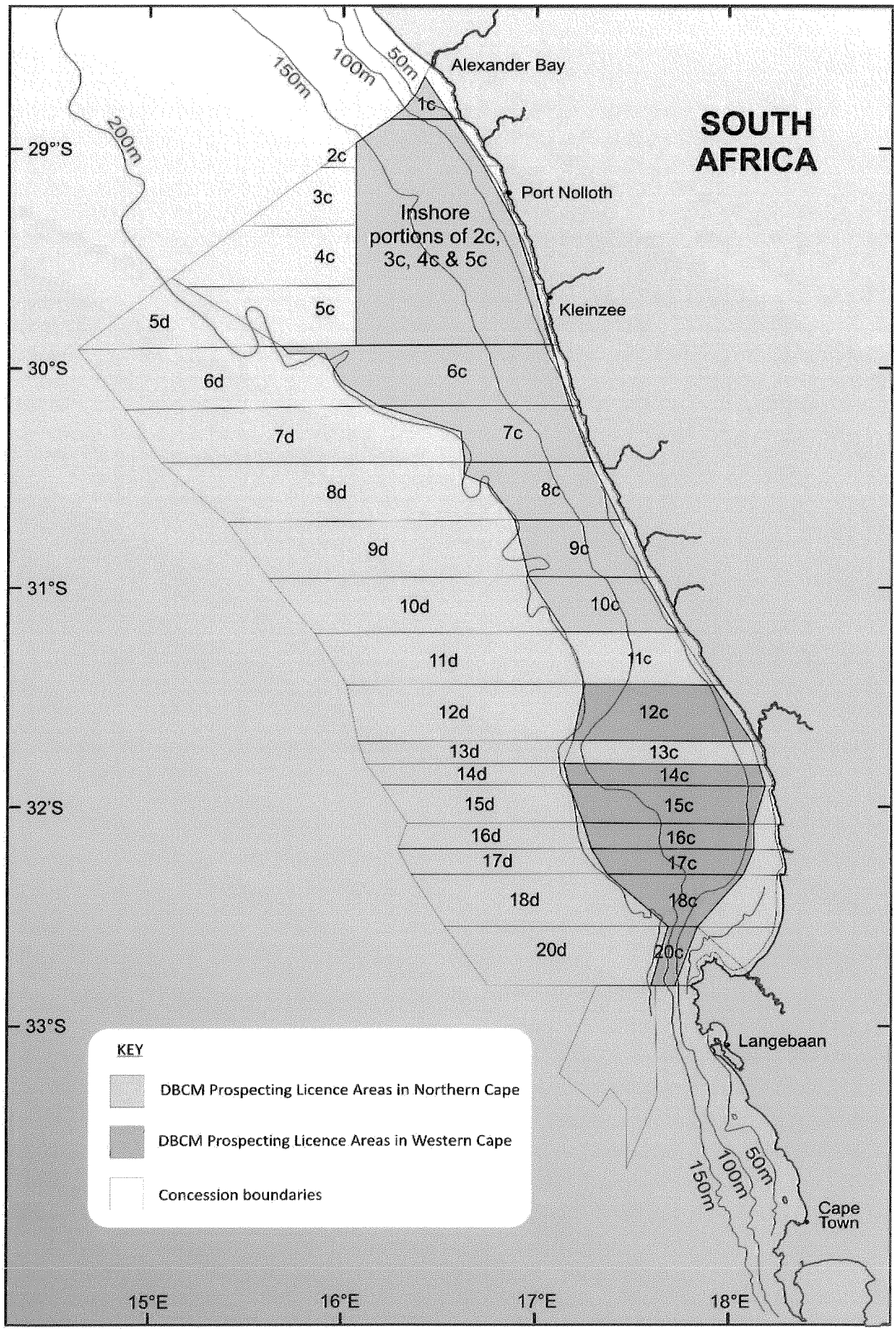

Figure 1: Location of the Prospecting Rights Areas, off the west coast of South Africa.

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List of acronyms and abbreviations

3D	Three-dimensional
AABW	Antarctic Bottom Water
AAIW	Antarctic Intermediate Water
BAR	Basic Assessment Report
CCA	CCA Environmental (Pty) Ltd
DEA	Department of Environmental Affairs
EAP	Environmental Assessment Practitioner
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
GN	Government Notice
HWC	Heritage Western Cape
I&APs	Interested & Affected Parties
IMO	International Maritime Organisation
LOSC	United Nations Convention on Law of the Sea, 1982
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973/1978
MPA	Marine Protected Area
MPRDA	Mineral and Petroleum Resources Development Act (No. 28 of 2002)
NBSA	National Biodiversity Spatial Assessment Report
NEMA	National Environmental Management Act (No. 107 of 1998)
NHRA	National Heritage Resources Act (No. 25 of 1998)
OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990
PASA	Petroleum Agency SA
SAHRA	South African Heritage Resources Agency
SAMSA	South African Maritime Safety Authority
SAN	South African Navy

1. INTRODUCTION

This chapter provides background to the proposed project, describes the purpose of this report, presents the assumptions and limitations of the study and describes the structure of the report. It also invites Interested and Affected Parties (I&APs) to submit comments on the Draft Basic Assessment Report (BAR).

1.1 BACKGROUND TO THE PROPOSED PROJECT AND BASIC ASSESSMENT PROCESS

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), a joint venture entity created by De Beers Group Exploration Holdings Limited and AngloGold Ashanti Marine Exploration Limited, has been formed to act as the operator to undertake Marine Prospecting Activities in these sea areas (refer to Figure 1.1). The proposed prospecting activities include the identification of heavy minerals, platinum group metals, gold and sapphire (gemstones).

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At the time that these EMP's were submitted to DMR, the proposed project did not trigger any listed activities in terms of the National Environmental Management Act (107 of 1998) (NEMA). However, with the amendment to the Environmental Impact Assessment (EIA) Regulations in 2010 the proposed project now triggers listed activities in terms of Government Notice (GN) R 544. Thus a Basic Assessment Process is required to be undertaken in terms of GN R 543 and Environmental Authorisation obtained from the Department of Environmental Affairs (DEA) before the project can proceed.

AuruMar has appointed CCA Environmental (Pty) Ltd (CCA) as the independent Environmental Assessment Practitioner to undertake a Basic Assessment process for the proposed Marine Prospecting Activities in accordance with the requirements of NEMA and the EIA Regulations 2010.

1.2 PURPOSE OF THIS REPORT

This Draft BAR has been compiled as part of the Basic Assessment process that is being undertaken for the proposed Marine Prospecting Activities in various sea areas off the west coast of South Africa (see Figure 1.1). This Draft BAR summarises the process followed to date and provides a description of the proposed project and affected environment. It also provides an assessment of the impacts of the proposed project. It should be noted that DEA's standard BAR template has also been completed and is presented in Appendix 1.

This report has been made available for public comment (see Section 1.4). Comments received, and responses to these comments, will be incorporated into a Final BAR that will be submitted to DEA for decision-making.

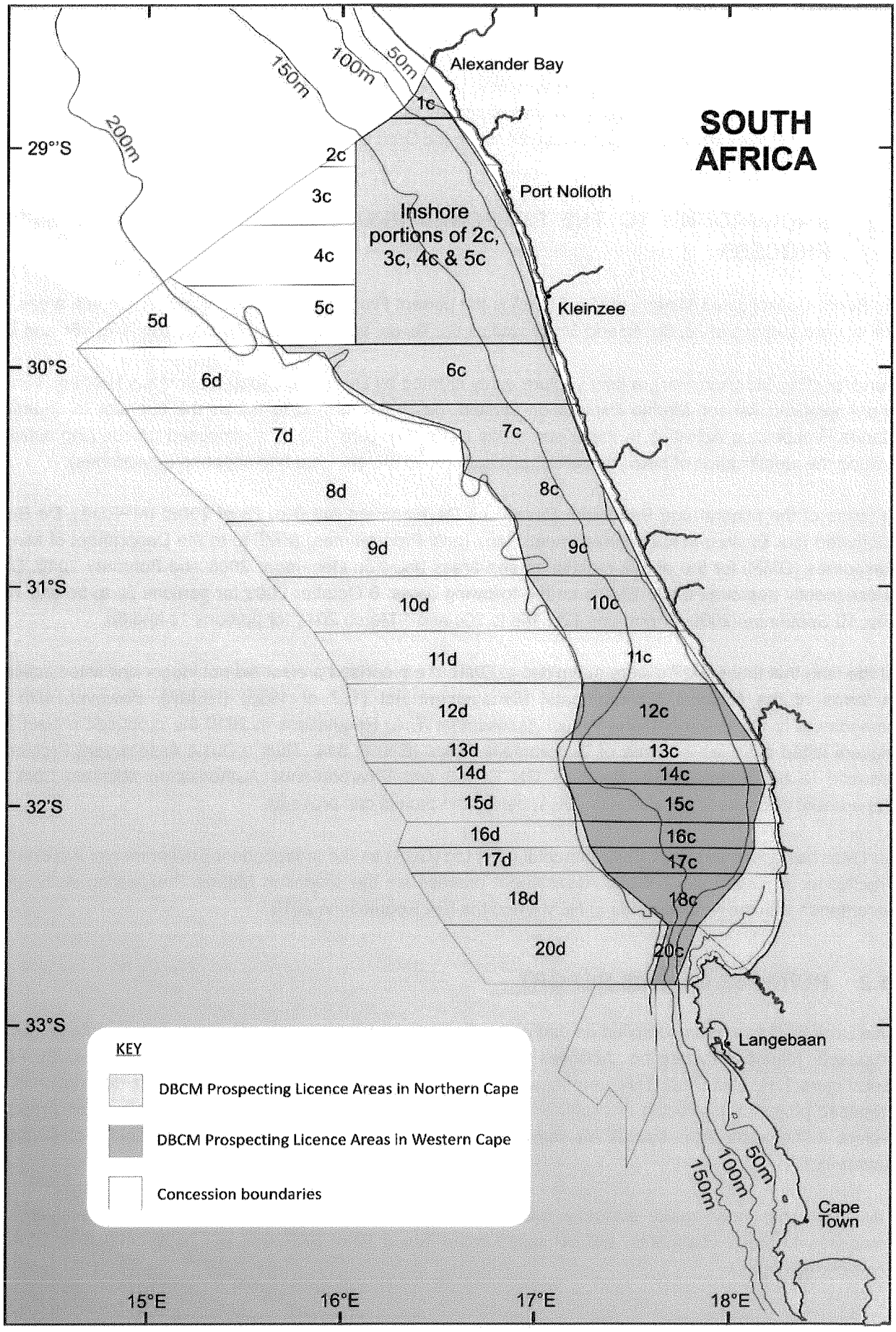

Figure 1.1: Location of the Prospecting Rights Areas, off the west coast of South Africa.

1.3 ASSUMPTIONS AND LIMITATIONS

The study assumptions and limitations are listed below:

- The study assumes that CCA has been provided with all relevant project description information by AuruMar and that it was correct and valid at the time it was provided;
- There will be no significant changes to the project description or surrounding environment between the completion of the report and implementation of the proposed project that could substantially influence findings, recommendations with respect to mitigation and management, etc;
- Certain details regarding the proposed Marine Prospecting Activities were not available at the time of report writing, e.g. the actual specific locations of the sample sites, vessels to be used, etc.); and
- The study assumes that all mitigatory measures incorporated into the project description would be implemented as proposed.

1.4 STRUCTURE OF THIS REPORT

This report consists of eight chapters and five appendices, the contents of which are outlined below.

Section	Contents
Executive Summary	Provides an overview of the main findings of the BAR.
Chapter 1	**Introduction** Provides background to the proposed project, describes the purpose of this report, presents the assumptions and limitations of the study, and describes the structure of the report. It also invites I&APs to submit comments on the Draft BAR.
Chapter 2	**Basic Assessment approach and methodology** Covers the legislative requirements of the Basic Assessment process, presents the process undertaken and presents the way forward in the Basic Assessment process.
Chapter 3	**Project description** Provides a description of the proposed Marine Prospecting Activities.
Chapter 4	**Description of the affected environment** Describes the existing biophysical and social environment that could be affected by the proposed project.
Chapter 5	**Impact description and assessment** Describes and assesses the potential impacts of the proposed project on the affected environment. It also presents mitigation or optimisation measures that could be used to reduce the significance of any negative impacts or enhance any benefits, respectively.
Chapter 6	**Conclusion and recommendations** Provides conclusions to the BAR and summarises the recommendations for the proposed project.
Chapter 7	**Environmental Management Programme for Marine Prospecting Activities** Provides an Environmental Management Programme for the proposed Marine Prospecting Activities.
Chapter 8	**References** Provides a list of the references used in compiling this report.
Appendices	Appendix 1: DEA's standard BAR template Appendix 2: DEA correspondence and I&AP letter Appendix 3: Marine Benthic Input Appendix 4: Fishing Input Appendix 5: Convention for assigning significance ratings to impacts Appendix 6: I&AP database Appendix 7: Advertisements Appendix 8: Previous Heritage Assessment

1.5 COMMENT ON THE DRAFT BAR

This Draft BAR has been distributed for a 40-day comment period from **18 April 2011 to 1 June 2011** in order to provide I&APs with an opportunity to comment on any aspect of the Basic Assessment process and the proposed project. It should be noted that I&APs have been given a total of 45 days to comment, as this period includes the five public holidays that fall within the commenting period. Copies of the full report have been made available at the following locations:

3. Offices of CCA; and
4. On the CCA website www.ccaenvironmental.co.za.

Electronic copies (disk) of the report can be requested from CCA, at the contact details provided below.

Any comments should be forwarded to CCA at the address, telephone/fax numbers or e-mail address shown below. For comments to be included in the Final BAR, comments should reach CCA **no later than Wednesday 1 June 2011**.

Tamryn Heydenrych
CCA Environmental (Pty) Ltd
Unit 35 Roeland Square, 30 Drury Lane, Cape Town, 8001
PO Box 10145, Caledon Square, 7905

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2. EIA APPROACH AND METHODOLOGY

This chapter outlines the key legislative requirements for the proposed study and outlines the methodology and I&AP consultation process followed in the study.

2.1 LEGISLATIVE REQUIREMENTS

2.1.1 NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998

Section 2 of NEMA, as amended, sets out a range of environmental principles that are to be applied by all organs of state when taking decisions that significantly affect the environment. Included amongst the key principles is that all development must be socially, economically and environmentally sustainable and that environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably. NEMA also provides for the participation of I&APs and stipulates that decisions must take into account the interests, needs and values of all I&APs.

Chapter 5 of NEMA, as amended, outlines the general objectives and implementation of Integrated Environmental Management, which provides a framework for the integration of environmental issues into the planning, design, decision-making and implementation of plans and development proposals. Section 24(4) provides the minimum requirements for procedures for the investigation, assessment and communication of the potential impact of activities.

The EIA Regulations 2010 promulgated in terms of Chapter 5 of NEMA provide for the control of certain activities that are listed in Government Notices (GNs) R544, R545 and R546 of 18 June 2010. Activities listed in these notices must comply with the regulatory requirements listed in GN R543, which prohibits such activities until written authorisation is obtained from the competent authority. Such environmental authorisation, which may be granted subject to conditions, will only be considered once there has been compliance with the EIA Regulations 2010. GN R543 sets out the procedures and documentation that need to be complied with in undertaking an EIA. In terms of GN R544, the following two activities are applicable to the proposed project (see Table 2.1).

Table 2.1: Activities listed in GN R544 triggered by the proposed project.

Activity No.	Activity description and brief description of proposed project triggering the activity
16(vi)	*Construction or earth moving activities in the sea ..., in respect of infrastructure covering 50 m^2 or more.* The two proposed sampling phases would cover more than 50 m^2 (accumulatively and never at one time) and would include the following: <u>Initial deposit assessment phase</u> During the initial deposit assessment phase, it is proposed that a minimum of 300 core samples would be obtained. <u>Resource delineation phase</u> During the resource delineation phase a maximum of 4 500 cores would be obtained. Sampling for the above two phases 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

Activity No.	Activity description and brief description of proposed project triggering the activity
	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 would then move to the next sampling location.
18(ii)	*The infilling or depositing of any material of more than 5 m^3 into, or the dredging, excavation, removal or moving soil, sand, shells, shell grit, pebbles or rock from the sea.* Initial deposit assessment phase The volume of each core sample would be approximately 0.178m^3 at each core site and therefore the total volume of seabed sediment that would be removed for 300 cores would be approximately 53 m^3 over the total prospecting area. The core samples would be collected in up to 60 target areas over the 27 600 km^2 prospecting area. Clusters of up to five cores would be collected at each target area with individual core spacing of approximately 70 m. Resource delineation phase The total volume of seabed sediment that would be removed during the sampling of the estimated 4 500 cores would be approximately 799 m^3 over the total prospecting area. The cores would be collected at a core spacing of 50 m to 200 m apart. There would be no infilling or depositing of material during either of the two sampling phases.

2.1.2 MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002

In terms of the MPRDA a Prospecting Right must be granted by DMR prior to the commencement of any sampling activities. A requirement of obtaining a Prospecting Right is that an EMP must be compiled in terms of Section 39 of the MPRDA and submitted to DMR for approval.

As noted earlier, in terms of the MPRDA, DMR has granted Prospecting Rights to De Beers for the Marine Prospecting Activities in the applied sea areas.

2.1.3 OTHER RELEVANT LEGISLATION

In addition to the foregoing, AuruMar must also comply with the provisions of other relevant international and national legislation and conventions, which includes, amongst others, the following:

International Marine Pollution Conventions

- International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL);
- Amendment of the International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL) (Bulletin 567 – 2/08);
- International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (OPRC Convention);
- United Nations Convention on Law of the Sea, 1982 (LOSC);
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (the London Convention) and the 1996 Protocol (the Protocol);

Other South African legislation

- Carriage of Goods by Sea Act, 1986 (No. 1 of 1986);
- Dumping at Sea Control Act, 1980(No. 73 of 1980);
- Hazardous Substances Act, 1983 and Regulations (No. 85 of 1983);
- Marine Living Resources Act, 1998 (No. 18 of 1998);
- Marine Traffic Act, 1981 (No. 2 of 1981);

- Marine Pollution (Control and Civil Liability) Act, 1981 (No. 6 of 1981);
- Marine Pollution (Prevention of Pollution from Ships) Act, 1986 (No. 2 of 1986);
- Marine Pollution (Intervention) Act, 1987 (No. 65 of 1987);
- Maritime Safety Authority Act, 1998 (No. 5 of 1998);
- Maritime Safety Authority Levies Act, 1998 (No. 6 of 1998);
- Maritime Zones Act 1994 (No. 15 of 1994);
- Merchant Shipping Act, 1951 (No. 57 of 1951);
- National Environmental Management: Air Quality Act, 2004 (No. 39 of 2004);
- National Environmental Management: Integrated Coastal Management Act, 2008 (No. 24 of 2008);
- National Heritage Resources Act, 1999 (No. 25 of 1999);
- Occupational Health and Safety Act, 1993 (No. 85 of 1993);
- Sea-Shore Act, 1935 (No. 21 of 1935);
- Sea Birds and Seals Protection Act, 1973 (No. 46 of 1973);
- Ship Registration Act, 1998 (No. 58 of 1998);
- Water Act, 1998 (No. 36 of 1998); and
- Wreck and Salvage Act, 1995 (No. 94 of 1995).

2.2 BASIC ASSESSMENT PROCESS

The Basic Assessment has the following important objectives:

- To provide a reasonable opportunity for I&APs to be involved in the study;
- To ensure that all potential key environmental issues and impacts that would result from the proposed project are identified;
- To assess potential impacts of the proposed project alternatives during the different phases of project development;
- To present appropriate mitigation or optimisation measures to minimise potential impacts or enhance potential benefits, respectively; and
- Through the above, to ensure informed, transparent and accountable decision-making by the relevant authorities.

The Basic Assessment process consists of a series of steps to ensure that the objectives are achieved and that it complies with the EIA Regulations 2010 as set out in GN R543. A flowchart indicating the Basic Assessment process is presented in Figure 2.1. The process involves an open, participatory approach to the study and full involvement of I&APs to ensure that all impacts are identified and that planning and decision-making takes place in an informed, transparent and accountable manner.

2.2.1 PROCESS UNDERTAKEN TO DATE

The Basic Assessment process undertaken to date is summarised below.

- An Application Form and Declaration of Interest were submitted to DEA on 31 March 2011 (see Appendix 2).
- Specialist input was provided on the likely impact on the benthic environment and fishing industry by the proposed prospecting activities (see Appendix 3 and 4, respectively). Impacts were assessed according to pre-defined rating scales (see Appendices 5).
- 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).

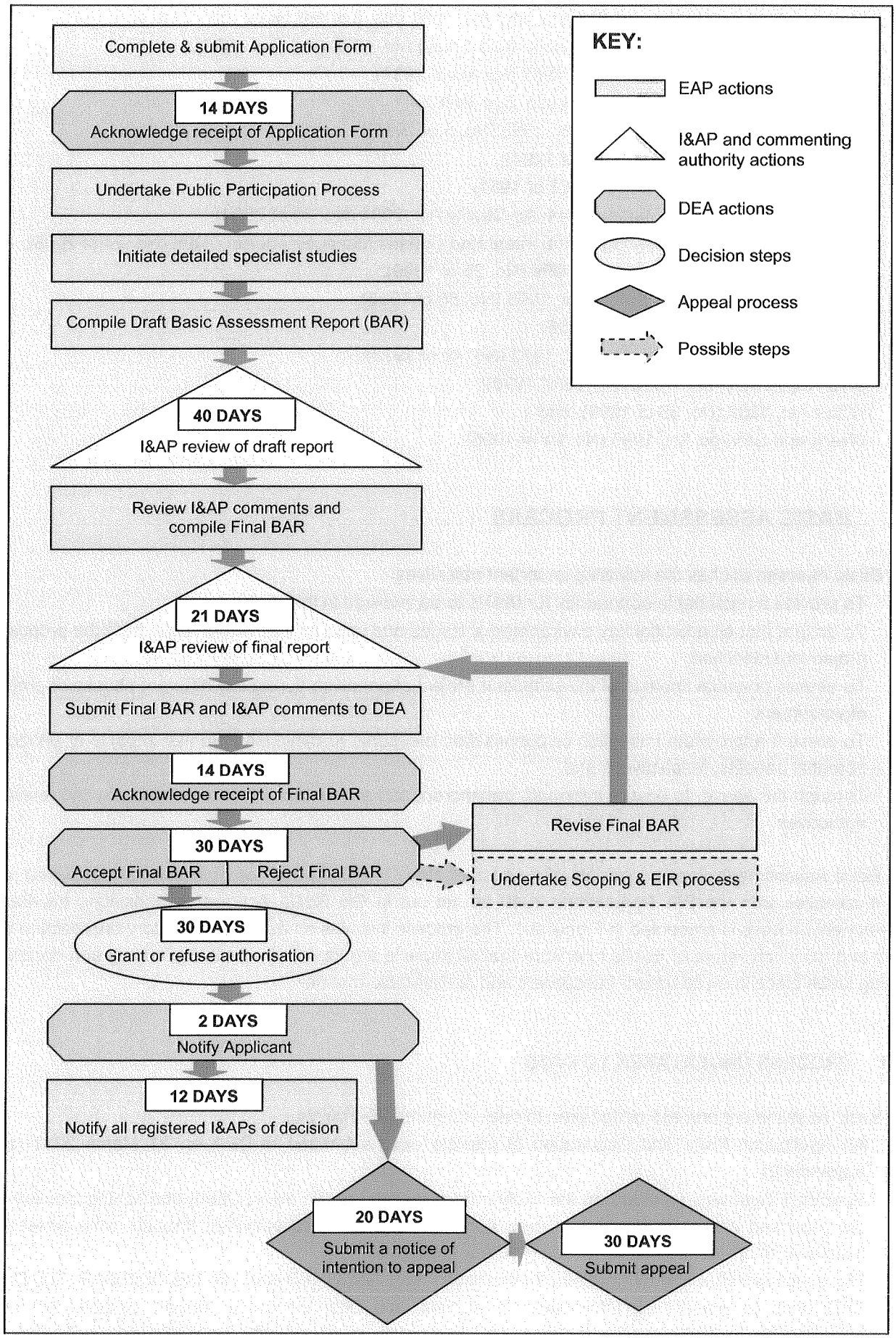

Figure 2.1: Basic Assessment process.

- 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 6).

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 7); 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.

2.2.2 WAY FORWARD IN THE BASIC ASSESSMENT PROCESS

The following steps will be undertaken in the remainder of the Basic Assessment process (see Figure 2.1):

- After closure of the comment period, the Draft BAR will be updated into a Final BAR. Comments received on the Draft BAR will be incorporated into a Comments and Responses Report that will be appended to the Final BAR;
- The Final BAR will be released for a further 21-day comment period. All I&APs on the project database will be notified of the availability of the Final BAR for comment;
- The Final BAR and any comments received from I&APs on the Final BAR, will be submitted to DEA for consideration and decision-making.
- After DEA has reached a decision, all I&APs on the project database will be notified of the outcome of the application and the reasons for the decision; and
- A statutory appeal period in terms of Chapter 7 of the EIA Regulations 2010 will follow the issuing of the decision.

3. PROPOSED PROJECT DESCRIPTION

This chapter provides general information on the proposed project, the need and desirability of the proposed project, description of alternatives, and information on the proposed sampling activities.

3.1 GENERAL INFORMATION

3.1.1 PROSPECTING RIGHT APPLICANT

De Beers is the applicant for the Marine Prospecting Activities; however, AuruMar would be the operator representing the applicant for the proposed project.

Address: **De Beers Consolidated Mines Ltd**
PO Box 616,
KIMBERLEY
8300

Operator: **AuruMar (Pty) Ltd**
Project Manager: Mr Neil Fraser, Venture Manager, AuruMar (Pty) Ltd
Telephone: +27 (0)21 658 3213
Facsimile: +27 (0)21 658 3354
Cell: +27 (0)83 388 8788
E-mail: neil.fraser@aurumar.co.za

3.1.2 PROSPECTING SEA AREA DETAILS

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). The proposed prospecting activities include the sourcing of heavy minerals, platinum group metals, gold and sapphire (gemstones). 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 Table 3.1 and refer to Figure 3.1.

Table 3.1: Coordinates of the Proposed Prospecting Area Boundary

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

3.1.3 PROPOSED WORK PROGRAMME

AuruMar's proposed timeframes to complete the prospecting work is provided in Table 3.2.

Table 3.2: Proposed work programme.

Activity	Timeframe
Initial Deposit Assessment Programme	4th Quarter 2011
Evaluation of results	1st Half 2012
Detailed geophysical survey	Mid 2012
Resource Delineation Programme	4th Quarter 2012 – Nov 2013

Due to the dynamic nature of prospecting and evaluation the work programme may have to be modified, extended or curtailed as results and data become available.

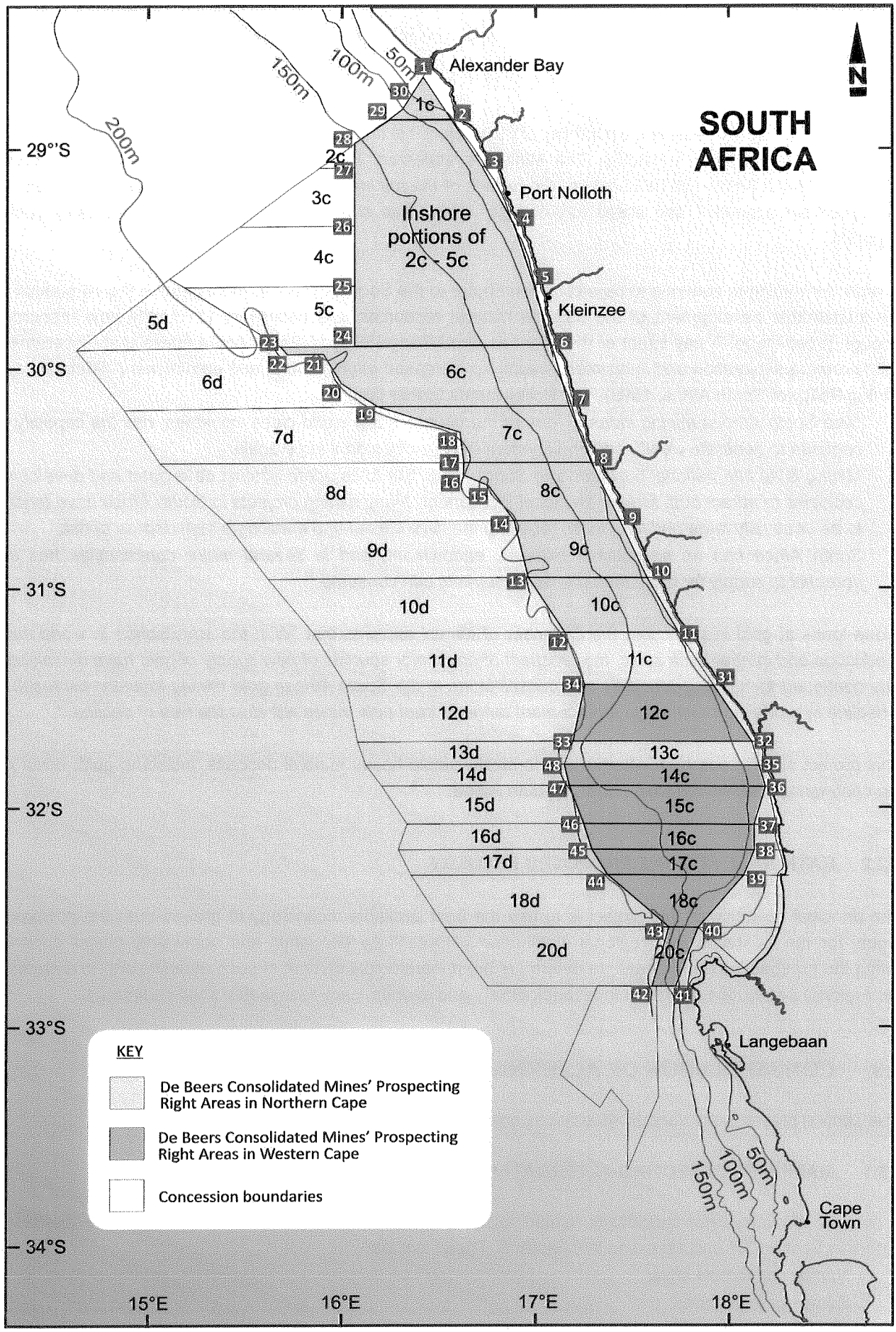

Figure 3.1: **Map showing location of the prospecting area, as well as the position of coordinates, as per table 3.1**

3.2 NEED AND DESIRABILITY OF THE PROPOSED PROJECT

3.2.1 BACKGROUND

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.

3.2.2 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.

3.3 CONSIDERATION OF ALTERNATIVES

This section presents the various alternatives considered in this Basic Assessment.

3.3.1 MARINE PROSPECTING ALTERNATIVES

A number of alternatives specifically related to the proposed Marine Prospecting Activities are discussed further in Section 3.4 and assessed in Chapter 5. These include:

- Number of sample sites;
- Sampling techniques;
- Choice of survey tools; and
- Choice of sampling platform.

3.3.2 THE NO-GO ALTERNATIVE

The No-Go alternative is the non-occurrence of the proposed project. The negative implications of not going ahead with the proposed project are as follows:

- Loss of opportunity to establish whether 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.

3.4 MARINE PROSPECTING OVERVIEW

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.

3.4.1 EXPLORATION SAMPLING

The proposed prospecting activities would utilise AuruMar's Sonic VibroCorer (SVC) in order to collect the required samples (see Figure 3.2). 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.

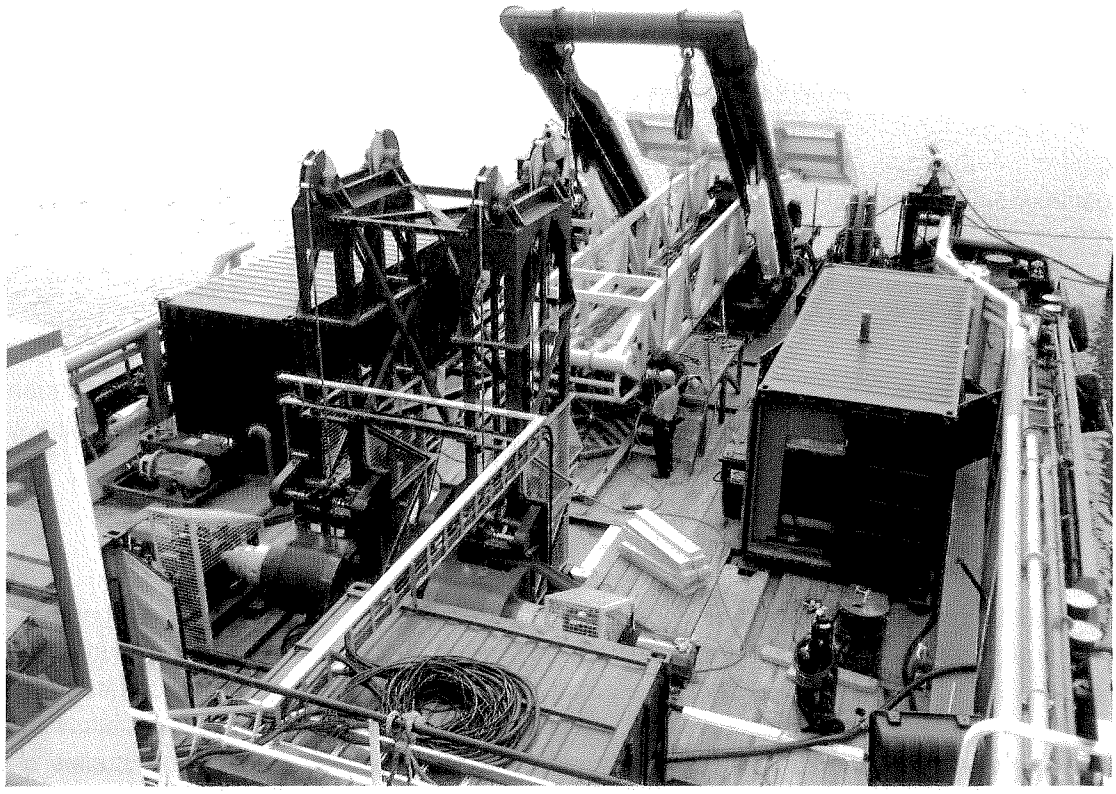

Figure 3.2: AuruMar's Sonic VibroCorer on a vessel.

3.4.2 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 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 (see Table 3.3).

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

Table 3.3: 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	1.8×10^{-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			

3.4.3 PHASE II - RESOURCE DELINEATION PROGRAMME

Phase II is split into a detailed geophysical survey as well as further exploration sampling activities (as described in Section 3.4.3.2)

3.4.3.1 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 (see Figure 3.3) 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) (see Figure 3.4) could be used to survey in areas where the survey line spacing is less than 50 m apart. The survey tools are deployed from a vessel of opportunity contracted for the period of the survey programme (see Figure 3.5). Table 3.4 lists the survey equipment (and its source level noise) that is likely to be used for the geophysical survey.

Table 3.4: 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

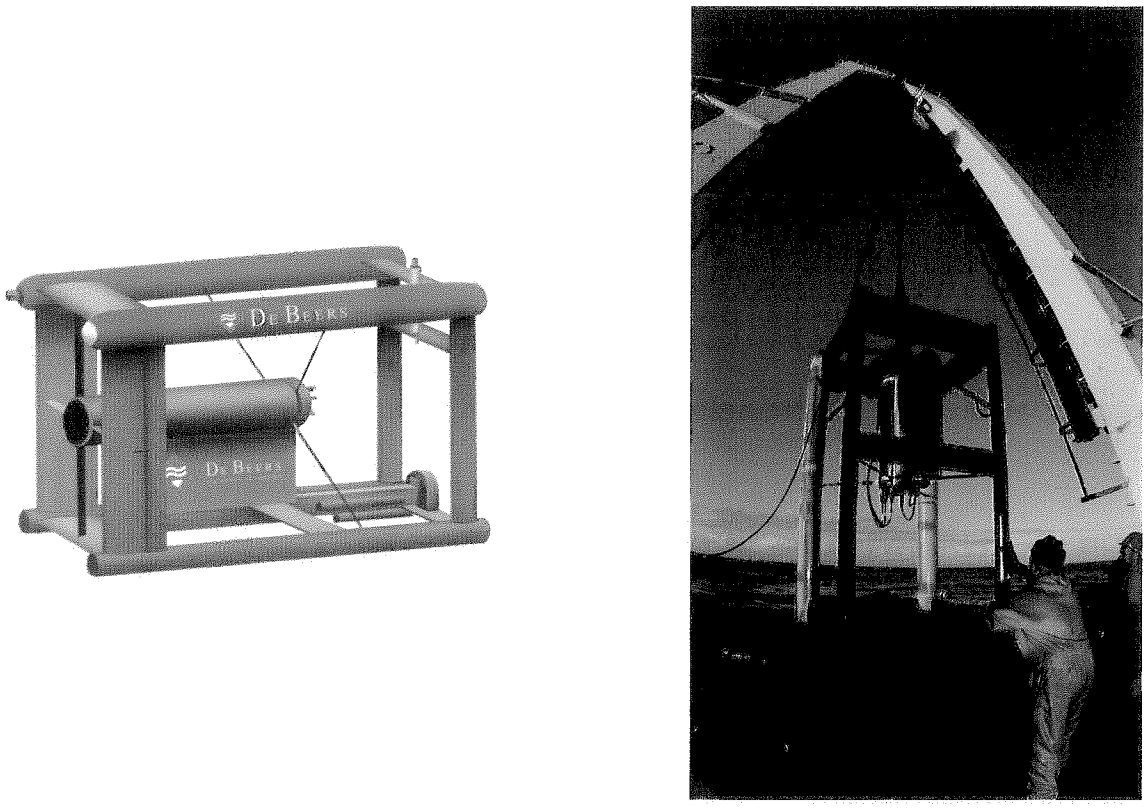

Figure 3.3: Focus Towfish could be used to collect both side scan sonar and Chirp seismic data.

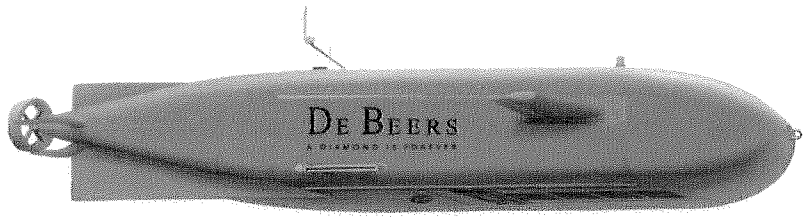

Figure 3.4: An Autonomous Underwater Vehicle (AUV).

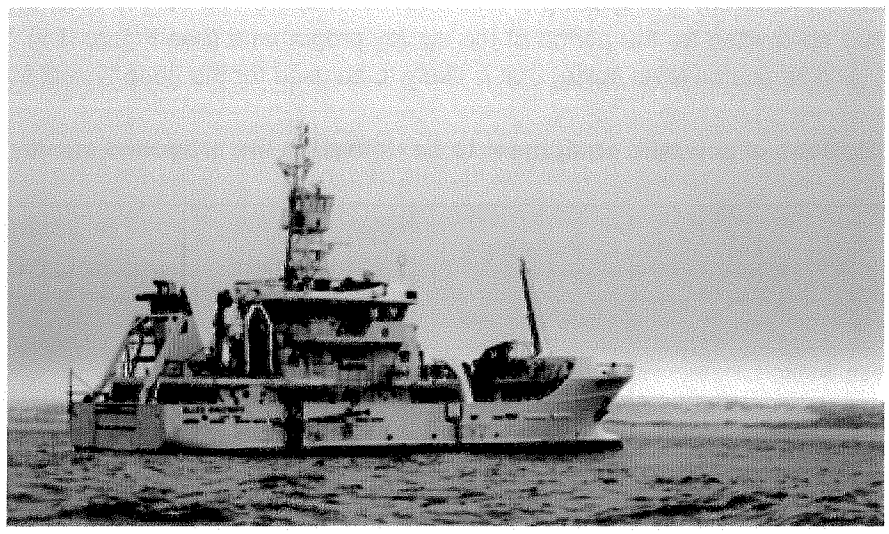

Figure 3.5: Photograph of mv Ellen Khuzwayo, a typical vessel of opportunity used as a platform for geophysical survey activities.

3.4.3.2 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 I (see Section 3.4.1 above). 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 3.5).

Table 3.5: 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.			

3.4.4 VESSELS

It is proposed that a vessel of opportunity would be used for the sampling activities (see Figures 3.6).

Figure 3.6: An example of the type of vessel that could be used for the proposed sampling activities.

3.4.5 ONSHORE CORE AND DATA PROCESSING

Cores would be dispatched onshore from the vessel on a monthly basis. A dedicated processing facility would be established in Cape Town for the initial preparation and selection of the samples. The 10 m cores

would be logged in detail and subdivided into 0.5 m sequential samples. Individual samples would be screened to separate out the coarse (>5 mm) fraction. The remaining fine fraction (<5 mm) would be dried crushed to 2 mm and subdivided for further mineral analysis and assay. Mineral analysis and assay would be conducted by an accredited laboratory, either by fire assay or bottle roll leach extraction.

3.5 EMISSIONS AND DISCHARGES

This section provides a brief description of the types of emissions and discharges that are expected from the activities relating to the sampling activities. These would include:

- Discharges such as deck drainage, machinery space wastewater, sewage, etc; and
- Disposal of solid waste such as foodwaste.

These are discussed in more detail below.

3.5.1 DISCHARGES TO SEA

3.5.1.1 Vessel machinery spaces (bilges), ballast water and deck drainage

The concentration of oil in discharge water from any vessel (bilge and ballast) would comply with the MARPOL Regulation 21 standard of less than 15 ppm oil in water. Any oily water would be processed through a suitable separation and treatment system to meet the MARPOL standard before discharge overboard. Drainage from marine (weather) deck spaces would wash directly overboard.

3.5.1.2 Sewage

Although 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.

3.5.1.3 Food (galley) wastes

The disposal into the sea of food waste is permitted in terms of MARPOL when it has been comminuted or ground and the vessel is located more than 3 nautical miles (approximately 5.5 km) from land. Such comminuted or ground food wastes shall be capable of passing through a screen with openings no greater than 25 mm. Disposal overboard without macerating can occur greater than 12 nautical miles (approximately 22 km) from the coast. The daily discharge from a sampling vessel is typically about 0.15 m^3.

3.5.1.4 Detergents

Detergents used for washing exposed marine deck spaces would be discharged overboard. The toxicity of detergents varies greatly depending on their composition. Water-based detergents are low in toxicity and are preferred for use. Preferentially biodegradable detergents would be used. Detergents used on work deck space would be collected with the deck drainage and treated as described under deck drainage (see Section 3.5.2.4 above).

3.5.1.5 Other

The sampling vessel would have a certified antifouling coating system that is tin free.

3.5.2 LAND DISPOSAL

A number of other types of wastes generated during the sampling activities would not be discharged at sea but would be transported onshore for ultimate disposal. Waste transported to land would be disposed at a licensed municipal landfill facility or at an alternative approved site. Operators would co-operate with local authorities to ensure that waste disposal is carried out in an environmentally acceptable manner.

A summary of these waste types generated by a vessel used during a typical sampling operation, their expected amounts, environmental properties, and destination is given below. Typical volumes are presented in Table 3.5 (note: these quantities should be viewed as rough estimates based on experience).

Garbage generated on board would be sorted and stored in separate bins e.g. plastic, paper, metals, food stuffs and glass.

Table 3.6: 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

3.5.2.1 Garbage

This includes wastes originating from vessel and sampling operations, including waste paper, plastics, wood, metal, glass, etc. All waste would be disposed of at an onshore landfill site in accordance with legal requirements.

3.5.2.2 Scrap metal

Scrap metal would be stored and recycled / disposed of on land in accordance with legal requirements.

3.5.2.3 Drums and containers

Empty drums containing residues, which may have adverse environmental effects (solvents, lubricating/gear oil, etc.), would be recycled / disposed of in a local landfill site in accordance with legal requirements.

3.5.2.4 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.

3.5.2.5 Chemicals and hazardous wastes

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.

3.5.2.6 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. All such waste will be stored and brought onshore for disposal via a registered medical waste company.

3.5.2.7 Filters and filter media

This includes air, oil and water filters from machinery. Oily residue and used media in oil filters that may contain metal (e.g. copper) fragments, etc. are possibly toxic. Filters and media would be transported onshore and disposed of at a licensed landfill facility.

3.5.3 DISCHARGES TO AIR

3.5.3.1 Vessel machinery

All vessel engines would comply with the requirements for the prevention of pollution by smoke, as dictated by Marpol (Marpol Annex VI).

4. THE AFFECTED ENVIRONMENT

This chapter provides a description of the biophysical and socio-economic environment likely to be affected by the proposed prospecting activities in the study area. The information provided here is based on previous information compiled for the area (CCA Environmental 2005; CCA Environmental 2007a; CCA Environmental 2007b; and De Beers Marine 2008) and the specialist benthic study undertaken as part of this study. This chapter has been divided into two sections, *viz.* marine environment (offshore) and nearshore region and shoreline environment.

4.1 MARINE ENVIRONMENT (OFFSHORE)

This section provides a general overview of the physical and biological oceanography and human utilisation of South African West Coast and, where applicable, detailed descriptions of the marine environment that may be directly affected by the proposed prospecting activities.

The study area lies within the southern zone of the Benguela Current region and is characterised by the cool Benguela upwelling system (Shillington 1998; Shannon 1985). A conceptual model of the Benguela system is shown in Figure 4.1.

4.1.1 METEOROLOGY

The meteorological processes of the South African West Coast have been described by numerous authors, including 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, Macarthur and Reason 1990).

A second important wind type that occurs along the West Coast are katabatic '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.

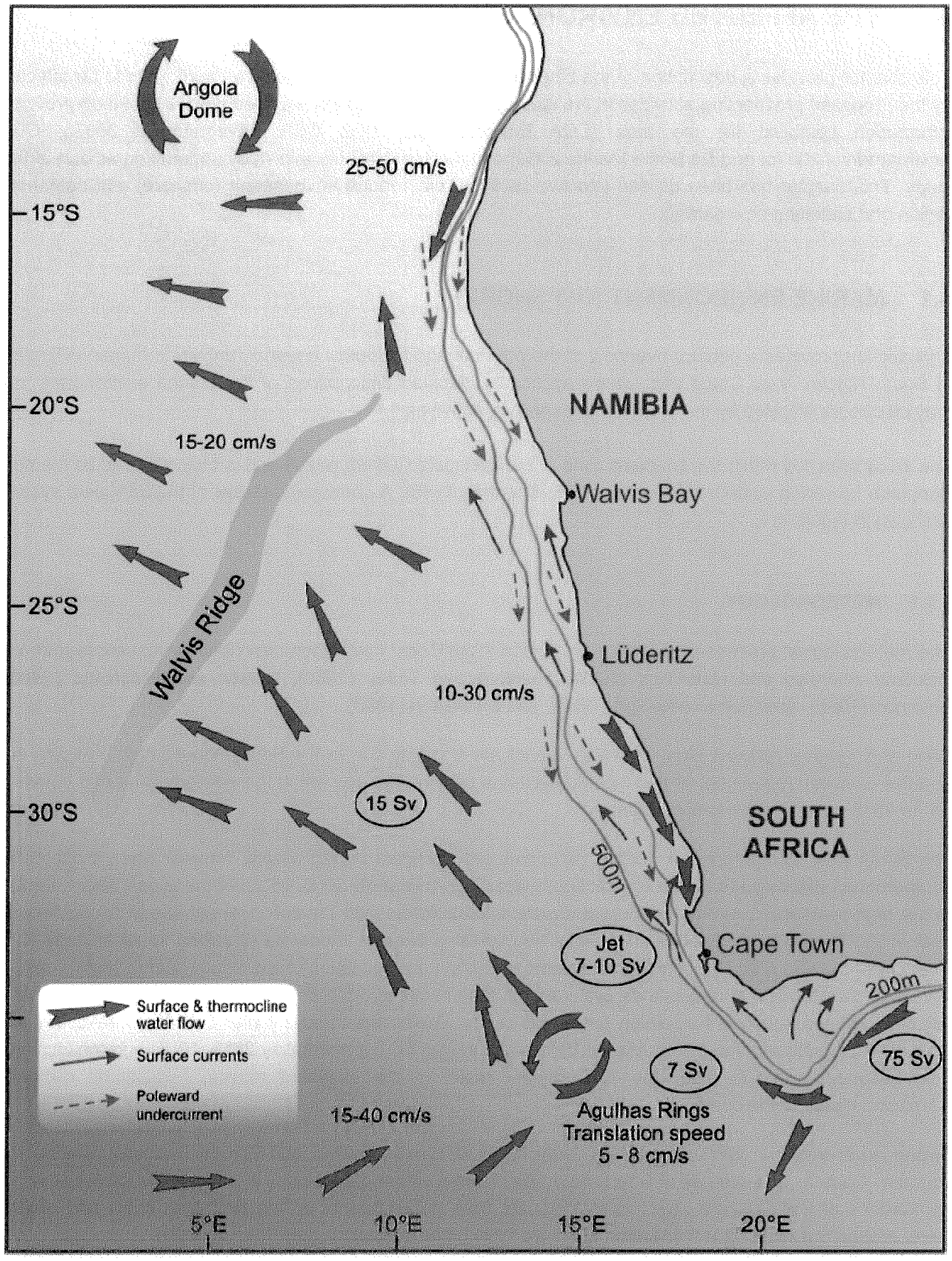

Figure 4.1: Circulation and volume flows of the Benguela current (after Shannon & Nelson, 1996).

4.1.2 PHYSICAL OCEANOGRAPHY

4.1.2.1 Waves

The direction and size of waves present at different sites along the West Coast have been reported by Heydorn and Tinley (1980), Bickerton (1981a and b, 1982) and Morant (1984).

Wave patterns along the West Coast are strongly influenced by the seasonal meteorology. The majority of swells are generated by mid-latitude cyclones to the south of the country, and thus originate from the SW.

Wave period is similar and unimodal along the West Coast to the north of Cape Point. Peak energy periods range from 9.7 to 15.5 seconds and reach the coast from the west-south-west (WSW) to south-south-west (SSW) in the south (indicating that large swells originate from mid-latitude cyclones).

Wave height decreases with both distance north along the West Coast and with distance offshore. There is little seasonal variation in the wave regime along the West Coast, although a slight increase in swells from the WSW-west direction occurs in winter. The largest waves (6 to 8 m) originate from the SSW sector. Large wave events usually last for 2 to 4 days, although they may last for as long as a week.

4.1.2.2 Tides

Tides along the West Coast are subject to a simple semi-diurnal tidal regime 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.

4.1.2.3 Topography

The bathymetry and topography of the West Coast offshore region has 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 both wide and deep, although large variations in both depth and width occur (Figure 4.2). 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 immediate nearshore area consists mainly of a narrow (to about 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 lacks relief and slope gently seawards reaching the shelf break (where the slope becomes significantly steeper) at a depth of approximately 500 m. Banks on the continental shelf include the Orange Bank (Shelf or Cone), a shallow (160 to 190 m) zone that reaches maximal widths (180 km) offshore of the Orange River, and Childs Bank, situated about 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 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 (closest to shore) and outer slopes separated by a gently sloping ledge.

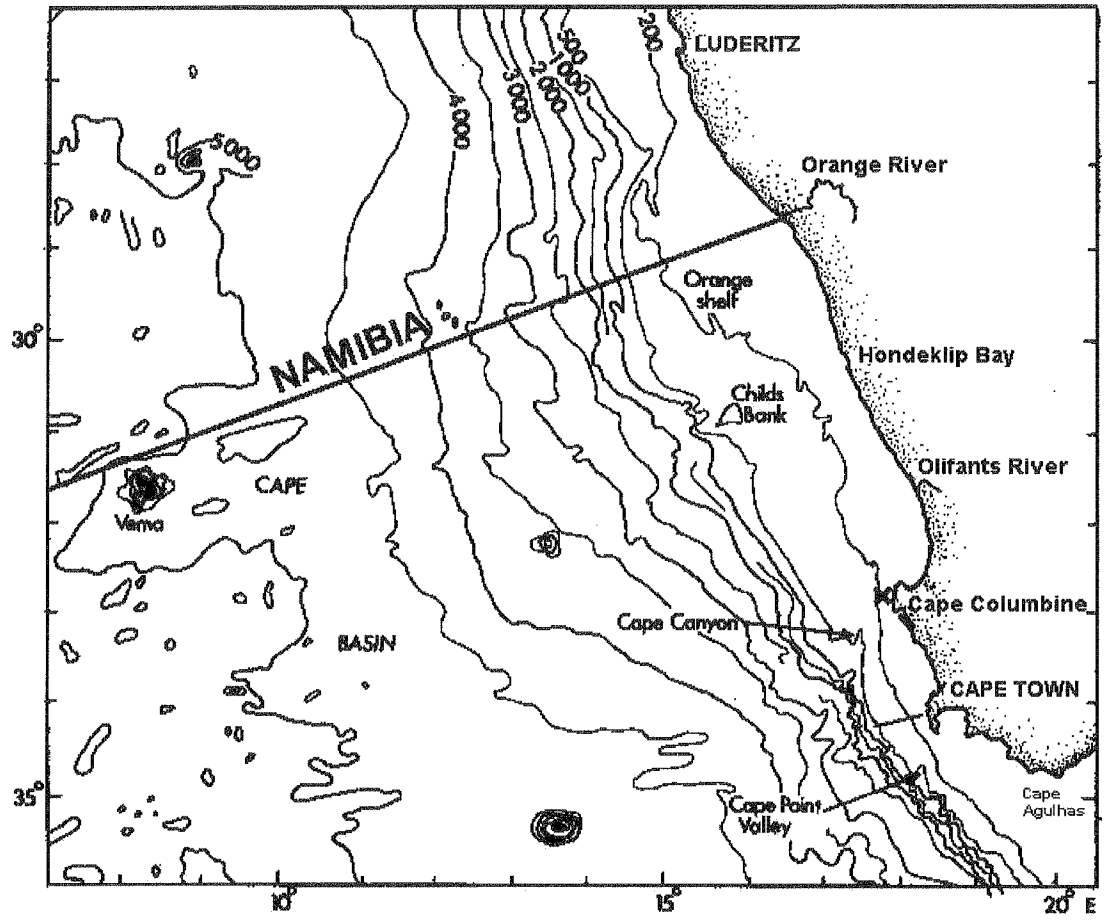

Figure 4.2: Bathymetry of the continental shelf off the West Coast of southern Africa (after Dingle *et al.* 1987).

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

4.1.2.4 Sediments

Figure 4.3 summarises 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, Rogers, Bremner and Moir 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.

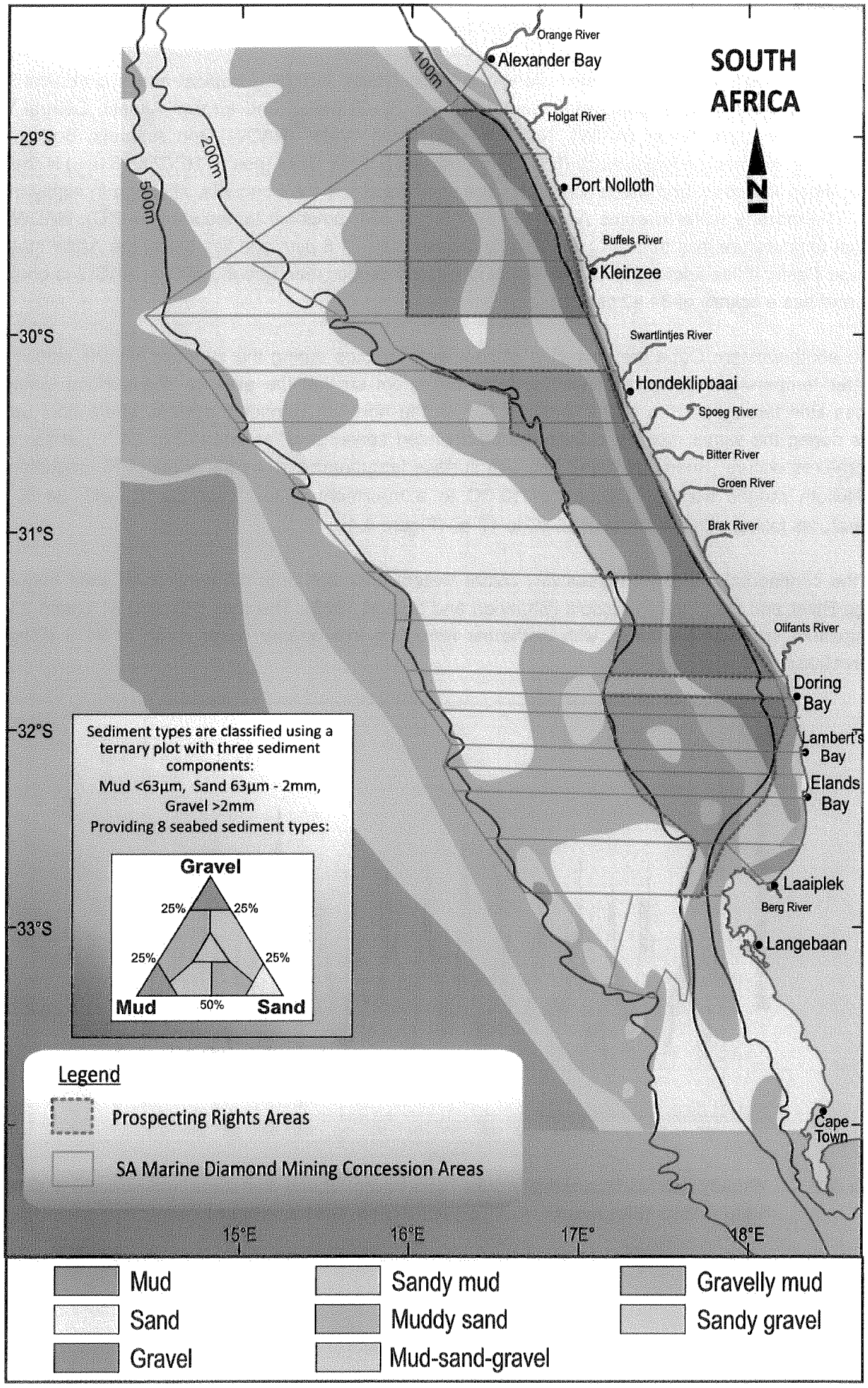

Figure 4.3: Map of the distribution of seabed surface sediment types off the South African west coast (from Lane & Carter 1999).

4.1.2.5 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) is that which upwells along the coast and which 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 less than 3°C and salinity greater than 34.8 psu, and lies below the AAIW stratum. In the Cape Basin, it lies above the AABW, which is located deeper than about 3 800 m. 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 (Figure 4.4).

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).

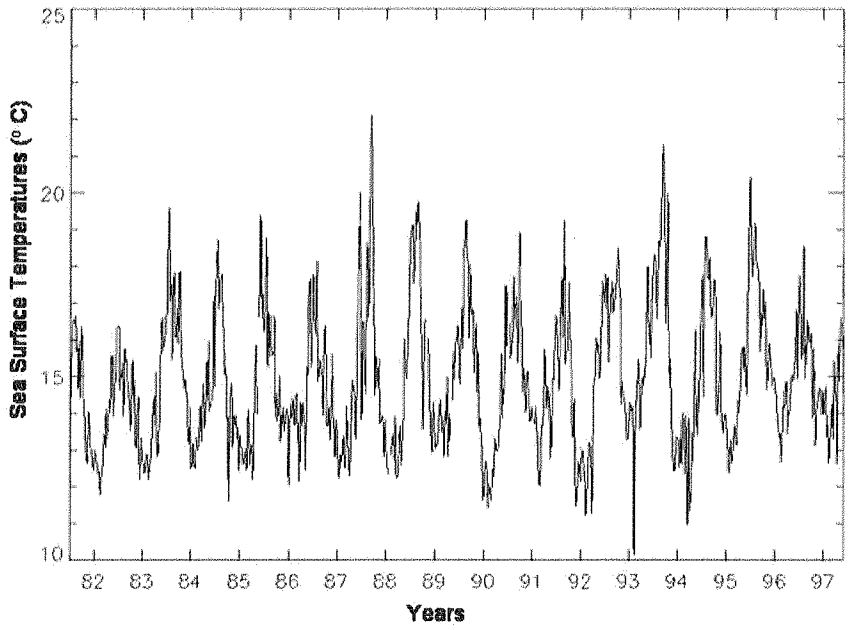

Figure 4.4: Weekly sea surface temperature recordings for the Namaqualand coastal waters, from 1980 – 1998 (Figure after Enviro-Fish Africa, Grahamstown).

4.1.2.6 Water Circulation

Water circulation off the West Coast is dominated by upwelling (see Section 4.1.2.7).

The ocean currents occurring off the Namaqualand coast are complex. Data suggests that currents north of Cape Columbine are weaker and more variable than the currents to the south (Boyd *et al.* 1992). The most

important is the Benguela current, which constitutes a broad, shallow and slow NW flow along the West Coast between the cool coastal upwelled waters and warmer Central Atlantic surface waters further offshore. The current is driven by the moderate to strong S to SE winds which are characteristic of the region and is most prevalent at the surface, although it does follow the major seafloor topographic features (Nelson and Hutchings 1983). The average current speed is reported to be 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).

A southward flow of surface water occurs close inshore during periods of barotropic reversals and during winter when upwelling is not taking place. Agulhas Current water does occasionally enter the south-east Atlantic in summer as warm water filaments (<50 m deep) or eddies (several 100 m wide and deep). These warm water tongues are usually at least 180 km offshore and seldom move further north than 33°S and do not appear to impact the Benguela shelf region.

4.1.2.7 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 (Figure 4.5). The principle upwelling centre on the West Coast lies off Lüderitz and the Lüderitz 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).

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. Upwelling off the Cape Peninsula is among the most marked in the world with upwelling rates estimated to average 21 m/day (maximum of 32 m/day). A well-defined front exists over the shelf break off the Cape Peninsula, outside of which is a well developed equatorward jet reaching speeds of 60 $cm.sec^{-1}$ on the surface and 120 $cm.sec^{-1}$ at 150 m (Andrews and Hutchings 1980).

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).

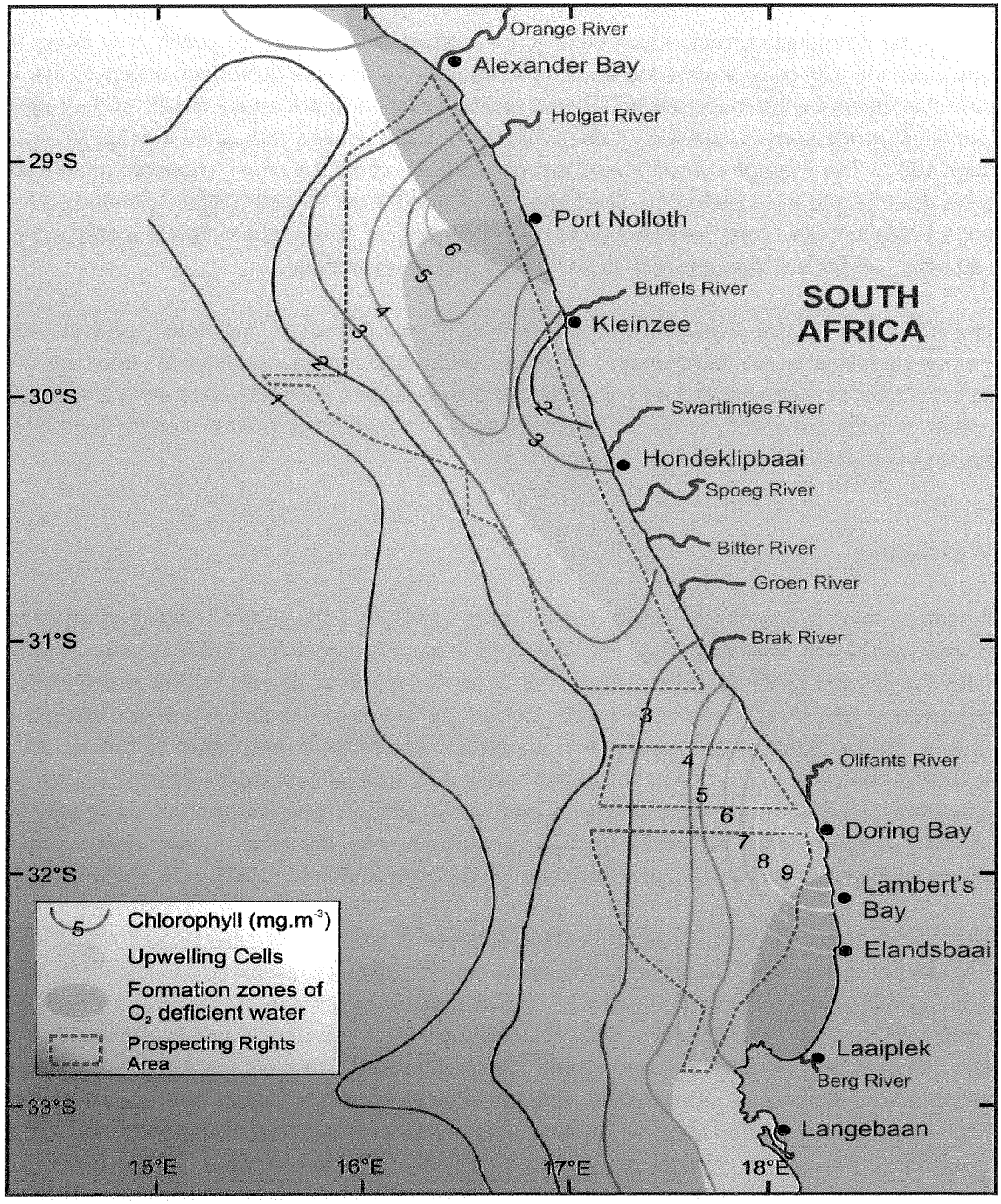

Figure 4.5: **Map of the main upwelling areas, contours of resultant mean phytoplankton production (measured as mg.m^{-3} of chlorophyll-a and areas of subsequent natural formation of low oxygen water off the South African west coast (modified from Brown *et al.* 1991) (Pulfrich, 2011).**

4.1.2.8 Nutrient distribution

Above thermoclines (that develop as water movement stabilises) phytoplankton production consumes nutrients, thus depleting the nutrients in the surface layer. Below the thermocline, nutrient re-enrichment occurs as biological decay occurs. As upwelled water is nutrient enriched compared to surface water, nutrient distribution on the West Coast are closely linked to upwelling (Chapman and Shannon 1985). Highest nutrient concentrations are thus located at the upwelling sites (Andrews and Hutchings 1980), offshore of which it decreases (Chapman and Shannon 1985).

Phosphate levels are low at the surface and offshore, but high (up to 3.0 μM) in bottom waters of the shelf and in newly upwelled waters. Upwelled waters can at times be enriched in phosphate as they pass over phosphorus rich shelf sediments. Phosphate is unlikely to ever become a limiting nutrient in the Benguela region.

Nitrate normally occurs in greater concentrations at the bottom than in upwelling source water, and decreases in availability at the surface (to less than 1 μM). Nitrate appears to be the limiting nutrient in the Benguela region.

Silicate levels range between 5-15 μM within the Benguela system, although these may at times be enhanced considerably over the shelf. It is not likely to be limiting in the southern Benguela.

4.1.2.9 Oxygen concentration

The Benguela system is characterised by large areas of very low oxygen concentrations, including three centres of oxygen-depleted shelf water; one of which is well north of the region (2°S to 24°S), another to the north of the Namaqualand upwelling cell and the third in St Helena Bay (Chapman and Shannon 1985).

Generally, oxygen concentrations appear to increase from the Orange River region southward. Surface oxygen levels are higher than bottom waters (water is regularly supersaturated) due to phytoplankton production, especially during less intense upwelling.

Oxygen depleted water has at times upwelled along the West Coast, resulting in rock lobster strandings.

4.1.2.10 Turbidity

Natural turbidity and/or suspended sediment concentration measurements from the West Coast are sparse. Suspended sediment distributions within South African nearshore waters range between 5 $mg.l^{-1}$ – 5 $g.l^{-1}$. The higher values are associated with high wave conditions resulting from storms and/or floodwaters (Bremner, Rogers and Willis 1990).

4.1.3 BIOLOGICAL OCEANOGRAPHY

4.1.3.1 Plankton

Plankton comprises three components:

(a) Phytoplankton

Features of phytoplankton distribution in the Benguela system are summarised in Figure 4.6.

There is considerable variation in phytoplankton abundance off the West Coast (Pitcher *et al.* 1992), in terms of both the longshore and offshore scales (productivity levels between Cape Point and the Orange River mouth range from 0.3 to 11 $gC.m^{-2}.day^{-1}$).

Mean chlorophyll concentrations measured in the surface 30 m of the water column in each of inshore and offshore areas off the West Coast to the north of Cape Columbine are shown in Table 4.1. A well-defined thermal front separates high biomass of phytoplankton in coastal waters from the lower biomass found in more oceanic waters offshore.

Phytoplankton cells are greatest during upwelling. However, as phytoplankton production is related to nutrient supply, seeding and water column stability, production at the upwelling site *per se* is low (chlorophyll a levels range from 0.4 to 0.9 $mg.m^{-3}$), but increases offshore and 'downstream' (northward) from upwelling sites, where the water column is more stable.

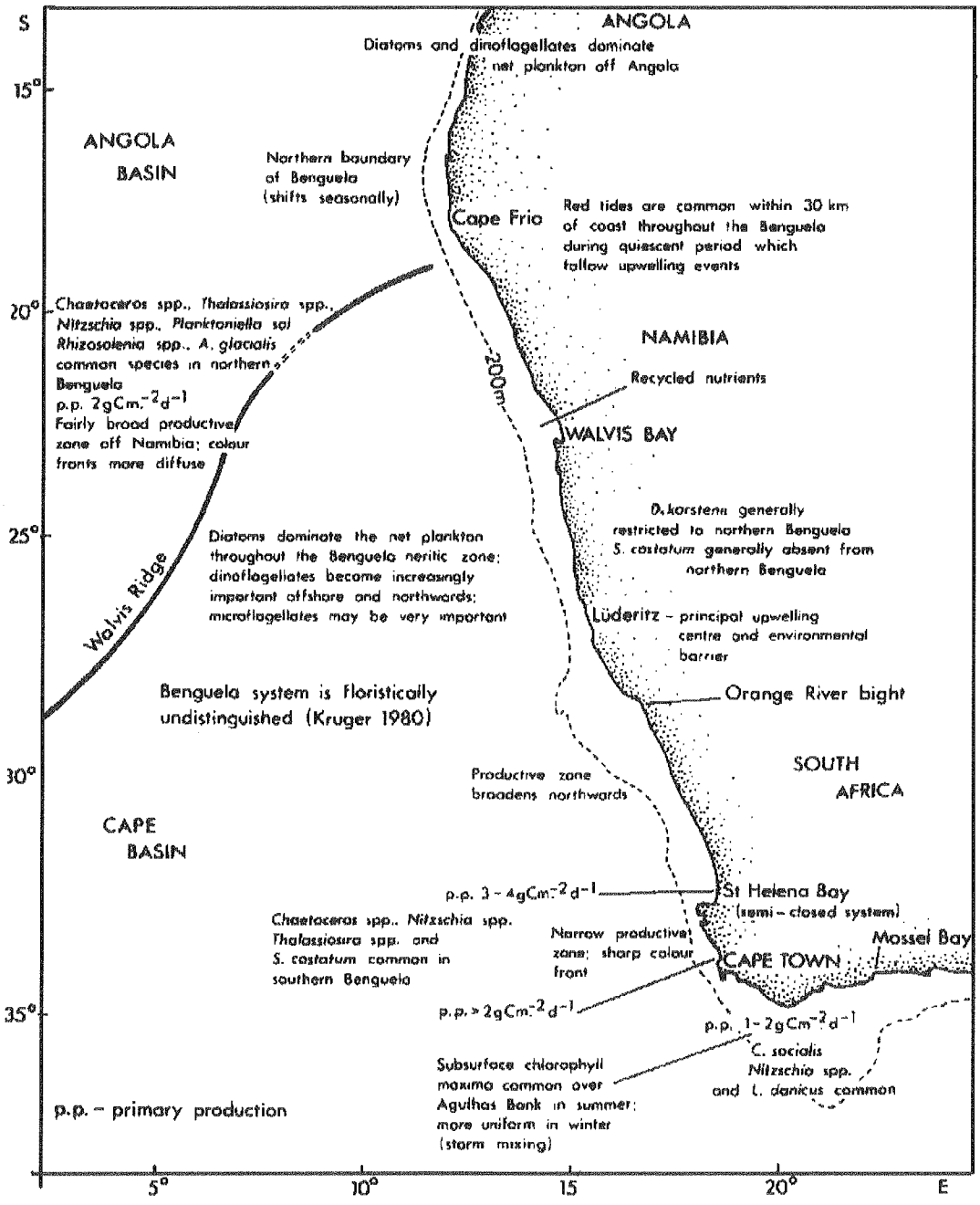

Figure 4.6: Features of phytoplankton distribution in the Benguela System (after Shannon and Pillar 1986).

Although diatoms are reported to contribute the bulk of the phytoplankton in the Benguela current (Andrews and Hutchings 1980; Olivieri 1983), dinoflagellates are also important (Chapman and Shannon 1985). Red tides (dinoflagellate and/or ciliate blooms) may occur inshore along the coast north of Cape Point (especially in the Lamberts Bay to St Helena Bay region), usually during relaxation of upwelling cells in late summer to autumn. Such red tides (which can range in colour) may be toxic and animals, particularly filter feeding species, may accumulate toxins in their tissues. Furthermore, decomposition of red tides may strip the remaining oxygen from the water and turning it anoxic (known as a "black tide"), having catastrophic

consequences on the inshore fauna of the affected area. The massive mortality of fish, lobsters and other inter- and subtidal invertebrates between Cape Columbine and the Berg River mouth during 1994 serves as an example of a black tide.

Table 4.1: Mean concentrations of chlorophyll a in the southern Benguela system over the period 1971 to 1989 (after Brown 1992).

Season	Mean chlorophyll a concentrations ($mg.m^{-3}$)		
	Total shelf	Inshore shelf (< 200m depth)	Offshore shelf (200m – 500m depth)
All year	2.11	3.32	0.78
Spring	4.98	5.41	
Summer	2.28	3.62	0.79
Autumn	2.68	3.94	0.52
Winter	1.88	2.75	0.88

(b) Zooplankton

Features of the zooplankton distribution in the Benguela system are summarised in Figure 4.7.

Zooplankton biomass is related to that of phytoplankton, and is thus seasonal, being minimal during winter when the rate of upwelling is lower (Andrews and Hutchings 1980). Zooplankton biomass is low in newly upwelled waters, but increases as these waters age and develops substantial phytoplankton. However, zooplankton blooms lag phytoplankton blooms and thus are found 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 is best described divided into mesozooplankton (>200 µm) and macrozooplankton (>1 600 µm). Copepods dominate the mesozooplankton (Andrews and Hutchings 1980; Hutchings *et al.* 1991; Verheye *et al.* 1994), 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.

Euphausiids (18 species) dominate the macrozooplankton (Pillar 1986), of which *Euphausia lucens* and *Nyctiphanes capensis* are the most abundant in the shelf region with *E. lucens* dominating the region between Lüderitz and Cape Agulhas (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) (see Gibbons *et al.* 1992). 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.

(c) Ichthyoplankton

Ichthyoplankton comprises both fish eggs and larvae, and despite comprising a small component of the overall plankton, is important due to commercial fisheries. Features of the ichthyoplankton distribution in the Benguela system are summarised in Figure 4.7 (Shannon and Pillar 1986).

Separate spawning areas exist for pilchard (*Sardinops sagax*) off the south-western Cape and off Namibia (Figure 4.8), and it is generally accepted that there are two populations separated by the Lüderitz upwelling

cell. Within the southern Benguela system two spawning areas for pilchard once existed namely off St Helena Bay and on the Western Agulhas Bank, (Shannon and Pillar, 1986), although spawning off St Helena Bay declined to negligible levels by 1966, possibly due to overfishing (Crawford 1980).

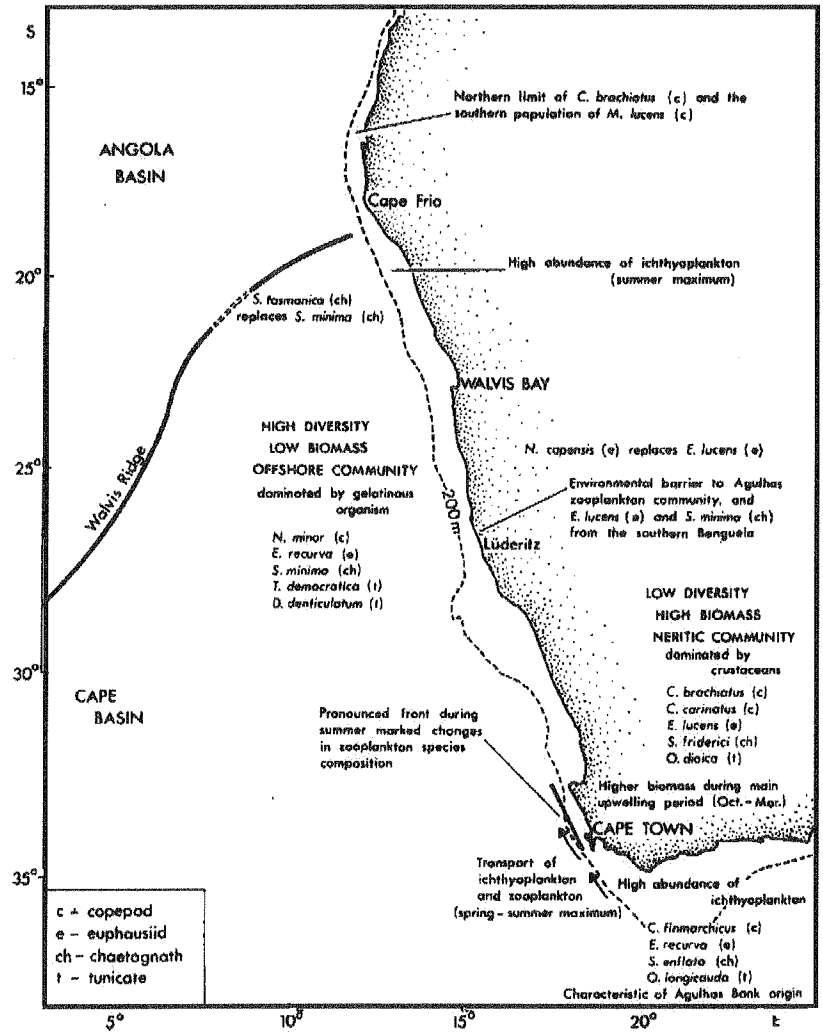

Figure 4.7: Features of zooplankton and ichtyoplankton distribution in the Benguela system (after Shannon and Pillar 1986).

As with pilchard, separate spawning areas exist for anchovy (*Engraulis japonicus*) off Namibia and the south-western Cape (Figure 4.8), and it is generally accepted that these are separate stocks. Each spring, anchovy migrate southwards from the West Coast to spawning grounds on the western Agulhas Bank (Peterson *et al.* 1992), where the fish spawn serially with frequency of spawning being dependent on food concentration (copepod biomass). Most spawning takes place to the east of Cape Point some 40 to 100 km offshore in 16 to 19°C water. Unlike pilchard and anchovy, the round herring spawns seaward of the shelf break. Horse mackerel spawns offshore in fairly deep water off the Cape (Figure 4.8).

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 (see Figure 4.9). 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.

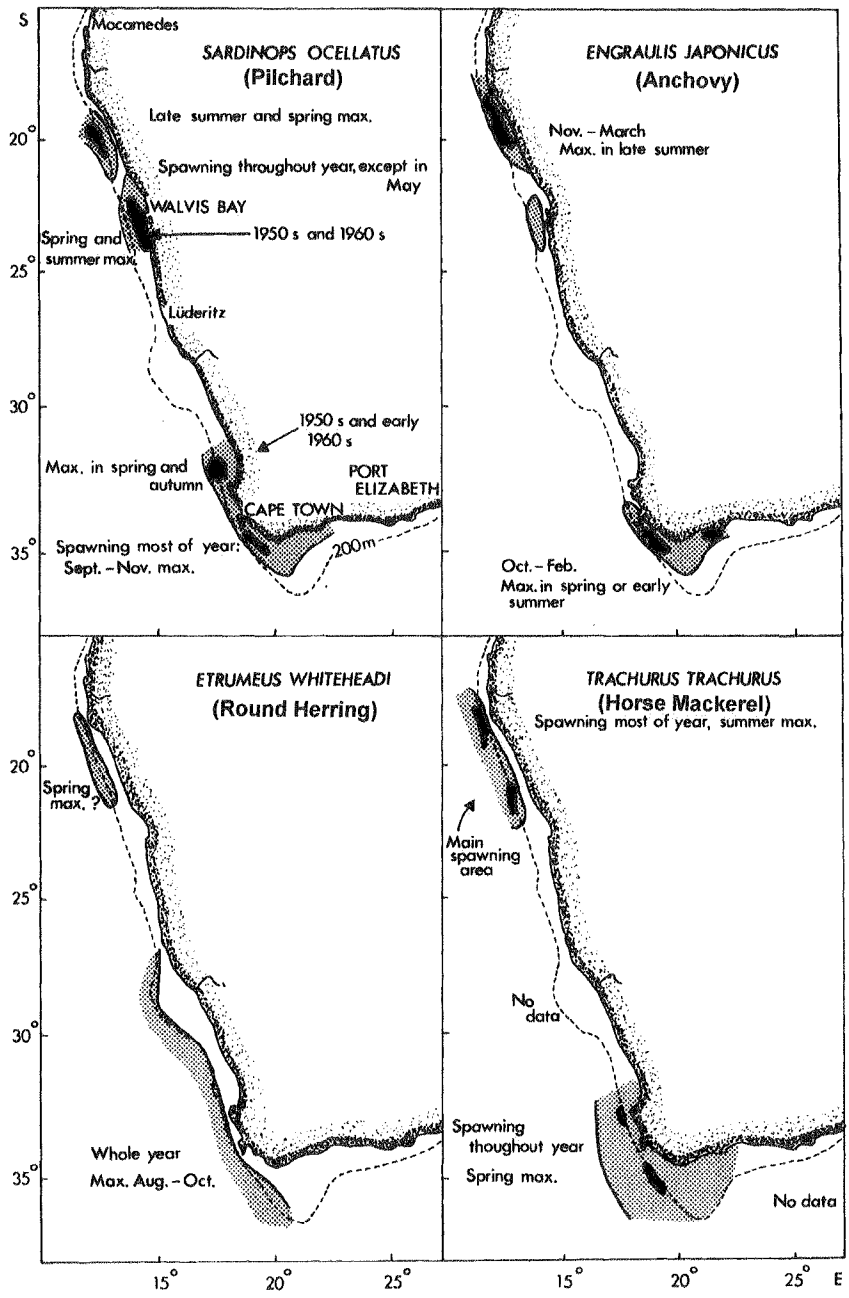

Figure 4.8: Spawning and recruitment areas for different pelagic species inhabiting the West Coast. Modified from Shannon & Pillar (1986).

4.1.3.2 Benthic macrofauna

Benthic macrofauna (species living within or above seabed sediments) are considered good indicator species with which to measure environmental impacts (Gray 1974, Warwick 1993, Salas *et al.* 2006). These organisms influence major ecological processes (e.g. nutrient cycling, pollutant metabolism, sediment stability) and serve as important prey for commercially valuable fish species (Gray 1974, Snelgrove 1998, Salas *et al.* 2006). 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).

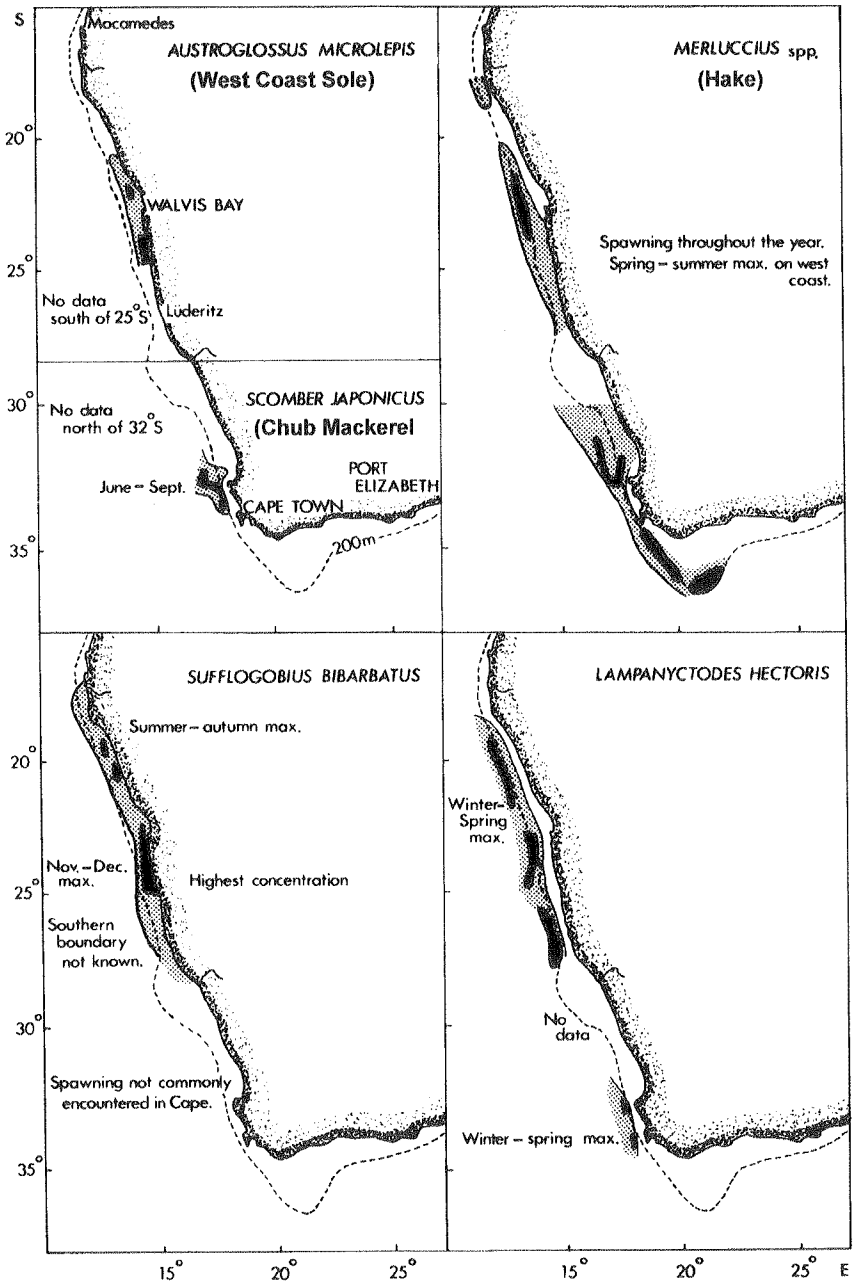

Figure 4.9: Spawning and recruitment information for a number of pelagic and demersal fish species inhabiting the West Coast. Modified from Shannon & Pillar (1986).

Living within or in close proximity to the sediment, macrofaunal communities are strongly influenced by the sediment type and texture (Gray 1974, Warwick *et al.* 1991). Apart from the strong influence of biogeography and water depth, sediment composition has been defined as one of the most important physical factors shaping benthic macrofaunal assemblages (Gray 1974, Warwick *et al.* 1991). Long-term or permanent changes in physical sediment physical 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.

According to Pulfrich (2011), 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. It is likely 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).

The sediment type within the study area (which ranges from sand to mud) supports diverse infaunal assemblages. From the shore to 80 m depth the benthic environment comprises primarily of polychaetes (bristle worms), crustaceans (largely amphipods, crabs and prawns), molluscs (bivalves and gastropods), cnidarians and some echinoderms (brittle stars and sea cucumbers). In contrast, the mid-shelf mudbelt (70 - 120 m depth) is a particularly rich benthic habitat and 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 (Pulfrich, 2011). Below this mid-depth zone, very fine sands dominate the sediment texture and crustaceans increase in relative importance in the biota, with amphipods comprising the major component at these deeper depths (Pulfrich, 2011).

Monitoring surveys undertaken by De Beers Marine have infrequently found a species of sea pen (*Virgilaria* spp.) and should, therefore, be considered rare in the habitat type occurring in the study area.

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). According to Pulfrich (2011), 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 Vulnerable Marine Ecosystems (VMEs) on the West Coast is limited. Whilst there is no sound evidence for the presence of such sensitive or vulnerable habitats or species occurring within the study area, there is a possibility that cold-water coral reefs and carbonate mounds may occur in the area. The presence of cold water reef building corals (*Solenosmilia variabilis* and possibly *Lophelia pertusa*) have been noted in Block 2A, a section of which overlays a portion of the prospecting area.

4.1.3.3 Cephalopods

On the basis of abundance and trophic links with other species, eight species of cephalopod are important and a further five species of have potential importance within the Benguela system (Table 4.2).

Table 4.2: Cephalopod species of importance or potential importance within the Benguela System (after Lipinski 1992).

Scientific Name	Importance
Important species:	
Sepia australis	Very abundant in survey catches, prey of many fish species. Potential for fishery.
Loligo vulgaris reynaudii	Fisheries exist, predator of anchovy and hake, prey of seals and fish.
Todarodes angolensis	Fisheries exist (mainly by-catch), predator of lightfish, lanternfish and hake, prey of seals.
Todaropsis eblanae	Some by-catch fishery, predator of lightfish and lanternfish, prey of seals and fish. Potential for fishery.
Lycoteuthis lorigera	Unconfirmed by-catch, prey of many fish species. Potential for fishery.
Octopus spp.	Bait and artinisal fishery, prey of seals and sharks.
Argonauta spp.	No fisheries, prey of seals.
Rossia enigmata	No fisheries, common in survey catches.
Potentially important species:	
Ommastrephes bartramii	No fisheries.
Abraliopsis gilchristi	No fisheries.
Todarodes filippovae	No fisheries.
Lolliguncula mercatoris	No fisheries.
Histioteuthis miranda	No fisheries.

4.1.3.4 Fishes

(a) Recruitment areas, distribution and movement

This section reports on species-specific recruitment and the recruitment areas, distribution and movement of post larval fishes of fishery importance, namely pelagic and demersal species. There are two groups of pelagic species: i) mainly clupeoid filter-feeding species that are planktivorous, and ii) larger predatory species that feed mostly on the smaller pelagic species including the large highly migratory tunas and billfishes.

Demersal species are those that are usually associated with the substrate and are generally found on or near the sea floor. Most demersal species are piscivorous, often migrating diurnally in the water column. Figure 4.10 depicts the recruitment areas of some important commercial fish species.

(b) Pelagic species

Nought-year-old *pilchards* recruit to the pelagic fishery along the coast north of Cape Point (particularly north of Cape Colombine) in March. Pilchard spawn on the South Agulhas Bank from August to December. The adults then migrate back up the West Coast. Eggs from the spawn drift northwards in the Benguela current in the water column and hatch after about two weeks. Thereafter the larvae develop quickly along the West Coast. The bays along the coast act as sanctuaries for these juveniles who feed on the nutrient rich waters and soon recruit to the fishery in their first year. As the year progresses surviving one to two year old fish migrate southwards again and spawn in Spring and early Summer on the Agulhas Bank. No movement of pilchard from the Western Cape into Namibia has been reported, while little movement has been reported in the opposite direction.

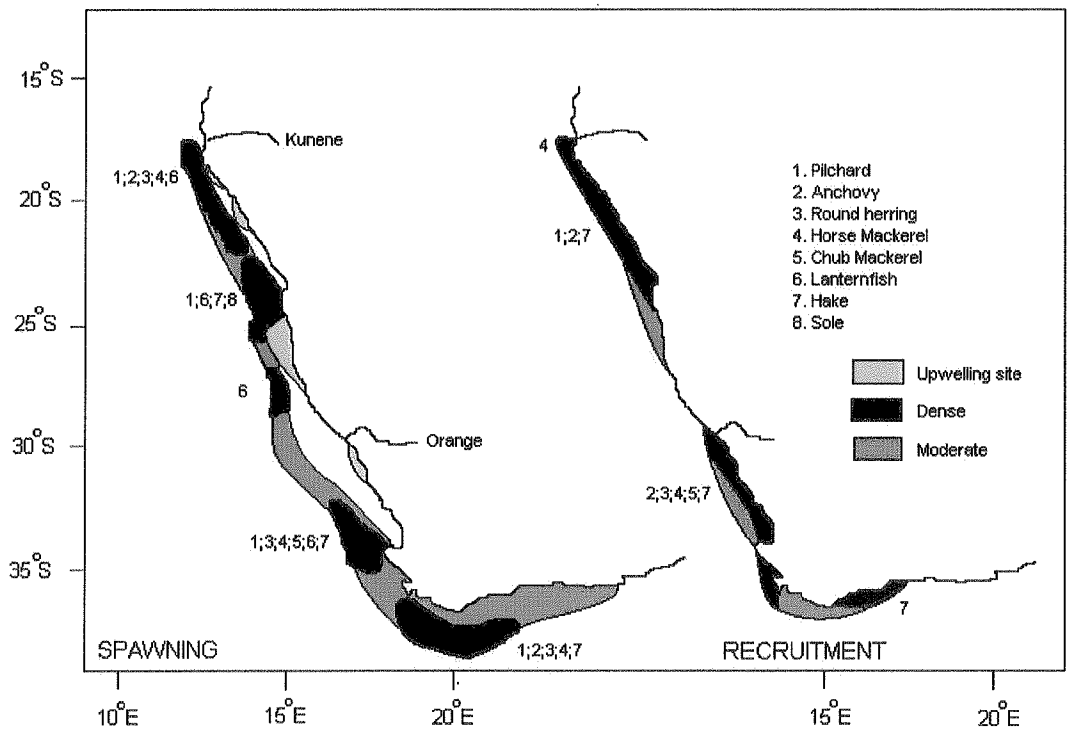

Figure 4.10: Schematic of the main spawning and recruitment areas of different fish species from the southern Benguela, in relation to upwelling centres. Modified from Crawford (1989).

Anchovy spawning movements are similar to those of pilchard (Crawford *et al.* 1987). Juvenile anchovies are often found shoaling with juvenile pilchards, round herrings and horse mackerel of similar size (juvenile pelagic fish generally form large shoals of similar sized individuals). However, as they mature and recruit to the fishery the shoals disperse into species specific shoals.

Round herring juveniles, like those of pilchard and anchovy, also move south at the end of winter. Round herring are caught by the purse seine fleet on the West Coast predominantly from January to May and are found further offshore than pilchard and anchovy and shoal in deeper water.

The purse seine fishery also catches *horse mackerel* juveniles. Availability varies inter annually with catches of juveniles highest on the West Coast between January and May.

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.

A number of *tuna* species inhabit waters off the West Coast (Table 4.3), these usually being distributed offshore near the thermal front (at the shelf break). Their offshore distribution is also related to the presence of shoaling pelagic fish species (*e.g.* pilchard, anchovy, round herring). Many of these tuna species are found along the whole of the West Coast, although no tuna populations are permanently resident within the Benguela system, and no tuna species spawn within it. Tuna are classified as highly migratory species and the many stocks of these species are a shared resource between the coastal states on both sides of the South Atlantic.

Table 4.3: Percentage contribution of catches of some tuna species landed along the West Coast of South Africa to the overall catch of these landed within the south-eastern Atlantic during 1972-1984 (from ICSEAF Statistical Bulletins).

Common name	Scientific name	% Contribution
Longfin tuna	*Thunnus alalunga*	99.8
Yellowfin tuna	*Thunnus albacares*	31.3
Southern bluefin tuna	*Thunnus maccoyii*	20.0
Bigeye tuna	*Thunnus obesus*	99.8
Skipjack tuna	*Katsuwonus pelamis*	1.9
Eastern little tuna	*Euthynnus alletteratus*	0.8
Bullet tuna	*Auxis thazard*	-

(c) Demersal species

Hake: Adult *Merluccius paradoxus* (deep-water hake) inhabit deeper waters than adult *M. capensis* (shallow-water hake), although juvenile *M. paradoxus* mix with adult *M. capensis* at intermediate depths (250 to 350 m). Both species 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: A single kingklip stock is found between 27 and 35°S on the West Coast. Kingklip inhabit predominantly hard or rocky substrates but are also found on trawl grounds (normal soft muddy